# Container Deposit Study:

## *Phase III: Costs and Benefits of Residential Packaging and Paper Product Recycling in Washington State*

King County
Department of Natural Resources and Parks
Solid Waste Division
Waste Prevention • Resource Recovery • Waste Disposal
www.kingcounty.gov/solidwaste

Seattle Public Utilities

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## The Responsible Recycling Task Force

The Responsible Recycling Task Force (RRTF) was formed by King County's Solid Waste Advisory Committee (SWAC) and Metropolitan Solid Waste Management Advisory Committee (MSWMAC) in April of 2018 to respond to changes in international recycling markets and to develop a coordinated approach to improving recycling in the region. The task force consists of representatives from the King County Solid Waste Division, the City of Seattle, cities in King County, solid waste management companies, and other stakeholders. This report was prepared for the RRTF by the King County Solid Waste Division in collaboration with Seattle Public Utilities.

## Contact and Information

For more information on the Responsible Recycling Task Force and the resulting recommendations, go to the Responsible Recycling Task Force website.

## Authors

This report was authored by Eunomia Research & Consulting Inc., with support from Cascadia Consulting and C+C.

## Disclaimer

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# Executive Summary

This report is the third in a series of three produced for the King County Responsible Recycling Task Force (RRTF) to address Action Item 1E from the Recommendations Report, published in January 2019, which was to:

> ***Develop a feasible model for beverage container stewardship in Washington similar to the Oregon Beverage Recycling Cooperative model.***

This report builds on the Extended Producer Responsibility (EPR) model developed in the March 2020 report for King County, *Extended Producer Responsibility Policy Framework and Implementation Model: Residential Recycling of Packaging and Paper Products in Washington State*.[1]

This study assesses the impacts of implementing a deposit refund system (DRS) for beverage containers in Washington State. In addition, it studies the impacts of an EPR system for packaging and paper products (PPP) generated from consumers in the home. This study considers the costs as well as the environmental, social and economic benefits of several models of DRSs and/or EPR systems.

## Summary of Potential Future System Scenarios Modeled

This study presents the costs and benefits of seven potential future systems (FS) for PPP recycling that could be implemented under a policy framework utilizing EPR principles and compares these to the current system (baseline). All FSs are highlighted in Figure and summarized below.

FS 1 applies EPR principles to beverage containers only and utilizes a DRS as a mechanism for collection. A second set of FSs (2-4) applies EPR to all residential PPP without the use of a DRS, illustrating different possible configurations of recycling collection services and their associated costs and benefits. A third set of FSs (5-7) applies EPR to all PPP and also includes the use of DRS for beverage containers.

All the FSs, with the exception of FS 1, include the switch to an EPR model of recycling in which the responsibility for covering costs of the recycling system shifts from jurisdictions and ratepayers to producers. The EPR implementation scenarios assume the conditions listed in Box 1.

A summary of the structure of all the systems is provided below.

**Box 1: Assumptions for EPR for PPP**

- The percentage of single-family households with access to curbside service and multifamily households with on site recycling increases from 89% to 100%, providing convenient, equitable access to all.
- A common set of PPP materials are collected curbside/on-site, as detailed in Section 1, with flexible/film plastic and expanded polystyrene (EPS) collected at drop-off locations;
- Producers of PPP are required to fund and coordinate the recycling (i.e. collection, transportation, sorting and marketing) of materials from the residential sector;
- Producers are authorized to form a "Producer Responsibility Organization" (PRO) to manage the responsibilities established in the policy; and
- A legislated "regulatory authority" is appointed that has authority to monitor compliance and enforce legal requirements.

**Current System:** Under the current system, 21% of households in Washington do not automatically receive curbside or on-site recycling services and the materials collected in curbside programs vary from jurisdiction to jurisdiction, preventing a consistent statewide approach to educational efforts. There are some drop-off collection programs for flexible plastic and polystyrene foam packaging, but access to drop-off locations is inconsistent and geographically limited, and end markets for collected materials are unreliable.

**FS 1 – Current System with DRS**: This FS considers the impacts of adding a DRS for beverage containers paid for by providers to the current system of recycling services. System design principles and stakeholder roles and responsibilities include:

- **Legislated redemption rate target of 90%** with an initial deposit of $**0.10 deposit** for **all beverage container types**, including wines and spirits, milk and milk alternative based drinks. **One redemption point per 5,000 residents** and with no households required to travel more than five miles to a redemption point.
- **Producers, manufacturers, and first importers** are designated as responsible parties for the DRS. The cost of the system is paid for by producers through a producer fee that is administered through the PRO.
- **PRO** set up by producers to oversee the operation of and financially manage the DRS on their behalf.
- **Retailers** greater than or equal to 5,000ft$^2$ are obligated to redeem deposit bearing containers, unless they are granted an exemption from the PRO.
- **Consumers** redeem containers through in-store or at-store redemption points or redemption centers using reverse vending machines (RVMs) or bag drops.
- **MRF operators** claim the deposit refund on containers that enter their facilities if separated and verified through a counting/redemption center. MRFs may also contract with the PRO to provide counting services.
- **State government or government-appointed agency is** the program administrator, responsible for oversight and auditing of the system.

**FS 2 (EPR) - Enhanced Collection, Coverage and Capture:** This EPR system requires the producers of PPP to finance the statewide residential recycling system. FS 2 assumes the EPR factors listed in Box 1 plus 100% coverage of all households with recycling services equivalent to their trash services (except that households with new curbside recycling will be required to recycle glass through drop-offs) and a common set of materials collected in curbside recycling with drop-off for EPS and film plastic. Services continue to be delivered at the current frequency using the same collection methodologies, with increased and coordinated education and engagement. Through the coverage of a greater number of households with recycling services and collection of more materials more consistently, the capture rate across the state is assumed to rise to equal to the current capture rate in single family households in the City of Seattle. In multi-family households, capture rates for each material were assumed on average to be slightly above 70% of the capture rates for single family households in the City of Seattle.

**FS 3 (EPR) – Aligned Collection Methodology and Frequency – single stream recycling (excluding glass) every other week with separate glass collection every fourth week:** Similar to FS 2, except that all households receive the same service at the same frequency, providing consistency across the state. Glass is collected separately to preserve the integrity of all PPP materials.

**FS 4 (EPR) – Aligned Collection Methodology and Frequency - dual stream, fibers and metals/plastics/glass (MPG):** Households receive a weekly recycling collection that alternates material by week (i.e. week one: fibers, week two: MPG). This system would be an increase in frequency to most households in Washington. No increase in capture rate has been assumed under this FS compared to the other EPR single stream systems, though this is a possible outcome. The modeled performance benefits of this system are: increased capture over the baseline and increased bale purity levels, attracting higher and more stable material sale prices.

**FS 5 (EPR) – Enhanced Collection, Coverage and Capture with DRS:** This FS is similar to FS 2, but in addition, there is a DRS in order to maximize the capture rates of beverage containers.

**FS 6 (EPR): Aligned Collection Methodology and Frequency – single stream with glass to drop-off plus DRS:** FS 6 is similar to FS 3, but with the addition of a DRS and without curbside glass collection every fourth week.

**FS 7 (EPR) – Aligned Collection Methodology and Frequency – dual stream plus DRS:** This is the same as FS 4, but with the addition of a DRS.

**Figure 1: Overview of Future Systems Modeled Against the Current System**

| | BASELINE Current System | FUTURE SYSTEM 1 Current System + DRS | FUTURE SYSTEM 2 EPR + Enhanced Collection and Coverage | FUTURE SYSTEM 3 EPR + Aligned Universal Collection Option 1 | FUTURE SYSTEM 4 EPR + Aligned Universal Collection Option 2 | FUTURE SYSTEM 5 EPR + Enhanced Collection + DRS | FUTURE SYSTEM 6 EPR + Aligned Universal Collection Option 1 + DRS | FUTURE SYSTEM 7 EPR + Aligned Universal Collection Option 2 + DRS |
|---|---|---|---|---|---|---|---|---|
| **EPR** | N | Partial, only for DRS | Y | Y | Y | Y | Y | Y |
| **DRS for Beverage Containers** | N | Y | N | N | N | Y | Y | Y |
| **Single Family Curbside / Multi-Family On-Site** | 89% of HH | 89% of HH | 100% of HH | 100% of HH | 100% of HH | 100% of HH | 100% of HH | 100% of HH |
| **Common Set of Materials Collected** | N | N | Y | Y | Y | Y | Y | Y |
| **Aligned Common Collection System** | N | N | N | Y<br>Biweekly collection of paper, plastics & metals<br>Collection of glass every four weeks | Y<br>Biweekly collection of metals, plastics & glass<br>Alternate Biweekly collection of paper | N | Y<br>Biweekly collection of paper, plastics & metals<br>Glass collected only through drop-off | Y<br>Biweekly collection of metals, plastics & glass<br>Alternate Biweekly collection of paper |
| **Post Collection Sorting System** | Existing | Existing plus DRS | Existing with Secondary MRF | Existing with Secondary MRF | Dual Stream MRF | Existing with Secondary MRF plus DRS | Existing with Secondary MRF plus DRS | Dual Stream MRF |

## Costs, Benefits and Stakeholder Impact

### Costs and Benefits

Each of the FSs has been evaluated against a set of cost, environmental and social metrics, as follows:

*Cost*

- Cost per ton recycled;
- Total cost;
- Annual PPP disposal cost savings;
- Value of materials recycled;
- Gross Value Added (GVA);
- Social cost of carbon reduction; and
- Net cost benefit per ton recycled.

*Environmental and Social*

- Recycling rate;
- Tons recycled;
- MT$CO_2$e emissions reduced;
- Litter reduction; and
- Jobs.

Figure 2 shows the performance of each FS against each of the cost-related metrics and Figure 3 shows the performance of each FS against the environmental metrics.

No one FS outperforms the others against every metric. Those that have been modeled to deliver the highest recycling rates have higher cost, because the system is targeting the more difficult PPP to recycle and covering both urban and rural single and multifamily households, which increases the total cost of the system. The highest performing FS has been highlighted for each metric in Figure 2 and Figure 3 , commentary is provided below on the three main metrics:

- Recycling rates;
- Cost per ton recycled;
- Net benefit per ton recycled, which incorporates the monetized GHG benefits (social cost of carbon) as well as the GVA which accounts for any change in the number of jobs.

FS 7 delivers the most environmental and social benefits, while FS 6 has the lowest cost per ton recycled, both of these systems include a DRS.

**Figure 2: Overview of Environment and Social Benefits**

| | BASELINE Current System | FUTURE SYSTEM 1 Current System + DRS | FUTURE SYSTEM 2 EPR + Enhanced Collection and Coverage | FUTURE SYSTEM 3 EPR + Aligned Universal Collection Option 1 | FUTURE SYSTEM 4 EPR + Aligned Universal Collection Option 2 | FUTURE SYSTEM 5 EPR + Enhanced Collection + DRS | FUTURE SYSTEM 6 EPR + Aligned Universal Collection Option 1 + DRS | FUTURE SYSTEM 7 EPR + Aligned Universal Collection Option 2 + DRS |
|---|---|---|---|---|---|---|---|---|
| **PPP Recycling Rate** | 49% | 55% | 69% | 71% | 72% | 74% | 73% | 75% ★ |
| **PPP Recycled (Thousand Tons)** | 525K | 589K | 737K | 753K | 767K | 787K | 783K | 804K ★ |
| **MT CO2e Avoided (Millions)** | -1.399M | -1.488M | -1.964M | -1.970M | -2.050M | -1.967M | -2.024M | -2.088M ★ |
| **Beverage Related Litter Reduction from Baseline (%)** | | 80% | | | | 80% | 80% | 80% |
| **Jobs (Direct, Indirect and induced)** | 3,870 | 5,700 | 5,530 | 5,420 | 6,490 | 7,310 | 6,410 | 7,850 ★ |

★ = Best Performer in Category

**Figure 3: Overview of Cost and Financial Benefits**

| | BASELINE Current System | FUTURE SYSTEM 1 Current System + DRS | FUTURE SYSTEM 2 EPR + Enhanced Collection and Coverage | FUTURE SYSTEM 3 EPR + Aligned Universal Collection Option 1 | FUTURE SYSTEM 4 EPR + Aligned Universal Collection Option 2 | FUTURE SYSTEM 5 EPR + Enhanced Collection + DRS | FUTURE SYSTEM 6 EPR + Aligned Universal Collection Option 1 + DRS | FUTURE SYSTEM 7 EPR + Aligned Universal Collection Option 2 + DRS |
|---|---|---|---|---|---|---|---|---|
| Cost per Ton Recycled (USD) | $471 | $523 | $454 | $503 | $529 | $532 | $442 ★ | $542 |
| Total Cost of System (Millions, USD) | $247M ★ | $308M | $334M | $379M | $406M | $419M | $346M | $436M |
| PPP Disposal Cost Savings (Millions, USD) | $0 | $7.3M | $25.9M | $27.9M | $27.9M | $31.4M | $30.7M | $31.9M ★ |
| Material Value (Millions, USD) | $21.5M | $50.7M | $37.4M | $36.9M | $44.9M | $64.3M | $64.6M | $71.4M ★ |
| GVA (Millions USD) (Direct, Indirect, Induced) | -$497M | -$848M | -$705M | -$694M | -$834M | -$1,050M | -$928M | -$1,132M ★ |
| Social Cost of Carbon (Millions, USD) | -$105M | -$112M | -$147M | -$148M | -$154M | -$148M | -$152M | -$157M ★ |
| Net Benefit per Ton Recycled (USD) | -$542 | -$998 | -$643 | -$558 | -$704 | -$939 | -$886 | -$1,012 ★ |

★ = Best Performer in Category

### Recycling Rate

In 2017, Washington achieved a residential PPP recycling rate of 49% driven by paper and cardboard which accounts for 73% of the total PPP recycled. Results of the modeling found that:

- FS 1: DRS - without making any changes to the current system, adding a DRS would increase the overall recycling rate by almost 6%, to 55%, resulting in 590,700 tons of material recycled, and almost doubling the rigid plastic recycling rate to 40%.
- All of the FSs with DRSs outperform the equivalent system without DRS.
- FS 7 is the highest performing system, estimated to deliver a 75% residential PPP recycling rate.

The recycling performance of each system is provided in Table 1 and shows that under FS 2 (whereby all households have a curbside or on-site service for a common set of material and performance increases to that of the City of Seattle), the recycling rate increases to 69%.

**Table 1: Projected Recycling Rates for Major Material Categories for each Future System**

| Material | Current System | FS1 Current System with DRS | FS2 EPR Enhanced Collection + Coverage | FS3 EPR Aligned Collection (SS + G) | FS4 EPR Aligned Collection Dual Stream | FS5 EPR Curbside + DRS | FS6 EPR Aligned Collection SS Glass to Drop-off + DRS | FS7 EPR Aligned Collection Dual Stream + DRS |
|---|---|---|---|---|---|---|---|---|
| All Plastic | 16% | 27% | 37% | 37% | 38% | 43% | 43% | 43% |
| Rigid Plastics | 22% | 40% | 51% | 51% | 53% | 61% | 61% | 62% |
| Flexible Plastics | 5% | 5% | 12% | 12% | 12% | 12% | 12% | 12% |
| All Metals | 47% | 59% | 58% | 58% | 64% | 66% | 66% | 72% |
| Steel | 39% | 39% | 62% | 62% | 63% | 62% | 62% | 63% |
| Aluminum | 53% | 72% | 58% | 55% | 65% | 69% | 69% | 78% |
| All Paper and Card | 56% | 57% | 80% | 80% | 81% | 80% | 80% | 81% |
| All Glass | 63% | 90% | 66% | 79% | 78% | 91% | 87% | 94% |
| Total | **49%** | **55%** | **69%** | **71%** | **72%** | **74%** | **73%** | **75%** |

*Source: Eunomia*

### Cost per Ton Recycled

**FS 6 (where single stream recycling without glass is collected every other week at the curbside and glass is collected via a network of drop-offs, the infrastructure for which is optimized alongside the DRS infrastructure) presents the lowest cost per ton recycled system.** Glass beverage containers account for 81% of the glass PPP stream. When removed from the curbside collection through a DRS, the quantity of glass to be captured drops significantly making collection through drop-off an option, leading to a reduction in curbside collection costs. The curbside collection costs under FS 6 are 48% less than the direct curbside costs of the system which has the highest collection costs (FS 4 dual stream without DRS).

Disposal cost savings resulting from less material being disposed of as residues from a MRF are not included in this cost per ton recycled analysis, but are estimated to deliver an additional $30 savings in each EPR system. There would also be savings associated with collecting less PPP in the trash, but these savings are also excluded in this study.

### Total Net Benefit Per Ton Recycled

The net cost per ton recycled is calculated as follows:

> ***Total Net Benefit per Ton Recycled = (Total System Cost – Material Revenue – GVA – Social Cost of Carbon)/ Tons Recycled***

When the social cost of carbon and the GVA is factored into total system costs for the PPP residential recycling in Washington, all recycling systems, current and future, result in a net benefit to society. When a price is placed on carbon, the more that emissions-intensive materials (e.g. aluminum) are recycled, the greater the GHG savings. This is due to a greater supply of the secondary material collected, which is assumed to reduce the need for primary sources of aluminum. The GVA is primarily driven by the number of people employed in the recycling sector, so those systems that create more jobs contribute more to the economy in the form of GVA. The systems that deliver the highest net benefit per ton are those that include a DRS (FSs 1, 5, 6 and 7). All of the systems with DRS outperform the equivalent system without DRS. The reasons for this are:

- A DRS results in an additional 860 direct jobs created;
- DRSs maximize the capture rate of aluminum cans, which result in significant reduction of GHG emissions;
- DRSs delivers a higher material revenue for PET, due to the level of purity of bales.

The system with the highest net benefit is FS 7.. Even if the social cost of carbon is removed, the FSs that include DRS still provide the greater net benefits than those without, because of their impact on increased recycling rates for key high-value materials and on job creation and GVA.

An additional benefit of FSs including DRS that is not included in this calculation is the monetized amenity benefit of living in a less littered environment. A DRS system helps reduce litter by capturing beverage containers that would be littered when consumed outside of the home. For FSs that include a DRS, this is an estimated additional $171M in benefit, which equates to $5 per household per month.

## Stakeholder Impact

Moving to a producer managed and financed recycling system will impact a range of stakeholders. Table 2 summarizes some of these impacts when a DRS system is introduced and when EPR for all PPP materials is in place.

Table 2: Stakeholder Impacts for EPR and DRS Systems

| Stakeholder | DRS for Beverage Containers[i] | Full EPR for all PPP |
|---|---|---|
| Municipalities | Less material collected at the curbside in both recycling and trash streams, potential to review collection frequencies and container sizes to reduce costs.<br><br>Potential for **reduced MRF tipping fees,** if less material collected at the curbside (~$7M)<br><br>**Disposal cost tipping fee savings (~$7M)**<br><br>**6% increase in recycling rate** without the need for jurisdictions to increase household rates. | **Producers cover the cost of recycling** based on agreed cost recovery mechanisms. Municipalities no longer have to recover the cost of PPP services from households.<br><br>Option to manage, provide directly or contract the services allowing PPP services to be aligned with streams - trash and organics.<br><br>Disposal cost tipping fee savings (FS 7 ~$32M) |
| Waste Haulers | Waste haulers will have the **opportunity to provide services** to the DRS PRO as well as to continue to provide services to municipalities. The PRO will have over $43M annually of collection related service to procure from the market to service the redemption network. | Continue to provide services to municipalities under contract.<br><br>**More properties to collect from** as a result of 100% coverage and more material to collect as a result wider range of materials targeted at the curbside. |
| MRF operators | While there will be a loss to the MRF from reduced tipping fees and material revenues, the value of the deposit containers passing through the MRF, which can be redeemed, can make up for some or all of this loss. Additionally, MRFs can be provided **access to the unclaimed deposits** when targets are met, which will deliver ~$73M over the three-year DRS implementation period. Unclaimed deposits when producers do not meet | **Greater quantity of material will be collected at the curbside** and as such require sorting, resulting in a potential increase in revenue from tipping fees (FS 7 ~$20M).<br><br>Under EPR, one option is that producers own the material collected and sorted, under this |

[i] DRS is a form of EPR for beverage containers, as producers have a financial and operational responsibility to support the system

| Stakeholder | DRS for Beverage Containers[I] | Full EPR for all PPP |
|---|---|---|
| | targets in initial years will be available for investment in existing sorting facilities to maximize capture and value of other PPP. Revenue losses from reduced tipping fees and material sales only relevant when DRS implemented without wider EPR (see EPR impacts on the right).<br><br>**Option for MRF to also provide counting center function** under contract to the PRO providing an addition opportunity to increase revenue. Counting center function costs estimated at almost ~$47M. | assumption MRF operators will no longer have to shoulder the material risk associated with fluctuating markets.<br><br>Level of uncertainty as to how the PRO may contract for services over the long term especially if there is a desire to move towards a dual stream system, which will require a new sorting facility network. Opportunity to provide a broader range of services to the PRO including transfer and secondary processing. |
| Washington State | **Significant increase in direct, indirect and induced jobs** (+1,830) and associated annual GVA (~+$351M) resulting from the DRS.<br><br>**More high value materials captured for recycling**, supporting a circular economy (~+64k tons per annum (tpa)).<br><br>**Reduction in GHG emissions** (additional savings of ~89M MTCO$_2$e compared to the baseline).<br><br>**80% reduction in beverage related litter**. | **Additional direct, indirect and induced jobs** (FS 7 ~+3,970) and associated annual GVA (FS7 ~+$635M) resulting from increase in the amount of PPP collected and recycled.<br><br>**More high value materials captured for recycling**, supporting a circular economy (FS 7 ~+280k tpa).<br><br>When material specific targets are set high, **producers will invest in developing material markets** and infrastructure necessary to meet the targets. |
| Producers | Producers are required to meet **redemption targets** and to fund and coordinate the recycling (i.e. collection, transportation, sorting, and marketing) of beverage containers materials to ensure the redemption and geographical targets are met.<br><br>Producers are effectively responsible for the end-of-life management of their beverage containers. Estimated cost to producers of ~$59M. | **Producers of PPP are required to fund and coordinate recycling** (i.e. collection, transportation, sorting, and marketing) of materials from the residential sector and to ensure material specific targets are met and to educate households on the services offered. Producers are effectively responsible for the end-of-life management of their PPP. Estimated cost to |

| Stakeholder | DRS for Beverage Containers[l] | Full EPR for all PPP |
|---|---|---|
| | Reduction in litter, reducing reputational damage associated with littered containers in the environment | producers ranging from $346M to $436M per annum. |
| Retailers, large and small | **Options for involvement in the DRS**, either: return at retail; return to retail (parking lot bag-drops); or exemption if it can be demonstrated that there are sufficient redemption points to meet geographical coverage target. Handling fee, calculated based on cost coverage, paid to retailers for their role in supporting redemption. Increase in footfall through stores as the value of the deposit will mean that redeemers are also consumers. Technology driven redemption routes reduced retailer time. Bag drop program reducing retailer involvement under the system.<br><br>**Small businesses, under 5,000 sq ft not required to redeem under the system and can chose to opt-in.** | No impact. |
| Households | **Access to two recycling systems, greater incentive to recycle.**<br><br>**Reduction in litter** increases public amenity of local environment.<br><br>No increase in household rates (waste management fees). | **No longer required to pay for PPP recycling services**, currently total cost of recycling estimated at ~$247M equating to per household annual savings of ~$78.[ll]<br><br>**Ability to recycle a broader range of materials**.<br><br>Increased spending on recycling education to ensure households correctly participate in recycling programs. |

[ll] It is possible that producers may pass on some or all costs to consumers through price increases, which would reduce the savings to residents.

| Stakeholder | DRS for Beverage Containers[I] | Full EPR for all PPP |
|---|---|---|
| Low income | Low income families that rely on bottled water could be impacted as they would be required to pay $0.10 more that the current price for the deposit on each container. If the empty container is returned, this outlay is only temporary, as the deposit could be recovered once the container returned. However, there is a potential burden associated with this initial payment. This payment could be mitigated by implementing a "deposit holiday" for the first week of the DRS program for non-carbonated water only. This would work as follows:<br>▪ Day 1 of DRS: Deposit initiated on all beverages but not paid by the consumer on non-carbonated water.<br>▪ Day 8 of DRS: Deposit paid on non-carbonated water.<br>This would allow low income households to purchase essential beverages during the first week of the new program without the burden of the deposit, but still be able to claim the deposit when returning the container, as if they had paid it. The producers would cover the cost of the deposit on all non-carbonated water sold in the first week. The cost of this to producers would be just over $3.2M, assuming all of those containers are returned. If only 70% are returned, then the cost would only be $2.3M and only $1.6M if only half redeemed. This program would alleviate the burden of an initial outlay of the deposit with the implementation of the DRS for non-carbonated water. [III]<br>Redemption locations located on transit routes and at retailers and other commonly visited locations will make redemption convenient and easy. | **No longer required to pay for PPP recycling services**. Average per household saving per annum of ~$78.[IV] |

[III] These figures are only for water, but this program could be extended to milk and other essential beverages.
[IV] It is possible that producers may pass on some or all costs to consumers through price increases, which would reduce the savings to residents if they purchased those products.

| Stakeholder | DRS for Beverage Containers[l] | Full EPR for all PPP |
|---|---|---|
| Rural areas | Able to recycle beverage containers at local redemption points that will be on transit routes. | **Coverage of curbside services extending to all households** ensuring all rural households receive recycling services. |
| Homeless | Ability to collect containers that are littered, providing a **source of income**. | No impact. |

## Conclusion

In this study, the existing residential recycling system (baseline) has the lowest overall system cost (but not the lowest per ton recycled cost). However, it is the lowest preforming system of those modeled and delivers the least benefits compared to other scenarios. This outcome indicates that the introduction of EPR for PPP and DRS, together or separately, would both result in a considerable increase in the amount of material recycled. As a result, the net benefits generated from residential recycling of PPP in Washington, even using conservative assumptions. This is evident in every future system modeled, where the overall recycling rate increases over the baseline.

**FS 1, which adds a DRS to current services and captures 90% of beverage containers, will increase the recycling rate by 6% without the need for a full EPR system or any increase in residential recycling fees or rates**.

**FS 7, which is a full EPR system and collects PPP from all households via a dual stream curbside collection system that alternates fiber and MPG on a weekly basis and includes a DRS, will deliver the greatest environmental and social benefits of the systems modeled, with an overall recycling rate above 75%**; 2.088M MTCO$_2$e of GHG emissions avoided; 7,860 jobs created with a GVA to the Washington economy of $1,132M. **FS 6, which operates a DRS alongside EPR for other PPP is estimated to deliver a recycling rate of 74% and also delivers a lower cost per ton compared to the baseline.** In general, the direct cost of recycling, presented as the cost per ton recycled, increases as more material is collected from all households, urban and rural. In FS 6, much of the glass is captured by the DRS and the remaining glass can be collected through drop-off locations. Some of the drop-offs can be co-located with the DRS infrastructure resulting in a reduction in overall costs. FS 6 delivers a lower cost per ton recycled and delivers a total societal benefit of $693M.

Performance targets set under an EPR policy should be aware of what is currently achievable, but also seek to drive investment and create future systems that can maximize the amount of material recycled and, in doing so, reduce GHG emissions. Targets should go beyond what is presented here as possible, they should increase over time and be phased to enable the development of improved infrastructure. Specific performance targets for beverage containers should be implemented as well, since a DRS is proven to be able to deliver a recycling rate of 90%. Without a DRS, recycling rates in excess of 75% are less likely to be achieved.

A future system that can yield high recycling rates, create jobs, deliver the most material back to the circular economy and reduce GHG emissions to the maximum extent, is one that includes both a DRS and an improved, expanded, and harmonized curbside recycling system for all residents, provided under an EPR policy framework. In this study, the greatest net benefits are achieved through FS 7, but the largest increase in recycling per dollar spent is in FS 6. Implementing any of the FSs modeled will provide a large increase in the benefits of the recycling system for Washington, but a combination of EPR and DRS provides the most optimal system possible. Washington should consider its priorities and the current economic, social and environmental benefits that are possible, as demonstrated through this study, when determining the future of the state’s recycling system.

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# Glossary

| Term | Definition |
|---|---|
| Bag Drop | A redemption option for deposit return systems in which consumers drop-off filled bags of empty beverage containers to a designated location. Beverage containers are later verified and counted, and consumers are refunded their deposits through a digital account. |
| Bale | A compacted and wire-bound cube or block of recyclable material.[2] |
| Baseline | PPP curbside, on-site and drop-off services provided to households in Washington in 2017 also referred to as the current system determined from data in Zero Waste Washington's *State of Residential Recycling and Organics Collection.*[3] Used as a comparison to assess benefits of future systems |
| Capture Rate | Material collected for recycling over material generated. |
| Commercial Sector | Waste generators that include private commercial businesses, industrial operations, and institutions. |
| Counting Center | A facility in which redeemed deposit containers are counted and verified through bulk counting machines. |
| Contamination | Unaccepted material or contaminants in a recycling or organics stream. Common recycling stream contaminants include electronics and small appliances, tanglers like cords and garden hoses, diapers, household hazardous waste, textiles and shoes, furniture, etc. |
| Curbside Collection | The collection method by which waste generators deposit specified materials in bins, carts, or dumpsters, and place those at the street or curb for periodic emptying by collectors. [4] |
| Current System | PPP curbside, on-site and drop-off services provided to households in Washington in 2017 also referred to as the current system determined from data in Zero Waste Washington's *State of Residential Recycling and Organics Collection.*[5] Used as a comparison to assess benefits of future systems. |
| Deposit | A sum of money required to be exchanged for a product in addition to the purchase price, in order to incentivize its return to the system and which is returned to the purchaser of the product when it is returned. |

| Term | Definition |
|---|---|
| Deposit Initiator | The first bottler, distributor or agent to collect the deposit on a beverage container. Also known as "producers," see definition below. |
| Deposit Return System (DRS) | Also called container deposit systems or "bottle bill," these programs place a refundable deposit on beverage containers which is returned to consumers when they redeem empty containers to a redemption location. As producers are responsible for costs of implementing this system, DRS is considered a form of EPR for beverage containers. |
| Direct Impact | Jobs and GVA resulting from organizations managing and contracted to supply waste management activities (e.g. collection agent, sorting facility worker, etc.). |
| Distributor | Refers to a person who engages in the sale of beverages in beverage containers to retailers in the state. |
| Drop-off | A form of collection of household recyclables wherein the generators deliver the items to a central aggregation location.[6] |
| Dual Stream | A curbside recycling practice in which two different groups of recyclable materials are collected separately, often in two different containers. In many jurisdictions, dual stream programs collect cans, bottles, and other containers separately from paper and cardboard. [7]. |
| Expanded Polystyrene (EPS) | A rigid cellular plastic foam found in a multitude of shapes and applications, often referred to by the brand name "Styrofoam." |
| Extended Producer Responsibility (EPR) | A mandatory type of product stewardship that includes, at a minimum, the requirement that the manufacturer's responsibility for its product extends to post-consumer management of that product and its packaging. There are two related features of EPR policy: (1) shifting financial and management responsibility, with state government oversight, upstream to the manufacturer and away from the public sector; and (2) providing incentives to manufacturers to incorporate environmental considerations into the design of their products and packaging. |
| Free-riding | When one firm (or individual) benefits from the actions and efforts of another without paying or sharing the costs. |
| Future System 1 (FS 1) | Potential future option for recycling services in Washington that includes all current services plus the addition of a deposit return system for beverage containers. |

| Term | Definition |
| --- | --- |
| Future System 2 (FS 2) | Potential future option for recycling services in Washington that assumes that services continue to be delivered at the current frequency using the same collection methodologies, which vary from jurisdiction to jurisdiction. However, services are extended to all households for 100% coverage. A common set of materials is collected curbside across the state, capture rates are increased to that being achieved in the City of Seattle and EPS and plastic film are accepted at drop-offs. Additional secondary processing of residues and bales of #3-#7 plastics. |
| Future System 3 (FS 3) | Potential future option for recycling services in Washington that includes aligned collection methodology and frequency with single stream recycling collected every other week and a separate glass collection every fourth week. Like FS 2, FS 3 provides services to households currently without services for 100% coverage. A common set of materials is collected curbside across the state and EPS and plastic film are accepted at drop-offs. Assumes all households receive the same service at the same frequency, providing consistency across the state. Additional secondary processing of residues and bales of #3-#7 plastics. |
| Future System 4 (FS 4) | Potential future option for recycling services in Washington that includes the same services provided in FS 3, but with a weekly recycling collection that alternates material by week (i.e. week one: fibers, week two: metals, plastic and glass), creating a dual stream recycling system. |
| Future System 5 (FS 5) | Potential future option for recycling services in Washington with the same service configuration as FS 2, plus the addition of a deposit return system for beverage containers. |
| Future System 6 (FS 6) | Potential future option for recycling services in Washington, FS 6 is similar to FS 3, but with the addition of a deposit return system and glass collected through drop-off and not at the curbside. |
| Future System 7 (FS 7) | Potential future option for recycling services in Washington with the same service configuration as FS 4, plus the addition of a deposit return system for beverage containers. |
| Generation | The total amount of waste, including recyclable material, produced by a resident, household, business, or other waste generator. The basic formula is disposal + diversion = generation.[8] |

| Term | Definition |
|---|---|
| Gross Value Added (GVA) | The measure of the value of goods and services produced in an area, industry or sector of an economy. |
| Handling Fee | A fee paid to parties providing redemption infrastructure calculated to cover the cost of receiving beverage containers from consumers and storing them prior to collection. |
| High-density polyethylene (HDPE) | A strong, durable, lightweight, and chemically resistant plastic material popular for a variety of applications, including rigid plastics. Coded as plastic resin #2. |
| Indirect Impact | Jobs and GVA generated as a result of the waste management sector using amounts of goods and services from other sectors, thereby generating employment and profit in these sectors (e.g. supply of recycling collection vehicles) |
| Induced Impact | The additional economic activity resulting from the direct and indirect economic impacts from recycling. This is the consequential economic impact created from, for example, workers spending their wages. |
| Landfill | A specially engineered site for disposal of solid waste by burying in the ground. The waste is generally spread in thin layers which are then covered with soil or other materials. [9] |
| Low-density polyethylene (LDPE) | A soft, flexible, lightweight plastic material. It is often used for sandwich bags and cling wrap. Coded as plastic resin #4. |
| Loss Rate | Percentage of material lost at a certain stage along the recycling value chain. |
| MPG | Metals, plastics and glass. |
| Manufacturer | Refers to a person who bottles, cans or otherwise places beverages in beverage containers for sale to distributors or retailers. |
| Materials Recovery Facility (MRF) | Also sometimes called a recycling processor or sorting facility, an establishment primarily engaged in sorting fully or partially mixed recyclable materials into distinct categories and preparing them for shipment to recycling markets. There are also recovery facilities that focus on specific materials, such as plastic recovery facilities (PRF) or container recovery facilities (CRF). |
| Packaging, and Paper Products (PPP) | Category of materials that includes traditional curbside recyclables, such as aluminum, glass, plastic, cardboard paperboard, newspapers, phone books, and office paper. |

| Term | Definition |
| --- | --- |
| Pass Rates | The number of properties passed by a waste collection vehicle over a given period of time (i.e. per day). Often an indication of how dense/urban or rural an area is. |
| Placed on Market (POM) | The amount of product sold by producers to retailers or consumers in Washington on an annual basis. |
| Polyethylene terephthalate (PET) | A clear, strong, and lightweight plastic that is widely used for packaging food and beverages, especially convenience-sized soft drinks, juices, and water. Coded as plastic resin #1. |
| Polylactic Acid (PLA) | A stiff polymer that may be partially or wholly made from corn starch, tapioca root or sugarcane. May be compostable in industrial composting facilities under certain conditions. Coded as plastic resin #7. |
| Polypropylene (PP) | A thermoplastic used in a variety of applications to include packaging for consumer products, like yogurt pots and margarine containers and many plastic bottle caps. Coded as plastic resin #5. |
| Polystyrene (PS) | A transparent thermoplastic that is found as both a typical solid plastic as well as in the form of a rigid foam material. Often used for producing disposable cutlery and dinnerware and coded as plastic resin #6. |
| Polyvinyl Chloride (PVC) | A common thermoplastic used in construction and generally known for its hardness. Coded as plastic resin #3. |
| Producer | An organization or company that is a brand owner, first importer, or franchisor that supplies designated packaging and paper products to consumers in a jurisdiction where producer responsibility obligations have been regulated. A manufacturer of packaging, e.g. the manufacturer of plastic bottles, is not necessarily a producer in the context of EPR. The producer is the company that uses the plastic bottle as packaging and sells it under its own brand. |
| Producer Responsibility Organization (PRO) | The entity (usually a non-profit organization) designated by a producer or producers to act on their behalf to administer an EPR or product stewardship program. |
| R/C | Remainder/composite |
| Recovery | Material that is diverted from the solid waste stream for the intended purpose of recycling, composting, burning source-separated materials for energy, anaerobic digestion, land application, and other beneficial uses. [10] |

| Term | Definition |
|---|---|
| Recyclables/ recyclable materials | Those materials identified for collection, sorting, recovery, or reuse as part of a local government, business, or other recycling collection program. [11] This term is not synonymous with "recycled materials," since not all recyclables end up being remanufactured into new items. |
| Recycling Rate | The recycling rate is one way to measure the effectiveness of the system, the greater percentage of PPP recycled, the less landfilled. The recycling rates presented in this study are based on tons coming out of MRFs/secondary sorting facility and sold to reprocessors over the amount of material generated. The recycling rate is not based on the amount collected for recycling, using the amount collected significantly increases the recycling rate as it includes contaminants that are not recycled. |
| Redemption Center | A staffed facility in which residents drop-off empty deposit beverage containers for recycling and can receive the associated deposit. |
| Redemption Rate | The amount of a target material (i.e. beverage containers) collected divided by the amount of the material generated, or put on market. |
| Reprocessor | Also called a reclaimer, these companies purchase post-consumer or post-industrial recycled commodities and process into resin feedstock to sell to manufacturers. For plastics reprocessors, end products include pellet, flake, and other resin products. Some vertically integrated reprocessors also have manufacturing operations and may use the recycled content feedstock that they reprocess in the production of their own products. |
| Residential Waste | Waste generated from single family and multifamily households. |
| Retailer | Also known as a dealer, refers to every person in the state who engages in the sale of beverages in beverage containers to a consumer. |
| Return-at-retail | A redemption option where deposit containers can be redeemed at a redemption point that is co-located with a retail establishment. Return-at-retail can take several forms, including bag drop locations, as described above, as well as kiosks incorporating RVMs that are located outside of the stores, usually in parking lots as a stand-alone redemption point. |

| Term | Definition |
|---|---|
| Return-in-retail | Refers to redemption when consumers present empty containers directly to a store associate who provides the deposit refund, or when RVMs are located within a retail establishment. |
| Reverse Vending Machine (RVM) | A machine through which beverage containers are returned, verified and compacted and deposits are automatically refunded. Used by consumers at DRS redemption points. |
| Secondary Processor | Processor that receives materials from a MRF or sorting facility, usually baled materials, and converts them to a usable material for reprocessors or manufacturers to make into new products (e.g. flaking of plastic). |
| Sector | Generator of the waste; can be: residential, commercial, institutional, etc. |
| Set out rates | The percentage of households that put out their recycling container during a single collection opportunity. |
| Single Stream | A municipal, commercial, or industrial practice in which multiple recyclable materials are combined for collection, with no sorting required by the generator. Sorting is performed at a central location, such as a MRF. [12] |
| Social Cost of Carbon | Estimate, in dollars, of the economic damages that would result from emitting one additional ton of greenhouse gases into the atmosphere.[13] |
| Sorting Facility | Also sometimes called a recycling processor or material recovery facility (MRF), an establishment primarily engaged in sorting fully or partially mixed recyclable materials into distinct categories and preparing them for shipment to recycling markets. |
| Tipping Fee | Fee paid by haulers to dump load of trash or recycling at a landfill, incineration or recycling facility. |
| Tpa | Tons per annum |
| Transfer Station | A facility that receives and consolidates solid waste and/or recyclables from collection trucks and other vehicles and loads the wastes onto tractor trailers, railcars, or barges for transportation to often distant disposal or recycling facilities. [14] |
| Utilities and Transportation Commission (UTC) | A three-member commission in Washington appointed by the governor and confirmed by the state senate. The commission regulates intrastate residential household movers, solid waste collection companies, private ferries, as well as the safety of |

| Term | Definition |
|---|---|
| | charter buses, railroads, railroad crew transportation, and transportation for persons with special needs such as private, non-profit transportation providers.[15] |
| Waste Diversion | The act of redirecting waste away from landfill disposal and incineration and instead into recycling or other beneficial uses. |
| Waste Stream | The flow of solid waste from its source, such as households or businesses, through to recovery, recycling or final disposal. |

# Section 1: Introduction

This report is the third in a series of three produced for the King County Responsible Recycling Task Force (RRTF) to address Action Item 1E from the Recommendations Report, published in January 2019, which was to:

> ***Develop a feasible model for beverage container stewardship in Washington similar to the Oregon Beverage Recycling Cooperative model.***

This report also builds on the March 2020 report for King County, *Extended Producer Responsibility Policy Framework and Implementation Model: Residential Recycling of Packaging and Paper Products in Washington State*,[16] produced to address the RRTF's Action Item 1A, which put forward a policy framework and implementation model for Extended Producer Responsibility (EPR), to support residential recycling of packaging and paper products (PPP) in Washington and to help build a circular economy.

## Supplying a Circular Economy in Washington

A circular economy is a model in which waste is designed out of the system and resources are kept in use for longer. This model avoids waste and creates a reverse supply chain that replaces the use of primary material, which in turn reduces the environmental impact.

Public policy, consumer engagement and collaboration across the value chain are required to create a closed-loop circular economy. Shifting from a linear to a circular economy, to build a thriving society, requires reducing the use of primary resources, designing waste-free products, harnessing the full potential of materials and implementing innovative technologies to bring about a regenerative system.

To create the circular economy necessary for producers to incorporate recycled content into their packaging and to therefore meet their global commitments, more recyclable material needs to be collected and sorted to a quality that meets market demand. While jurisdictions across Washington have committed to providing services that enable resources to remain in use, recyclables are global commodities. Recent challenges globally have resulted in a significant increase in the cost to recycle, due to the recent tightening of international recyclable markets imposing restrictions on the exports of recyclables as well as fluctuating values of materials, for example, for recycled plastics due to the low price of crude oil. As a result, the currently recycling rate for plastic packaging is only 16% statewide, and the statewide recycling rate for all PPP material is 49%.

Many factors affect the value of materials recycled, some within the control of the recycling system such as effectiveness of households to recycle only target materials, or the effectiveness of sorting facilities to capture material correctly to maintain high levels of bale purity. Others are outside the control and result from, for example, recycled materials being commodities that need to compete with virgin equivalents in the market and are largely outside control of the recycling system.

EPR is a policy tool that seeks to internalize the end-of-life environmental and financial cost of products and packaging to companies that make those products or use packaging ("producers"). At its essence, EPR is a policy tool by which individual producers are assigned the legal obligation to meet regulated performance standards for the management of waste associated with their products or packaging.

A deposit return system (DRS), when designed to involve producers in funding and implementation as the Oregon system does, is, effectively, a type of EPR system that also includes an economic instrument. A deposit on an item, whether a beverage container or a battery, provides a financial incentive for the user to return the item. Funding for system operations and administration is not fully covered by the deposit itself or from tax revenues but rather is required to be provided by the producers of the products or packaging covered under the DRS.

EPR and DRS are not new policy instruments for addressing packaging waste. The first DRS for beverage containers in the U.S. was implemented in Oregon in 1971. The first EPR policy for packaging was implemented in Germany in 1991. Both policy instruments are now widely used to address packaging waste around the world. Despite this fact, there is no common template legislation or standard approach for how EPR and DRS are delivered. In practice, these systems can look very different from place to place as they are customized to each jurisdiction's unique conditions at the time of implementation. However, evaluations of these policies have identified key elements correlated with success.[V]

The most successful forms of EPR and DRS are outcome-based. That is, they are prescriptive in respect to setting the desired outcomes – the material-specific recycling targets[VI] to be met over time or greenhouse gas (GHG) reduction requirements – but provide flexibility in implantation approaches and allow for innovations. Successful policies clearly outline the roles and responsibilities of each of the different stakeholders from a management and financial perspective, provide clarity on the material to be covered and, importantly, describe the mechanisms for calculating what is actually recycled, along with other mandated performance requirements.[VII] The recycling rates presented in this study are based on tons coming out of MRFs/secondary sorting facility and sold to reprocessors divided by the amount of material generated.

Assuming that any EPR legislation in Washington is created to enable outcome-based solutions, no absolutes can be given as to the final design of a future system. Therefore, in this report we provide

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[V] A more in-depth look at the structure of DRS programs around the world was provided in the Phase I report of this study, *Inventory of Existing Container Deposit Programs*. A recommended structure for Washington State was provided in the Phase II report, *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations*. The U.S. Product Stewardship Institute consolidates resources on EPR and provides a *Packaging EPR Toolkit* for policymakers.

[VI] As described in the report: *Extended Producer Responsibility Policy Framework and Implementation Model: Residential Recycling of Packaging and Paper Products in Washington State*, (March 2020) and implemented in the European Union and British Columbia.

[VII] The term "recycled" is often used to describe different stages in the process of collecting, sorting or reprocessing materials. The European Union recently standardized their definition of recycled to be limited to "waste materials…reprocessed into products, materials or substances whether for the original or other purposes" in VII DIRECTIVE (EU) 2018/851. This definition is more stringent than many and limits what can be called recycled and dispenses with the use of other, more lenient definitions.

the estimated costs and benefits for the current system and for seven possible future collection and sorting systems that could be implemented under a policy framework utilizing EPR principles. One of the future system (FS) scenarios (FS 1) applies EPR to beverage containers only and utilizes DRS mechanisms for collection. Other future scenarios (FSs 2-4) apply EPR to all residential packaging and paper products (PPP) without the use of a DRS, illustrating different possible configurations of collection service and their associated costs and benefits. And a third set of future scenarios (FSs 5-7) apply EPR to all residential packaging and paper products and also include the use of DRS for all beverage containers.

This report details the costs and the environmental, social and economic benefits of the potential future systems against the current system to allow policymakers and stakeholders to assess the impacts of various models and make an informed decision on how to create a better performing recycling system in Washington.

## Report Contents

This report is structured into the following sections:

- **Section 2: Summary of Potential Future System Scenarios Modeled**: Description of the future scenarios (FSs) modeled, including the structure of the DRS used for FSs 1 and 5-7.
- **Section 3: Modeling Approach Assumptions and Considerations**: This section describes the process taken to:
    - Calculate the performance and cost of current recycling services provided to single family and multifamily properties through curbside and drop-off services as a baseline;
    - Calculate the performance and costs of the seven possible future systems; and
    - Quantify the wider environmental, social and economic benefits of the alternative future systems and monetizes these wider benefits.
- **Section 4: Current System Costs and Benefits**: This section provides an overview of current recycling services in Washington and summarizes the 2018 estimated quantity of recyclable material generated, the amount collected for recycling and the amount sold to reprocessors, which is assumed to be recycled into new materials. It also describes the costs associated with the system and the environmental, social and economic benefits associated with the system, to serve as a baseline against which the potential future systems can be compared.
- **Section 5: Future Systems Costs and Benefits**: This section provides an overview of services in each of the seven future systems and details the estimated quantity of recyclable material generated, recycled and disposed for each. It also describes the costs and the environmental, social and economic benefits associated with each.
- **Section 6: Comparison of Systems and Conclusion**: This section provides an overarching comparison of the costs and benefits across each systems and associated takeaways.

# Section 2: Summary of Potential Future System Scenarios Modeled

Assuming that any EPR legislation in Washington is created to enable outcome-based solutions, no absolutes can be given as to the final design of a future system. However, this study presents the costs and benefits of seven potential future systems (FS) for PPP recycling and compares these to the current system (baseline).

The seven residential recycling future system scenarios that could potentially be implemented under a policy framework utilizing EPR principles, and for which estimated costs and benefits are calculated in this study, were developed through discussion with King County Solid Waste Division and Seattle Public Utilities staff. The analysis aims to provide insight into the relative differences in costs and benefits when compared to the current system services and to each of the alternative system options.

Several of these systems include a DRS, which would be an entirely new recycling system in Washington. The design and policy framework of the DRS is detailed in the Phase II report *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations* and briefly discussed in the section on DRS design, below.

An overview of each future system is provided in Figure 4 and detailed below.

**Figure 4: Overview of Current System and Seven Future Systems**

| | BASELINE Current System | FUTURE SYSTEM 1 Current System + DRS | FUTURE SYSTEM 2 EPR + Enhanced Collection and Coverage | FUTURE SYSTEM 3 EPR + Aligned Universal Collection Option 1 | FUTURE SYSTEM 4 EPR + Aligned Universal Collection Option 2 | FUTURE SYSTEM 5 EPR + Enhanced Collection + DRS | FUTURE SYSTEM 6 EPR + Aligned Universal Collection Option 1 + DRS | FUTURE SYSTEM 7 EPR + Aligned Universal Collection Option 2 + DRS |
|---|---|---|---|---|---|---|---|---|
| **EPR** | N | Partial, only for DRS | Y | Y | Y | Y | Y | Y |
| **DRS for Beverage Containers** | N | Y | N | N | N | Y | Y | Y |
| **Single Family Curbside / Multi-Family On-Site** | 89% of HH | 89% of HH | 100% of HH | 100% of HH | 100% of HH | 100% of HH | 100% of HH | 100% of HH |
| **Common Set of Materials Collected** | N | N | Y | Y | Y | Y | Y | Y |
| **Aligned Common Collection System** | N | N | N | Y<br>Biweekly collection of paper, plastics & metals<br>Collection of glass every four weeks | Y<br>Biweekly collection of metals, plastics & glass<br>Alternate Biweekly collection of paper | N | Y<br>Biweekly collection of paper, plastics & metals<br>Glass collected only through drop-off | Y<br>Biweekly collection of metals, plastics & glass<br>Alternate Biweekly collection of paper |
| **Post Collection Sorting System** | Existing | Existing plus DRS | Existing with Secondary MRF | Existing with Secondary MRF | Dual Stream MRF | Existing with Secondary MRF plus DRS | Existing with Secondary MRF plus DRS | Dual Stream MRF |

## Future System 1: Current System with Deposit Return System (DRS)

This scenario includes no change to existing curbside and drop-off recycling programs, which are considered the "baseline" for comparison. Under future system (FS) 1, residential recycling for single and multifamily households through curbside and/or drop-off collection continues to be provided at the same levels as available under the current system and are provided through cities and/or UTC-regulated haulers and paid for by residential ratepayers. However, in addition to the current curbside and drop-off recycling programs, a DRS for beverage containers is also provided, managed and paid for by beverage producers.[17]

DRS can be classified as partial EPR for beverage containers, as producers are paying for the DRS, but households continue to pay for curbside recycling services, which continue to be determined by local governments.

The *DRS Design* section below provides details on the design of the DRS. More detailed information is available in the Phase II report *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations*.

### *Future Systems 2-7: Extended Producer Responsibility (EPR) for Residential Packaging and Paper Products Recycling Programs*

FSs 2 through 7 include a shift to EPR in which the financial responsibility of the recycling system shifts from jurisdictions and ratepayers to producers. Legislation that sets high material-specific recycling targets and requires producers to manage a sustainable recycling system to meet those targets shifts the financial responsibility of management of PPP from households to producers. The overarching policy framework and implementation model for EPR used here is presented in the report for King County, *Extended Producer Responsibility Policy Framework and Implementation Model: Residential Recycling of Packaging and Paper Products in Washington State*.[18] The following key policy framework elements have been applied to the quantitative modeling in this report for Future Systems 2 through 7:

- Residents across the state must have convenient, equitable access to recycling collection services – curbside for single family and on-site for multifamily;
- A statewide uniform list of materials that must be collected/recycled, as detailed in Table 3;
- Producers of PPP are required to fund and coordinate the recycling (i.e. collection, transportation, sorting, and marketing) of materials from the residential sector;
- Producers are authorized to form a "Producer Responsibility Organization" (PRO) to manage the responsibilities established in the policy; and
- A legislated "regulatory authority" is appointed that has authority to monitor compliance and enforce legal requirements.

**Table 3: Common Set of Materials Collected Curbside/On-Site and through Drop-off Only**

| Packaging and Paper Product Item | Curbside SF and On-site MF (Y/N) | Drop-Off Only |
|---|---|---|
| Newspaper | Y | N |
| Magazine and Catalogues | Y | N |
| Writing paper, paper gift wrap and greeting cards | Y | N |
| Shredded paper | N | Y |
| Corrugated cardboard boxes | Y | N |
| Cardboard and boxboard | Y | N |
| Carrier trays for carryout drinks etc. | Y | N |
| Cores for paper towels and toilet tissue | Y | N |
| Cartons | Y | N |
| Molded boxboard | Y | N |
| Paper bags | Y | N |
| #1 PET Bottles | Y | N |
| #1 PET Other Packaging | Y | N |
| #2 HDPE Natural Bottles | Y | N |
| #2 HDPE Colored Bottles | Y | N |
| #2 HDPE Other Packaging | Y | N |
| #3 PVC Packaging | Y | N |
| #4 LDPE Packaging | Y | N |
| #5 PP Packaging | Y | N |
| #6 PS Packaging | Y | N |
| #7 Other Packaging | N | N |
| Expanded Polystyrene Packaging | N | Y |
| PE Plastic Bags & Film | N | Y |
| Other Plastic Film & Flexible Packaging | N | Y |
| R/C Plastic Packaging | Y | N |
| Bottles | Y (except for FS 2) | N (except for FS 2) |
| Jars | Y (except for FS 2) | N (except for FS 2) |
| Used Beverage Cans | Y | N |
| Non-hazardous aerosol cans | Y | N |
| Steel cans | Y | N |

*Source: Eunomia*

The specifics of FSs 2 through 7 are as follows:

### Future System 2: EPR + Enhanced Collection, Coverage and Capture

This is the first full EPR system and the responsibility for covering the cost of the residential recycling system shifts from jurisdictions and ratepayers to producers. Each subsequent system also utilizes the full EPR model.

The basis of this system is as follows:

- A common set of PPP materials collected curbside for single family and on-site for multifamily households across the state, with the exception of glass, which for those households that receive curbside or on-site services for the first time under this system would be required to recycle glass through drop-off locations, along with plastic film, shredded paper and expanded polystyrene (currently collected through existing drop-off facilities).
- Coverage of households with recycling services is expanded to such that all single-family households with access to curbside garbage service (which is available to virtually all single-family dwellings in the state) have parallel access to curbside recycling and all multifamily households are provided with an on-site collection.
- Collection methodology (e.g. single stream, three-bin, etc.) and frequency (weekly, every other week) remains the same for households that receive services in the current system. Households that do not have baseline services would receive single stream every other week collection excluding glass, with glass accepted at convenient drop-off locations.
- Increased capture is assumed that due to increased education and engagement with households necessary to drive up the amount of PP collected the capture rate for each material from single family increases to match the capture rate in single family households in City of Seattle, seen as one of the highest recycling jurisdictions in the US. In multi-family households, capture rates for each material were assumed on average to be slightly above 70% of the capture rates for single family households in the City of Seattle. The capture rates in multi-family households for fibers were assumed to be equal to the multi-family households in the City of Seattle.
- Post collection sorting is applied to all collected material through existing MRF facilities. Sorting facility residues and target materials that existing facilities cannot successfully separate are processed through a secondary sorting facility.

### Future System 3: EPR + Aligned Collection Methodology and Frequency – single stream recycling (excluding glass) every other week with separate glass collection every fourth week

The basis of this system is as follows:

- A common set of PPP materials is collected curbside for single family and on-site for multifamily across the state from all households as set out in Table 3;
- Films, shredded paper and expanded polystyrene collected through existing drop-off facilities**;**

- All single-family households move to biweekly single stream collection with glass collected separately once every four weeks. Multifamily households have an on-site container for glass plus separate containers for all other target materials comingled;
- All material is tipped at existing MRF facilities with glass transferred to a local reprocessor, likely Strategic Materials, and all other target materials in the single stream processed through existing sorting facilities. Sorting facility residues and target materials that existing facilities cannot successfully separate are processed through a secondary sorting facility.

### Future System 4: EPR + Aligned Collection Methodology and Frequency - dual stream, fibers and metal/glass/plastic (MGP)

The basis of this system is as follows:

- A common set of PPP materials is collected curbside for single family and on-site for multifamily across the state from all households, set out in Table 3;
- Plastic films, shredded paper and expanded polystyrene collected through existing drop-off facilities**;**
- All households move to a dual stream collection system. Single family properties receive an alternate week material collection (i.e. week 1: fiber collected, week 2: metals/glass/plastic (MGP)). Multifamily households receive separate containers on-site for fibers and MGP. The split between materials that are collected in the fiber steam versus in the MGP stream are indicated in Table 4.

**Table 4: Materials Collection through Dual Stream and Drop-off for FSs 4 and 7**

| Packaging and Paper Product Item | Fiber (Y/N) | Metal/Glass/Plastic | Drop-off Only |
|---|---|---|---|
| Paper and paper products | | | |
| Newspaper | Y | N | N |
| Magazine and Catalogues | Y | N | N |
| Writing paper, paper gift wrap and greeting cards | Y | N | N |
| Shredded paper | Y | N | Y |
| Corrugated cardboard boxes | Y | N | N |
| Cardboard and boxboard | Y | N | N |
| Carrier trays for carryout drinks etc. | Y | N | N |
| Cores for paper towels and toilet tissue | Y | N | N |
| Cartons | N | Y | N |
| Molded boxboard | Y | N | N |
| Paper bags | Y | N | N |
| Plastic | | | |

| Packaging and Paper Product Item | Fiber (Y/N) | Metal/Glass/Plastic | Drop-off Only |
|---|---|---|---|
| #1 PET Bottles | N | Y | N |
| #1 PET Other Packaging | N | Y | N |
| #2 HDPE Natural Bottles | N | Y | N |
| #2 HDPE Colored Bottles | N | Y | N |
| #2 HDPE Other Packaging | N | Y | N |
| #3 PVC Packaging | N | Y | N |
| #4 LDPE Packaging | N | Y | N |
| #5 PP Packaging | N | Y | N |
| #6 PS Packaging | N | Y | N |
| #7 Other Packaging | N | N | N |
| Expanded Polystyrene Packaging | N | N | Y |
| PE Plastic Bags & Film | N | N | Y |
| Other Plastic Film & Flexible Packaging | N | N | Y |
| R/C Plastic Packaging | N | Y | N |
| Glass | | | |
| Bottles | N | Y | N |
| Jars | N | Y | N |
| Metal | | | |
| Used Beverage Cans | N | Y | N |
| Non-hazardous aerosol cans | N | Y | N |
| Steel cans | N | Y | N |

*Source: Eunomia*

- Sorting facilities are established for fiber and MGP.

### Future System 5: EPR + Enhanced Collection, Coverage and Capture with DRS

Same conditions as FS 2, with the addition of a DRS. The *DRS Design* section provides details on the design of the DRS. More information is in the Phase II report *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations*.

### Future System 6: EPR + Aligned Collection Methodology and Frequency – single stream with glass to drop-off plus DRS

This system is similar to FS 3, but with the addition of a DRS and without the curbside collection of glass every fourth week. A proportion of the network of drop-off locations for DRS material (those that would be staffed) would also accept non-DRS glass for recycling.[VIII] The *DRS Design* section provides details on the design of the DRS more information is in the Phase II report *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations*.

### Future System 7: EPR + Aligned Collection Methodology and Frequency – dual stream plus DRS

Same conditions as FS 4, with the addition of a DRS. The *DRS Design* section provides details on the design of the DRS more information is in the Phase II report *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations*.

## DRS Design

The design and policy framework of the DRS is detailed in the Phase II report *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations*, a broad overview is briefly provided below with more detailed modeling assumptions included in Section 3 and in the Technical Appendix.

#### Broad Goals of DRS for Beverage Containers

The broad goals of a best-in-class DRS for beverage containers are:

- To maximize redemption rates in order to prevent litter and maximize the quality and value of the recyclable material, necessary for a circular economy.
- Provide equitable access for all residents across the state to be able to redeem their containers at convenient redemption points.
- Supplement and enhance the recycling system without jeopardizing existing curbside services.
- Remain dynamic and relevant to the current environment, with a design that allows for necessary adjustments over time without requiring additional legislation.

#### System Design Principles, Roles and Responsibilities

The broad goals, along with roles and responsibilities of the different stakeholders assumed for the cost benefit modeling have been developed from reviewing best-in-class systems across North America, Europe and Australia, which have led to system design principles:

- **Legislated redemption rate target, redemption point requirement and geographical coverage target, and application to containers for all beverage types**. Legislation should include mechanisms for levying penalties for non-achievement of targets. This may include adjusting the deposit if the redemption rate target is not met for three consecutive years, despite the geographic coverage target being achieved (which would indicate that redemption is

[VIII] It is possible that non-DRS glass could be recycled through RVMs, however, this would only be feasible if specific RVMs are used along with barcode-specific labeling for all DRS containers.

convenient, but not incentivized enough). These measures will also help to ensure success of the system. Specifically, these should include:

- A **90% redemption target**, which has been achieved with a $**0.10 deposit** for all beverage containers in Oregon.
- The geographical coverage target set **at one redemption point per 5,000 residents** and with no households required to travel more than five miles to a redemption point, as is currently being achieved in Maine.
- The deposit applies to containers for **beverages of all types**, including wines and spirits and milk or milk alternative based drinks.

- **Producers, manufacturers, and first importers designated as responsible parties for the DRS are individually obligated for meeting redemption and geographical coverage targets set in legislation**. Cost of system paid for by producers through a producer fee that is administered through the producer responsibility organization (PRO) and net of any revenue from material sales and unclaimed deposits associated with a 90% redemption rate. Producer fees, set by PRO modulated to reflect the cost or benefit of the specific beverage container type has on the total system costs.

- **PRO set up by producers to oversee the operation of and financially manage the DRS on their behalf.** The PRO is required to procure any services in accordance with Washington State procurement guidelines,[19] for services necessary to operate the system (e.g. collection of containers from redemption locations). The PRO is also responsible for licensing of redemption centers, paying handling fees to all redemption points based on the number of beverage containers handled, setting producer fees, reporting back to the state government oversight agency and ensuring sufficient infrastructure is in place to enable the redemption target to be met. The PRO must ensure that all containers are counted and verified through either RVMs or bulk sorting machines and is required to report annually on behalf of its members.

- **Retailers greater than or equal to 5,000ft$^2$ are obligated to redeem deposit bearing containers, unless they request and are granted an exemption from the PRO by demonstrating that an alternate redemption location exists (e.g. a redemption center) that fulfills the geographic coverage requirements.** The PRO has the ability to levy a fee on a retailer that is granted an exemption to support the funding of the alternative redemption location (i.e. a redemption center) for covering their obligations. Retailers less than 5,000ft$^2$ may choose to opt-in and act as redeemers in the DRS. Retailers that are obligated do not have to redeem containers via a return-in-retail model, but can instead provide return-*at*-retail facilities, such as kiosks containing RVMs and/or bag drops located in parking lots. The collection and servicing of these facilities can be managed through the PRO. The return-at-retail model ensures a "common stop" approach is maintained, whereby consumers can redeem their deposit containers and then shop during the same errand and, in doing so, reduce the need for additional trips.

- **Consumers able to redeem deposit containers through in-store, or at-store redemption points or redemption centers using RVMs or bag drops**. Consumers also have the option to continue to place containers in their curbside recycling bins and forgo the deposit refund.

- **MRF operators are able to claim the deposit refund on deposit bearing containers that come through their facility and that they can separate out and verify through a counting center or redemption center.** It may also be possible for MRF operators to contract with the PRO to use their facilities to provide the bulk counting center function and to be paid a sorting fee for this service.

- **State government or government-appointed agency designated as program administrator, responsible for oversight and auditing of the system**. This organization would manage the electronic data registration / management system through which producers or the PRO reports units placed on the market (POM)/sold into the state, by product, including the products' bar codes and the number of units redeemed, by product. Any unclaimed deposits associated with the failure by producers to meet the redemption target of 90% would be set aside in a fund dedicated to supporting investment in the wider recycling infrastructure in the state, (e.g. sorting facility equipment upgrades) and would be administered by the government agency.

An overview of the DRS for which the costs and benefits have been assessed is provided in Figure 5(flow of containers), Figure  (flow of money), and Figure  (flow of information). Some of the important design elements that impact on the costs of the system are summarized in *Section 3: Modeling* Approach, Assumptions and Considerations, with more detailed information provided in the Phase II report *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations*.

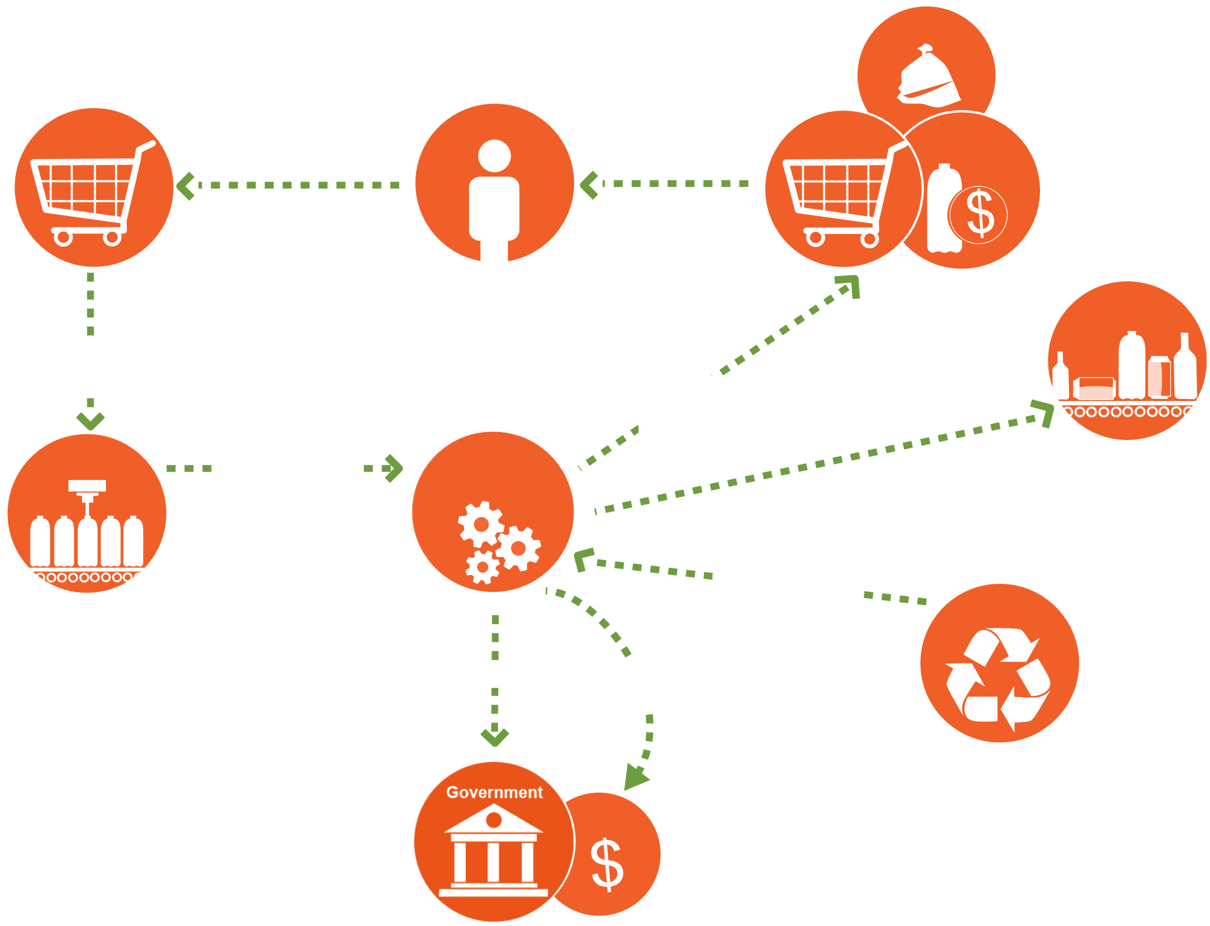
**Figure 5: Beverage Container Flow through DRS System**


*Full container*: The beverage producer or distributor supplies the retailer, who then supplies the consumer.

*Empty container:* Consumers can return containers through one of four redemption methods to redeem the deposit. Empty containers can also be placed in curbside containers, in which case the consumer forgoes the deposit refund, and sorting facilities can extract them and have them verified through counting centers to claim the deposit.

Containers whose bar code has not been verified through an RVM are taken to counting centers following sorting, where units are verified, counted and baled, and sold to reprocessors. RVM-verified and crushed containers are also consolidated and baled before being sold to reprocessors.

**Figure 6: Monetary Flow through DRS System**




*Deposit Payment:* Deposit is initiated by the producer or distributor (deposit initiator). Deposit is paid by the retailers to the deposit initiator, and by the consumer to the retailer. The deposit is then passed from the deposit initiator to the PRO.

*Deposit Redemption:* The deposit is refunded to the consumer when the consumer returns the container through one of the four redemption methods. The redemption facility recovers the deposit from the PRO once units have been verified through counting centers or RVM records. Unclaimed deposits associated with a 90% redemption rate remain with the PRO. Any deposits associated with a failure to meet the 90% redemption target are transferred to a fund held by the state government or government-appointed agency tasked with DRS administration and invested in the wider recycling infrastructure. Households that set up online accounts to enable them to use the bag-drop system will receive payments directly from the PRO electronically to their bank account.

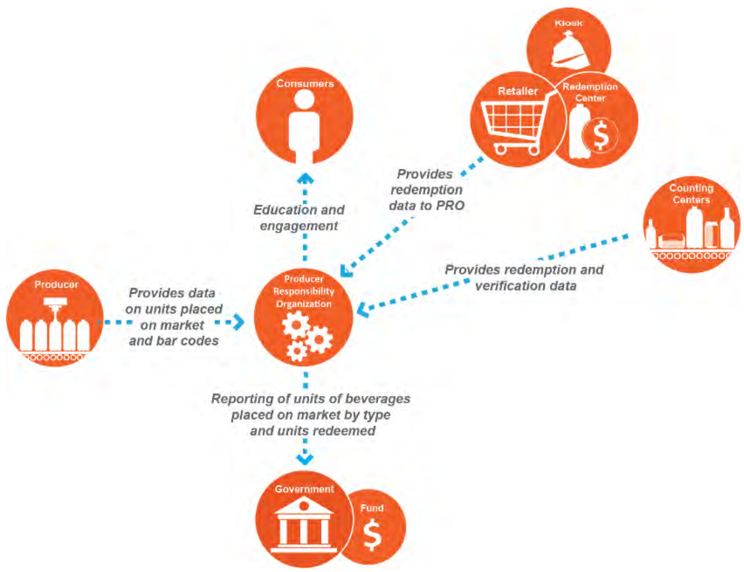
*Handling Fee*: The PRO pays the redemption facility a per container set handling fee as compensation for providing redemption infrastructure for the deposit containers. The fee may vary depending on the redemption type and is based on a cost coverage calculation determined periodically.

*Material Value*: Material is sold on behalf of the PRO and revenues are used by the PRO to offset the cost of operating the system.

*Producer Fee*: Producers pay a fee to the PRO to cover the cost of operating the system, net of any revenues. Fees will vary based on the number of units placed on the market as well as on the container's material value.

*Administration Fee*: PRO pays the government agency a fee for providing oversight of the systems.

**Figure 7: Information Flow through DRS System**




*Information to the PRO*: Counting centers and RVMs provide real-time data electronically to the PRO and, if required, also to the government agency. The deposit initiators also provide sales data information. This information is used to determine payment of handling fees, calculation of producer fees, and calculation of recycling rates.

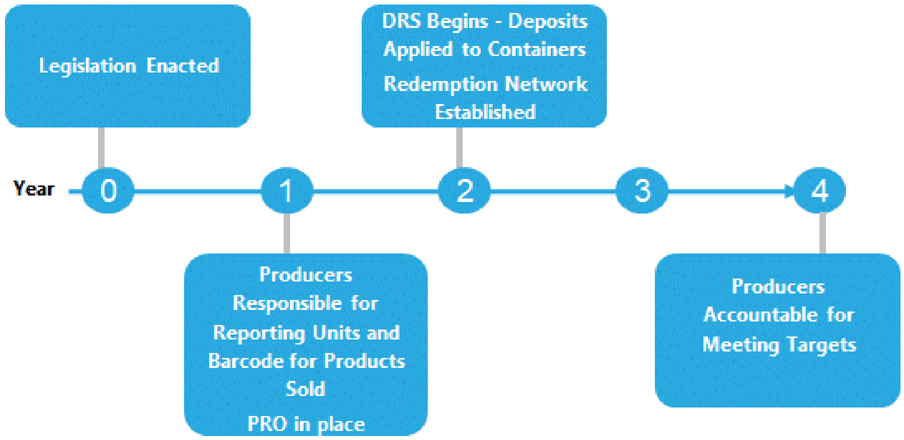
*Information to the government agency:* The PRO reports the beverages by type units placed on market (POM) as well as the redemption rates based on data from RVMs and counting centers to demonstrate they have me the legislated redemption target. The PRO also has to demonstrate that the geographical coverage requirements have been met.

Education: The PRO is responsible for educating the public on the program. Information must be provided on the location of the redemption locations and their operating hours as a minimum.

## Phasing of Implementation

The proposed timeline for implementation of the DRS and for producers to be required to meet the geographical coverage and redemption rate targets is provided in Figure 8.

**Figure 8: Indication timeline for implementing DRS**




## Infrastructure and Technology

The infrastructure network is critical for ensuring that redemption is convenient, redemption rates are accurately calculated, and that the program meets its mandated performance requirements and has the desired impact on beverage container recycling.

The proposed mechanisms for redemption and container verification in Washington combine those seen in high performing jurisdictions, including Norway and Oregon, and include four redemption method options for consumers, as described in Table 5, as well as consolidation and counting centers to bulk and verify units redeemed.

The redemption infrastructure allows for consumers to conveniently redeem containers at or near locations where they are available for purchase, as well as offering facilities for commercial businesses collecting from the hospitality sector. The redemption infrastructure also allows residential and commercial customers to use the existing curbside recycling collection system if they prefer, forgoing the deposit refund, and thereby transfer the deposit value of recycled containers to receiving MRFs. MRFs can then claim the deposit on any deposit bearing containers that they separate out and verify through a counting center. The redemption methods have been modeled to ensure adequate geographic coverage across the state, to enable all Washington residents to have easy access to redemption. The locations of redemption points assumed for the modeling is provided in Figure 9.

**Table 5: DRS Infrastructure Modeled for Washington**

| Infrastructure | Description |
|---|---|
| Redemption Methods | |
| Return-in-Retail: Automated Collection (RVMs) or Manual Collection |   Most larger retail stores would install RVMs to automate the process of redeeming containers by consumers. Those that do not use RVMs may collect containers and refund deposits manually. Any retailer that sells a deposit-initiated beverage can opt-in to redeem and collect empty containers and return the deposit to the consumer. |
| Dedicated Redemption Centers | These centers are likely to be situated in retail spaces or in warehouses on the outskirts of a town. They would be primarily used for high volume redemption, as well as by haulers providing services to the  commercial, hospitality and institutional sectors. Redemption centers may contain a mix of bag drops and RVMs. Technological solutions may also be used for on-site counting and verification of containers, to reduce onward transfers to dedicated consolidation and counting centers. |
| Return-at-Retail (Parking lot stand-alone container/ building) |  These facilities have been assumed to be on all retailer premises that are over 10,000sq ft in size and may contain both bag drops and/or RVMs. |
| Bag Drops | Consumers register for an online account and purchase special bags or stickers for bags that they fill with deposit containers. They drop-off full bags to unstaffed, standalone outlets and receive credit for deposit refunds to their accounts once bags are collected and containers are verified.  |
| Additional Infrastructure | |
| Consolidation and Counting Centers | These facilities count and verify all containers that are not redeemed through RVMs (as RVM verify containers at the point of redemption). They also carry out some sorting and baling of material. Counting and verifying all containers helps identify fraudulent activity and ensures payment is only made on eligible containers, reducing overall system cost. The entire process is automated. |

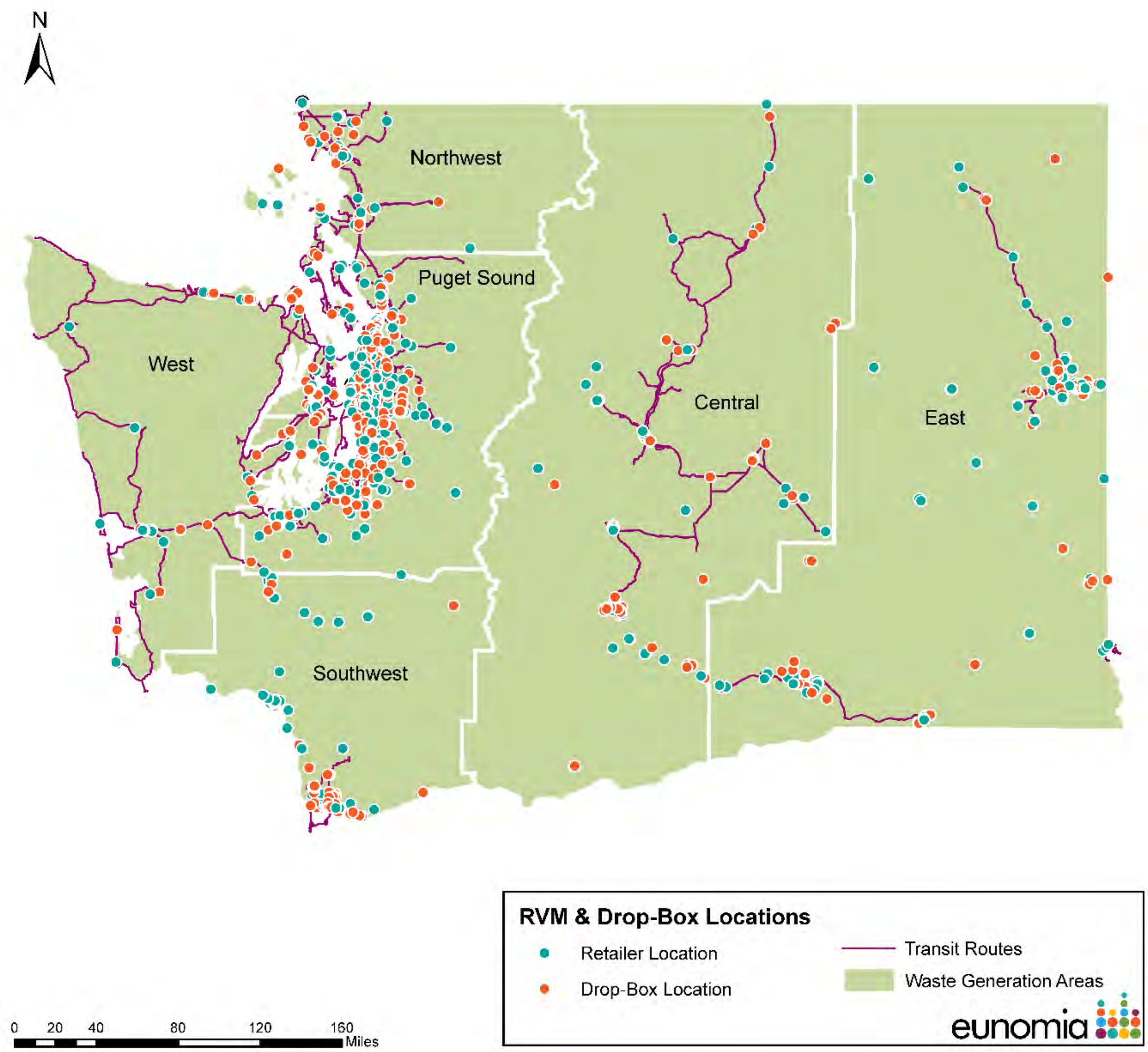
| Infrastructure | Description |
|---|---|
| | These centers could be provided by existing waste management service providers, such as MRFs, under contract to the PRO based on contractual arrangements that would ensure that appropriate procedures are in place to separate all containers redeemed through the redemption network from any MRF operations. Operators of these facilities would be paid for their services, *Section 5: Future Systems Costs and Benefits* summarizes the estimated cost for providing the counting centers. |

*Source: Eunomia*

The system design and costs modeled in this study assume that every unit redeemed is verified according to its bar code, which is used to track the system's performance against the legislated redemption rate target. Not all existing DRSs verify every unit, some only verify a percentage, while others only count the units. The benefit of verifying every unit is that it will better identify fraud in the system. Fraud in DRS systems can arise from beverage producers free-riding (i.e. not participating financially), underreporting the units they place on the market in the state or from cross-border redemption fraud (redeeming containers that were sold outside of the state and therefore not covered by a deposit paid at the point of sale). Verifying every unit is more expensive that just counting, but provides better system integrity and information.

Information systems for consumers are also a key feature of best-in-class systems. The modeled system includes the cost of online accounts through which consumers can be paid their refunded deposits for their returned containers.

**Figure 9: RVM and Drop-Box Locations**




*Source: Eunomia, Washington State Department of Transportation, and NAICS.*

## DRS with EPR for Broader Range of Materials

A DRS can be implemented with or without EPR for a wider range of packaging materials. Some of the benefits of operating it with DRS include but are not limited to:

- Single PRO to oversee both systems, providing consistency in report against targets to the state government oversight agency;
- Ability to contract for services together. For example, for haulers to collect materials from drop-off as well as from redemption centers, delivering cost economies of scale;
- Single entity providing education and engagement.

# Section 3: Modeling Approach, Assumptions and Considerations

The overarching approach taken to model the performance outcomes, costs and benefits for the current system and for the seven possible future EPR systems is summarized below.

1. Baseline:
    - Waste flows: Using waste characterization studies and reported data on disposal and material sorting, the tons generated, disposed, collected for recycling and recycled (assumed for the purposes of this study to be the quantity of material sold by a sorting facility to a reprocessor) were calculated for each PPP material.
    - Collection and drop-off costs:
        - Built up collection costs of current services (baseline) in *Hermes* (Eunomia's collection options modeling tool) using service cost data from select jurisdictions and service efficiency data from those jurisdictions and from private sector operators. Calculate jobs and costs for management, supervision and administration on a per route basis using data provided from jurisdictions;
        - Assessed drop-off costs based on container and haulage costs;
        - Cross-checked baseline costs against costs of service derived from household rate data.
    - Transfer, sorting and disposal costs:
        - Calculated sorting costs based on tons recycled and averaged cost of transfer and sorting;
        - Calculated disposal costs associated with target PPP not collected for recycling;
        - Calculated jobs per 1,000 tons recycled by role, e.g. management and administration, engineer, sorter using sorting facility published and provided data.
    - Material revenues:
        - Calculated material revenues based on tons recycled using data from jurisdictions and recyclingmarkets.net.
2. Future systems costs and performance:
    - Waste flows: Developed future system waste flows;
    - Collection and drop-off cost: Input future scenario waste flows into *Hermes* to calculate the vehicles, resources and containers needed to collect residential PPP under each FS as well as the number of routes. Calculated the amount of management, supervision and administration using the jobs per route calculation.

  - Transfer, sorting and disposal costs: Assessed the costs of alternative sorting options (e.g. secondary sorting for plastics or dual stream processing), as well as revised disposal costs.
  - EPR-associated costs: Estimated a cost for the PRO and government oversight.
  - One-off and capital costs: Assessed any one-time costs (such as for additional recycling bins for expanded service to a greater number of households), RMS's and bulk counting machines.

3. Wider economic, environmental and social benefits:
  - Quantified wider economic, social and environmental benefits (jobs created, gross value added, greenhouse gas emissions, social cost of carbon, litter impacts).
  - Monetized economic, social and environmental benefits.

Detailed directly below is the approach to calculating the economic, social and environmental impacts which are applicable to each scenario. The specific approaches to modeling the material flows and system costs for the current system and each future system is provided later in the section.

## Economic, Social and Environmental Benefits

### Economic Benefits

The economic impact of recycling is measured in terms of the contribution that recycling activities make to:

- Employment, measured as the number of jobs created; and
- Overall economic contribution, measured as gross value added (GVA).

GVA is the measure of the value of goods and services produced in an area, industry or sector of an economy. The model created for this study uses the income-based approach to measuring GVA, which sums up all of the income earned by individuals or businesses involved in the production of goods and services. The main components of income-based GVA are:

- Compensation of employees;
- Assessment of gross operating surplus and taxes are based on an assumption from the OECD for the US that compensation of employees is 56.5% of GVA and as such the remaining percentage is gross operating surplus and taxes. Income-based GVA is a common approach to measuring the contribution of a sector to overall gross domestic product (GDP) of a region.

The total economic impact is comprised of the following:

1. 'Direct' impacts: includes the employment and value-added impacts (i.e. GVA) that are generated in the state economy directly from waste management activities (collection, sorting, etc.).

2. 'Indirect' impacts: the economic impacts generated by the demand for goods and services from other sectors. They represent, for example, economic activity generated in the manufacturing and transportation sectors as a result of demand for materials and services by the waste management sector.
3. 'Induced' impacts: the additional, or "knock-off" economic activity stimulated by the spending of workers' salaries and wages earned as a result of the waste and recycling sector.

The estimation of economic impact is generally approached using type 1 (for indirect impacts) and type 2 (for direct, indirect and induced impacts) multipliers. The direct, indirect and induced employment multipliers are related to specific industry activities (each sector need a specific ratio of supplemental labor) and are calculated by the Economic Policy Institute using Bureau of Labor Statistics (BLS) data, published as Updated Employment Multipliers for the U.S Economy.

Economic output in GVA terms are estimated using a waste management sector multiplier sourced from the Institute for Scrap Recycling Industries Inc. (ISRI) 2017 Economic Impact Study.[20]

## Social Benefits

### Jobs Created

The number of direct jobs created in Washington as a result of PPP recycling services from the point of collection to the MRF sorting facility has been calculated as follows:

- *PPP curbside collection:* One of the outputs from Hermes is the number of resources needed to collect PPP directly from single family and multifamily households. This number varies by the amount of material collected, the collection methodology used in the area, the number of households collected and the pass rate. 20% additional driver and loader resources were added to the direct number of drivers and loaders required to deliver the service to cover for sickness, paid time off, etc. This figure was the average of data provided.
- *PPP collection management, supervision and administration and support services*: Data provided by jurisdictions on the resource need to manage and support in the delivery of services has been used to calculate jobs by type per route. This calculation has been multiplied by the number of routes needed to deliver the services currently as well as under future scenarios.
- *PPP drop-off:* Drop-off jobs have been pulled from data within Eunomia's existing database on jobs per 1,000 tons of PPP managed.
- *PPP transfer and sorting:* Transfer and sorting jobs were estimated from data published by Waste Management and data obtained from a private waste management service provider on the number of people working in sorting facilities at all levels, from management to sorting line personnel. Additionally, the tonnage processed through these facilities was used to calculate a jobs per 1,000 tons processed figure.

Details on the direct jobs per 1,000 tons and direct jobs per collection route can be find in the *Technical Appendix*.

Job numbers and wage data feed into GVA calculations.

## Environmental Benefits

### *GHG Impact and Social Cost of Carbon*

There are positive and negative GHG impacts associated with the collection, sorting and recycling of PPP. While there are benefits in reducing the amount of biodegradable waste to landfill, greater environmental benefits result from recycled material displacing the use of virgin materials in manufacturing of products. This substitution delivers significant embodied energy savings resulting primarily from reduced resource extraction. As an example, metals make up approximately 5% of the waste stream but account for a third of carbon emissions when embodied energy is considered.[21] The EPA's Waste Reduction Model (WARM model) V15[22] has been used to assess the $MTCO_2e$ resulting from PPP being recycled rather than landfilled or incinerated under each system. The distribution of landfilling versus incineration is not known, so the relative allocation of disposal methods for all tons (95% landfilled, 5% combusted) was used for modeling current disposition. The GHG emissions estimated in the WARM model indicate full life-cycle benefits.

There are also GHG emissions associated with the collection of residential PPP from curbside and drop-off facilities. The types of data needed to assess the impact of different collection systems include: frequency of collection; vehicle type; miles travelled and speed, fuel use and fuel efficiency. This level of detail was not available, and while it is recognized that the collection of PPP has an environmental impact, it is excluded from all systems' evaluation. The GHG impacts of sorting of PPP through a sorting facility were also excluded due to the level of data necessary to make this calculation. However, the impacts of both these sources of emissions are small compared to the impacts of changes in the amount of material that goes to disposal and the corresponding amount of virgin material displaced by recycled material.

Eunomia's DRS model separately calculates the impacts of transport-related activities as a result of implementing this additional recycling option. The DRS model includes an assumption related to consumer travel to redemption points, despite the belief that this activity will most often be combined with other activities, such as shopping.

A value of $75 per $MTCO_2e$ was then applied to the WARM model output to represent the social cost of climate pollution reduction associated moving from the current system to an EPR system delivering higher recycling rates. The estimated social cost of emissions was produced by the Interagency Working Group on Social Cost of Greenhouse Gases and adopted by the WUTC to represent the broad array of economic and social damage (i.e. climate change and associated social instabilities) caused by carbon and other GHG emissions. [23]

### *Litter*

Litter impacts are:

- Financial: There is a cost associated with the cleanup of litter, often underfunded and carried out by non-profit groups. Data on quantity collected and impact is inconsistently recorded. Washington's Litter Tax[24] provides some funds for litter education and clean-up.

- Environmental: Litter that is not collected remains either on the land or migrates into the aquatic environment, the impact of which is becoming more apparent although is not yet fully understood. Mechanisms, like DRS, that prevent the likelihood of items, especially those consumed and disposed of on-the-go, from becoming litter are necessary to prevent leakage into the environment.
- Social: Litter in the environmental impacts a person's ability to fully enjoy their environment, creating a loss in amenity.

In this study, we have not assessed the litter impact associated with all PPP just with beverages containers which, second to cigarette butts are the items most found as litter on Washington's beaches.[25]

The tons of beverage related litter reduced as a result of implementing a DRS is calculated. We also place a monetary value on the impact of litter on a person's amenity, defined as a 'welfare loss.' This loss is measured as a monetary value of a person's willingness to pay for a reduction in the levels of litter in their environment and the associated costs of restoration. Eunomia has calculated this willingness to pay using data from a number of academic studies to produce monetary values and adjusted them such that they are applicable to Washington.

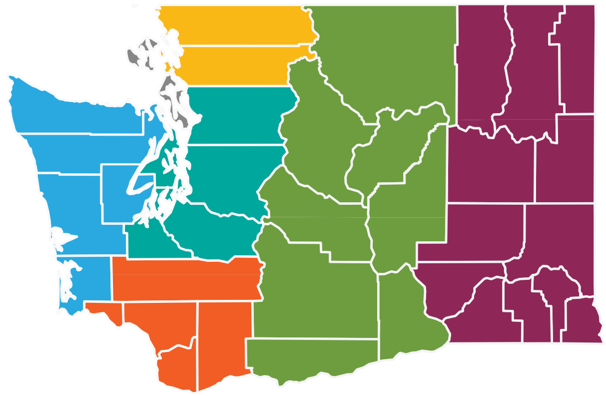
## Modeling of Current Recycling System in Washington

### Material Flows

Material flows have been developed for the current system using the following sets of data and are based on 2017 volumes:

- Detailed waste generation and recovery data provided by the Department of Ecology for 2017 (the most recent year for which data are available)[26];
- 2015-2016 Washington Statewide Waste Characterization Study[27];
- Data from Zero Waste Washington's *State of Residential Recycling and Organics Collection*[28] ;
- MRF data, including residue rates by material type from the King County report: *Materials Recovery Facility Assessment and Characterization of Single Stream Recyclables*[29] as well as MRF data provided by City of Olympia;
- Data gathered from a select number of municipalities and other Washington-based literature.[30]

**Figure 10: Six Waste Generation Areas in Washington**



The data available was sufficient to calculate, for each of the six waste generation areas shown in Figure 10, the tons of each PPP material:

- Generated;
- Collected for recycling;
- Sorted and sent to reprocessors, as well as the amount of PPP that ends up as residue due to sorting inefficiencies; and
- Collected and disposed in the trash stream.

The detailed approach taken to calculate the above for single and multifamily households in Washington across the six waste generation areas is contained in the *Technical Appendix.*

## Costs and Revenues

The residential PPP recycling system has been broken down into the following areas for the purposes of calculating the baseline costs:

- *Collection costs:* This includes the cost of curbside and drop-off recycling services, incorporating the costs of resources and vehicles used to collect and manage PPP as well as the associated costs of support services such as customer service costs;
- *Transfer and MRF sorting costs:* This includes the costs of transferring material and sorting it at MRFs;
- *Disposal costs:* This includes the current costs of landfilling residential PPP, including material that is collected within curbside trash collections, and MRF residues.

### *Collection Costs*

A two-pronged approach was taken to assess the costs of PPP recycling collection. The first uses Eunomia's proprietary collections model, *Hermes*. The material flow data for each region and for each collection type was input into *Hermes* in addition to the following specific service delivery and cost data for both single family and multifamily collections, as provided by a number of Washington jurisdictions and a local recycling hauler for 2019:

Service Delivery Data:

- Crew configuration by collection methodology (e.g. an automated single stream system likely requires collection routes be staffed by a driver only, whereas a three-box system likely requires a driver plus one loader);
- Vehicles specification and number;
- Number of drivers and loaders;
- Number of routes by service type;

- Number of tips per day and time taken to reach tipping location;
- Time taken to travel to and from drop-off to first collection;
- Break times;
- Working hours; and
- Number of households passed per route and number of households collected from per route.

Cost Data:

- Vehicle capital, interest rates and maintenance costs;
- Personnel costs including, healthcare, pension, taxes; and
- New and replacement container costs, specifically relevant for the systems when FS 3, 4 and 7 where additional containers are required.

*Hermes* is able to model multiple different collection systems. In each region, rural and urban routes were modeled for each collection system and for the various collection system frequencies. The *Technical Appendix* details the number of households collected from, by collection system in each region. The assumptions used for each service and cost data point are provided in *Technical Appendix.*

On top of the direct personnel and vehicles costs necessary to collect PPP from households in Washington, the following additional costs were built into the model:

- *Management, supervision and administration:* A proportion of senior management and supervision costs have been applied based on apportioning the time spent on PPP services by route determined from the data provided. This data was also used in the calculation of jobs created as a result of the services provided (see *Technical Appendix* for the calculated jobs and employee costs per route).
- *Taxes:* Service-related taxes and fees vary from jurisdiction to jurisdiction, depending on whether the jurisdiction is a city and charges a municipal utility tax, and franchise fee, or some other fee. Within the scope of the project, it was not possible to assesses every jurisdictions' tax structure so a consistent set of tax assumptions were added to the costs of services across all jurisdictions:
    - 6% municipal utility tax: this is the highest tax that a utility can charge without approval.[31]
    - 1.75% business and operations tax: applied to the percentage of the total services that are provided by private haulers.
- *Overheads and profit margin:* A flat 9% of revenue has been added to the total cost of services (before tax) to cover support services like HR, customer services, payroll, etc., plus profit margin for those jurisdictions that use a private hauler.

Washington also imposes a 3.6% Solid Waste Collection Tax;[32] this is intended only to be levied on collection, transfer, storage, or disposal of solid waste and not on recycling, so this has not been included.

#### *Transfer and Sorting*

MRF sorting and transfer costs vary across the state. For example, Seattle's gross sorting cost in 2019 was $94 per ton, versus the City of Olympia's, which for the same year was $90 per ton, plus a $63 transfer cost[33]. For the purposes of modeling, a gross per ton transfer and sorting cost of $120 per ton has been assumed due to the lack of data on both the number of jurisdictions that are required to transfer their PPP and on contracted tipping fees. Material values are then calculated based on the tons net of residues based on published Pacific Northwest 2017 averages[34] and data provided by City of Seattle and City of Vancouver from its MRF.[35]

#### *Disposal*

Disposal costs per ton are based on tipping fees for each region were developed based on the average tipping fees by county published by Washington's Department of Ecology, as detailed in the Technical Appendix and are based on averages from 2017.

### Cost Comparison

The bottom-up approach to calculating the collection and sorting costs used in this study was cross-checked against an assessment of costs using residential rates published by local governments and/or contracted service providers as well as residential recycling rates charged by UTC-regulated haulers according to published tariffs.

## Modeling of Future Systems in Washington

### Material Flows

Materials will flow differently through each of the systems modeled. The approach to calculating these changes is detailed below.

#### *Systems with DRS*

When a DRS is introduced, used beverage containers will shift from the trash stream to the DRS as well as from current curbside and drop-off recycling systems. In order to assess the impact of introducing a high performing DRS (≥90% redemption rate) on curbside services and on disposal costs, the first step was to calculate the redemption rate for each material type as the target is 90% across all material types. Data from programs such as that in Alberta, Canada show that redemption rates for cartons, for example, are always less those for PET and aluminum, the assumed redemption rates for each material are detailed in Table 6, this split delivers a 90% overarching redemption rate once the program is fully implemented.

**Table 6: Modeled Redemption Rates by Material**

| | PET | HDPE | Aluminum | Glass | Cartons/Aseptic |
|---|---|---|---|---|---|
| Redemption Rate | 93% | 90% | 93% | 90% | 60% |

*Source: Eunomia*

Next it was necessary to calculate the number of containers, by material, currently generated and to calculate the associated tons. Beverages containers are not specifically categorized with the 2015-16 Statewide Waste Characterization Study except for aluminum beverage cans. As such, in order to estimate the total tons of beverage containers in the system, the assumptions in Table 7 have been applied to the baseline generation data.

**Table 7: Percentage of Bottles and Containers that Beverage**

| Beverage Material | % of Bottles/Containers that are Beverage | Justification |
|---|---|---|
| PET | 80% | 2002 Cascadia Study conducted for NAPCOR on the composition of the Residential Recycling Stream in Seattle, 2005 Study on the Economic and Environmental Benefits of a Deposit System for Beverage Containers in the State of Washington by Sound Resource Management[36] and confirmed up to date estimate via correspondence with MORE recycling. [37] |
| HDPE Colored | 10% | In 2005, a report for Tacoma assumed that 5% of HDPE was beverage containers, excluding milk as a category, as such representing teas and juices for example. Due to the age of this study and in introduction of more drinks in HDPE color this 5% was increased to 10%. |
| HDPE Natural | 80% | Because not all DRS programs include HDPE there is little data on the percentage of HDPE bottles that are milked based products. Observations from Cascadia during waste sorts is that the vast majority of HDPE natural bottles are milk and as such a high percentage has been assumed. |
| Glass | 80% | Glass beverage bottles are included under glass containers. Based on the same reports used to assign the split for PET beverage bottles, the percentage of |

| Beverage Material | % of Bottles/Containers that are Beverage | Justification |
|---|---|---|
| | | glass beverage bottles of glass containers was assumed to be 80% based on a report done for the City of Tacoma in 2005 and Eunomia research and modeling from previous projects which estimated the percent of glass containers which are beverage.[38] |
| Cartons | 75% | Cartons volumes are low in general, and no specific data could be found on the percentage of cartons that are beverage related. An assumption of 75% of cartons being beverage-related was made based on an increasing number of milk and milk alternative products being in sold in cartons. |

*Source: Eunomia*

The Container Recycling Institute (CRI) annually calculates the number of beverages by type and material POM in Washington. They also have specific data on average beverage container weights.[39] The CRI beverage container weight data (contained in the *Technical Appendix*) has been applied to the proportion of baseline generation data calculated to be beverage to calculate the number of units generated. This number was compared with the CRI-calculated POM unit data. There was a noticeable difference in all materials except for aluminum beverage cans, with the most significant difference for glass. In all cases, the estimate of units using the generation data was less than that calculated by CRI. Possible reasons for these differences include:

- CRI data provided was for 2017, while the generation data was based on applying the 2015/16 Statewide Waste Characterization and applied to 2017 generation data. The composition of beverage containers is constantly changing. For example, information from CRI suggests that from 2017, PET bottle generation has increased by 9% and glass by 11%[40].
- Glass generation data is often underestimated because during waste characterization surveys glass often gets crushed and cannot be clearly identified in waste sorting studies, leading to an underestimation of the amount disposed and, therefore, to underestimation of the total generation estimate.

For the purposes of the modeling, and to remain consistent with the approach taken for other packaging types, the Washington-based generation data along with the CRI average beverage container weights has been used to calculate the quantity of material that would be diverted from current recycling and trash systems. The proportion of material that migrates from the curbside recycling and trash streams for each beverage material was apportioned based on the percentage by which the material is currently in the waste stream, considering both residential and commercial sectors. Currently, 63% of PET beverages are disposed of in the trash and 37% are collected for recycling. As such, 37% of containers necessary to meet a 90% redemption rate are shifted from the recycling system and 63% of the containers necessary are taken from the trash.

The material specific redemption rates have been applied to the POM data to calculate the number and tons of beverage containers redeemed through the DRS system. Of the remaining containers a percentage will still be placed in curbside PPP containers, a percentage disposed and a small percentage still littered, although this will be less than without a DRS system. There will be a loss rate associated with beverages collected through the DRS as well as those that continue to be collected through curbside services. In addition, a percentage assumption has been made for cross boarder fraud. This is expected to be minimal as Washington is only bordered by one non deposit state and the neighboring states with deposits have the same or a similar deposit value reducing the likelihood for cross board fraud.

### *EPR – Systems*

A target driven EPR policy is intended to drive the necessary investment into PPP programs to enable the target to be met. To gain a better understanding of what could be possible in the future the following relatively conservative assumptions have been made:

*Collection*

- **100% Coverage**: As set out in *Section 2: Summary of* Potential Future System Scenarios, when EPR is introduced under any of the future possible EPR systems (Systems 2-7), all single family or multifamily households will receive a curbside or on-site recycling service.
- **Common set of materials**: A common set of materials (*Section 2: Summary of* Potential Future System Scenarios) will be collected at the curbside, some of which will currently be non-target material in many jurisdictions.
- **Increase in capture rate for materials**: The percentage of each PPP material collected for recycling for all jurisdictions increases to that recorded for the City of Seattle which, due to many years of investment in programs and education necessary to reduce high disposal costs, has resulted in the City of Seattle achieving high capture and recycling rates.

*Post Collection Sorting – Systems 2, 3, 5 and 6*

- **Secondary processing of mixed plastics bales #3-7:** Only 16% of #3-7 plastics generated in Washington make it to market. 63% of this material is rigid PP which can attract a market value between 2-3c per lb.[41] Under the future EPR Systems it has been assumed that existing sorting facilities bale all #3-7 and this material is taken to a secondary processor to extract the PP value specifically. Discussions with PP processor EFS Plastics[42] who operate facilities on the east coast suggest that if there is sufficient volume on the west coast and if #3-7 bales have a minimum of 50% PP then they would consider investing in the region. Material flows through this secondary processor is provided under each of the future scenarios.
- **Capture of material in residues:** Target material such as PET bottles and aluminum cans are currently being disposed of with the residue, due to sorting inefficiencies. The quantity of this material has been calculated and included in the figures as additional tons that could be captured for recycling. If targets are set high enough, the investment needed to capture this material will be worthwhile to producers.
- The tons associated with each of these additional sorting steps has been included separately in the material flows and is summarized in the *Technical Appendix.*

*Post Collection Sorting – Systems 4 and 7 Dual Stream*

- Capture rates: Under the dual stream system, data provided from a sorting facility designer and equipment provider[43] that had access to Washington's residential PPP material breakdown has been used to assume a 95% material capture rate with bale purity of 95% can be achieved for new facilities.

The recycling collection performance benefits of these assumptions are provided in the material flows under each option and the cost implications within the total cost for each FS.

Some of the packaging materials accepted under EPR will be materials that are not current accepted under existing programs in some regions due either to low volumes, weak recycling markets, or both. While economically separating and marketing these materials may be still be difficult, increased collection volumes and concentration of these materials collected under EPR create economies of scale that are assumed to enable marketing and possible discussions for expanded infrastructure. Centralized management of PPP under EPR will increase the likelihood of post sorting systems being investigated especially if recycling targets are set high enough.

*Systems with Drop-off*

Under Future System 2, 11% of the Washington population will be required to take their glass to a drop-off/drop-box location. To model the cost of this system it has been assumed that there is one drop-off-location for every 15,000 population. Based on an estimated 365k people that would need to use these facilities, a total of 502 locations across Washington has been modeled, the majority located in the central and east where the number of households without a service currently is highest.

Under Future Systems 2 – 7 there will also be a requirement to collect Polyethylene (PE) plastic bags and film and expanded polystyrene (EPS) at drop-off locations. 502 locations will be required to service the total population of Washington based on the same coverage assumption.

### Costs and Revenues

#### *Systems with DRS*

There is a cost to implementing and operating a DRS which is in addition to the cost of providing PPP curbside services. Due to the DRS pulling materials from the PPP curbside and trash streams there is also a cost impact on curbside collection as well as a disposal cost saving resulting from less beverage containers being disposed.

Eunomia's DRS model calculates, from the bottom up, the cost of the redemption, collection and processing network necessary to meet 90% redemption and the geographical coverage target. The model uses Washington based inputs for labor, property cost, electricity, fuel costs etc. along with system-based assumption provided by operators of existing systems in the US, Canada and Europe. Data for example in relation to number of containers that can be collected per vehicle compacted and non-compacted, RVM compaction rates or per minute counting rates for bulking and counting have come from system operators and equipment suppliers.

The key factors that impact DRS costs are:

- **Number of redemption points**: Costs association with redemption points include: property rental costs, electricity, etc., as well as any labor costs associated with managing or maintaining each site. The number of redemption points will also impact on transport cost. In order to meet the geographic coverage targets – one redemption point per 5,000 population, and 80% of the population within a 5-mile drive of a location, 2,442 redemption points have been modeled.
- **Redemption type RVM vs bag drop:** There is a capital and maintenance cost for both RVM's and bag drop solutions. The redemption type also impacts on the collection and storage costs, for example, RVM's verify and crush cans and PET bottles reducing storage space requirements and space during transit. Units processed through an RVM also do not then need to be further counted and verified through a counting center. Bag drop programs while providing a level of convenience for users, require more storage space in retail and redemption center locations as well as on collection vehicles and also require counting and verifying adding time and cost to the system.
- **Collection and transfer:** As stated above, how and where containers are redeemed will impact on collection and transfer costs.
- **Counting and consolidation centers**: As stated above, counting facilities can either count and verify using bar code verification all, some or none of the containers. The model assumes that all containers will be verified and counted according to their bar code, this is a cost that systems that just count the container by material type do not have. The number of counting machines and the costs of operating them, in terms of buildings and labor, etc., is dependent on the number of containers that are verified through RVM's as these containers do not need to be counted and verified again through a bulk counting machine. Three counting centers have been modeled for the system.
- **PRO costs**: PRO costs include the labor associated with administering the system, information provided by other DRS PROs has been used to calculate a budget cost.
- **Revenue streams**: Key revenue streams assumed in the model include:
    - Material revenue values are estimated based on data from www.recyclingmarkets.net. Regional averages form the Pacific Northwest were chosen, finding the midpoint of values for 2017. More detail on the calculations can be found in the Technical Appendix;
    - Bag sales: Under the bag-drop programs residents purchase bags, this revenue is included in the model;
    - Bag drop convenience fee, as is the case with DRS program in Oregon, consumers wishing to use the bag-drop system pay a convenience fee per bag this offset some of the additional costs of handling the bags versus returning through an RVM.

In addition to the cost of operating the DRS there is a cost impact and benefit on the wider recycling system summarized as follows:

- **Reduced collection routes and costs**: Less material collected at the curbside can lead to collection efficiencies resulting in a reduction in the number of routes needed to collect the remaining PPP. Vehicle and collection personnel reductions have been calculated regionally by collection system, and assume that there will be some regional optimization of services. In reality, individual jurisdictions may choose to reduce collection frequencies to make efficiencies. In addition to reductions in PPP, curbside collection routes and resources, trash collections could also be optimized, because more material is being pulled from the trash stream than the curbside recycling stream. The cost benefit associated with reduced trash collections has not been included in the model because it is not directly linked to the cost of recycling PPP. However, there could be a further collection cost savings to jurisdictions by reducing collection frequency of trash collections, which would be possible due to lower volumes of PPP in the trash.

- **Reduced PPP disposal cost**: Less PPP will be disposed of in the trash, which will reduce the cost of disposal for jurisdictions. This cost saving has been included in the costs and benefit summary for all FSs.
- **Reduced sorting costs/income**: Less material collected at the curbside will result in less material requiring sorting. This will result in a loss in revenue for sorting facilities. If this loss is not compensated for with another revenue stream, it is likely to be passed through to the jurisdictions in the form of an increase in cost per ton of material for sorting. In all EPR FSs, there is also an increase in the amount of other PPP material, which helps to offset the loss in beverage containers. In the modeling, it is assumed that this cost impact is not passed through to jurisdictions because three alternative revenue streams are available to offset the loss:
  - Deposit: Sorting facilities, if they separate out deposit bearing containers can claim the deposit value $0.10 when the units are verified through a counting facility. There will always be consumers that continue to place containers in their curbside containers, this is likely to be higher in the initial years of the DRS.
  - Share of unclaimed deposits: It has been assumed that producers have three years to reach the DRS redemption target, in the early years when the target is not met the unclaimed deposits associated with the non achievement of the target (90%) will be placed in a fund managed by the state government or government-appointed agency and used to support investment in sorting facility infrastructure;
  - Provision of counting center function: Sorting facilities are well placed to operate a counting center and be paid to do so under contract to the PRO, assuming that they can ensure the integrity of the counting through proper technology.
- **Reduced material revenue:** Sorting facilities will lose revenue when beverage related aluminum, PET and HDPE moves to the DRS system. In the early years of the DRS these impacts have been assumed to be offset by the same mechanisms set out above. When the DRS is operated as part of a wider EPR program then sorting facilities will not take on the material revenue risk but be paid the cost of providing the sorting function.

The costs for the DRS system as well as the cost impacts on curbside services are provided for each system in *Section 5: Future Systems Costs and Benefits*

*EPR Systems*

Under the EPR systems, the  collection costs, compared to the baseline, are affected by:

- **Quantity collected**: The common list of materials collected at the curbside coupled with 100% of households having collection and an assumed increase in capture rates based on City of Seattle's current performance will increase the cost of collection as more material will be collected from more properties.
- **Collection type and frequency**: How material is collected and the frequency of collection will also affect costs. Dual stream collection systems modeled under FSs 4 and 7, where fiber is collected one week and MGP is collected the following week, is effectively a weekly service; this will have a greater cost than single stream collected biweekly.

Eunomia's collection model Hermes, uses the revised material flows to adjust the number of resources (vehicles and personnel) under each system, considering limiting factors such as working time, pass rates and vehicle capacity to calculate the revised number of routes and resources needed to provide the service under a specific collection system, e.g. dual stream, single stream without glass.

The amount of management, supervision and administration costs is then calculated by multiplying the number of routes under the new system by the resource per route metric calculated from the current system data.

**Drop-off facility** costs have been calculated using data provided City of Olympia for their glass drop-off/drop box system as well as data within Eunomia's database. The containers assumed to be used for glass under FS 1 and FS 6 well as for film and EPS under all EPR systems are 30 cubic yards in volume. The number of collections required from each site has been calculated using material bulk densities and the assumption that collections are made when containers are 80% full. Depreciated container capital costs and maintenance costs have been included. No allowance has been made for costs associated with placing these containers either on existing drop-off facility sites or on other locations, while there maybe cost associated with this, compared to other system costs these will be comparably small.

**The transfer and gross MRF sorting fees** under all future systems remains the same as for the current system. It is reasonable to assume that under FS 3, where glass is collected separately from other PPP material, that the sorting fee could be reduced, but no evidence of this could be found. Eunomia was also provided with some information to suggest that the average sorting fee for new fiber and metals/plastics/glass (MPG) sorting facilities could be as much as 25% less than for single stream, however these potential benefits were not included in the model. The current average sorting cost of $125 per ton was applied to all PPP sorted through all FS's except for System 4 and 7, where all households have a dual stream system, are the same as under the baseline. A sorting fee based on glass being excluded was sought but couldn't be found.

**Material Revenue:** Per ton material revenues vary across the systems according to how material is collected and the tons. The 2019 average mid-point per ton value by material as published by recyclingmarkets.net has been assumed for all FSs except for the dual stream systems where the average upper value has been taken, on the assumption that the bales from new dual stream sorting facilities will have a higher purity level as set out above. Exact values used for each material can be found in the Technical Appendix.

**Secondary processing: Under FS 2, 3, 5 and 6 it has been assumed that mixed bales of rigid plastics** #3-7 will be able to be marketed to a secondary processor and will attract a value of between 2-3c per lb. When recycling targets are set high enough, the PRO will be required to invest in infrastructure or support the development of local markets.

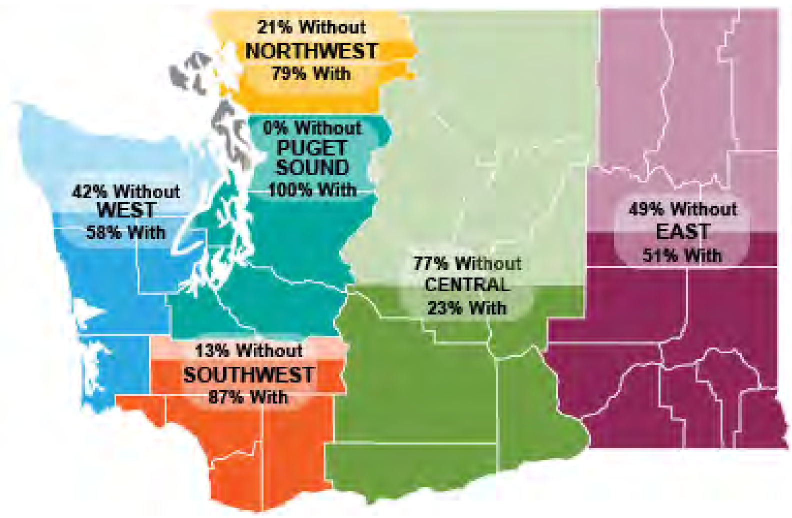
**Disposal Costs:** Current regional disposal rates have been assumed for all future systems.

# Section 4: Baseline Costs and Benefits

## Service Overview

Over 360,000 households in Washington, 9% of single family and 15% of multifamily, do not have any access to curbside (single family) or on-site (multifamily) PPP recycling service. The residents of these households are required to take their recyclables to drop-off locations for them to be recycled. A further 322,000 households have the option of a service; 25% of these households are assumed to subscribe. Access to curbside or on-site recycling services based on these assumptions, by region, are shown in Figure 11.

**Figure 11: The Percentage of Households with and without a Curbside Services**




The type and level of curbside or on-site recycling services provided to households varies from jurisdiction to jurisdiction with respect to the materials collected, collection methodology and frequency of collection, all of which impact the quantity and quality of PPP collected for recycling. Households may be provided recycling services directly by their city, by a private hauler under contract with their city or county, or by a private hauler under the UTC-regulated solid waste collection system. There are some drop-off collection programs for flexible plastics and polystyrene foam packaging, but access to drop-off locations is inconsistent and geographically limited, and end markets for collected materials are unreliable. All of these factors impact on the cost of service provision, which is reflected in household rates. Details of the type of services provided in each of the six regions in Washington are provided in the *Technical Appendix.*

## PPP Generated, Recycled and Disposed

While access to curbside recycling services in Washington is high compared to some other states, the recycling rates for different PPP materials vary from 16% for all plastics to 69% for container glass, as shown in Table 8. This is partly due to the fact that some materials are not accepted for recycling in parts of the state; but even for materials that are widely accepted, there is still a large percentage that ends up in the trash.

Table 8 shows the estimated tons of each PPP material generated, disposed, collected for recycling and sold by the sorting facility to a reprocessor. A recycling rate based on the sorting facility outputs is also provided. The actual quantity of material that will be recycled will be less than this amount, as additional contaminants will be removed at the reprocessor. However, for the purposes of this study, the sorting facility outputs are used as the point of measurement to calculate the recycling rate across all systems.

Paper and cardboard make up the majority of the PPP generated and account for 73% of the total amount of material recycled in the state. Plastics only account for 6% of the material recycled. Of all plastic PPP, 16% is currently recycled, the majority of which is PET, which has a recycling rate of 36%. The recycling rate for aluminum, which is a valuable market commodity is only 53%.

The recycling rate also varies across the different regions. Figure 12 shows the PPP recycling rate in each region of Washington State. These differences can be partly explained by differences in access to curbside services. Differences may also be influenced by the reach and effectiveness of education activities and regional differences in demographics or consumption patterns among households. Lack of data on these factors make it impossible to fully analyze the underlying causes of these regional differences in performance outcomes in the baseline.

Material collected for recycling is not equivalent to the amount that is sold to a reprocessor. Sorting facility inefficiencies can result in material either being lost to residuals or flowing through to other material streams. Similarly, material collected at the curbside may include PPP that is not a target material and for which there are currently no markets at small volumes. For example, 10% of PET bottles collected for recycling either end up in residues or in other material bales and therefore are not recycled.[44] Cartons are not collected by many jurisdictions, but where they are collected, they are not being recycled, mainly due to lack of markets for this material.

**Table 8: Tons of PPP Generated, Disposed and Recycled 2017**

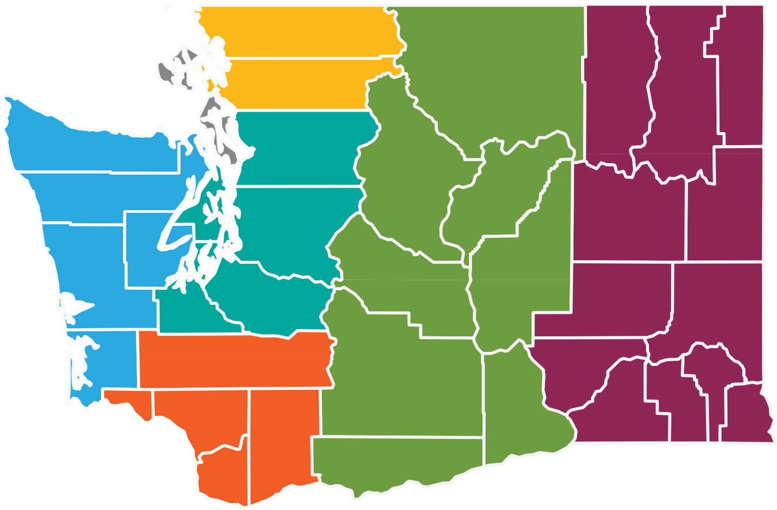
| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [IX] | Recycling Rate |
|---|---|---|---|---|
| All Plastic | **193,080** | **158,780** | **30,580** | **16%** |
| Rigid Plastics | **120,880** | **90,280** | **26,880** | **22%** |
| #1 PET Bottles | 34,100 | 21,900 | 12,200 | 36% |
| *#1 PET Bottles DRS Eligible* | *27,300* | | | |
| *#1 PET Bottles Not DRS Eligible* | *6,800* | | | |
| #1 PET Other Packaging | 20,000 | 17,500 | 2,500 | 13% |
| #2 HDPE Natural Bottles | 9,700 | 6,200 | 3,500 | 36% |
| *#2 HDPE Natural Bottles DRS Eligible* | *7,800* | | | |
| *#2 HDPE Natural Bottles Not DRS Eligible* | *1,900* | | | |
| #2 HDPE Colored Bottles | 12,800 | 8,700 | 4,100 | 32% |
| *#2 HDPE Colored Bottles DRS Eligible* | *1,300* | | | |
| *#2 HDPE Colored Bottles Not DRS Eligible* | *11,500* | | | |

[IX] MRF sorting facility tons to market

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [IX] | Recycling Rate |
|---|---|---|---|---|
| # 2 Other HDPE Packaging | 4,600 | 3,600 | 960 | 21% |
| #3 PVC Packaging | 110 | 110 | 0 | 0% |
| #4 LDPE Packaging | 70 | 70 | 0 | 0% |
| #5 PP Packaging | 13,000 | 10,100 | 2,900 | 22% |
| #6 PS Packaging | 1,700 | 1,300 | 420 | 25% |
| #7 Other Packaging | 5,600 | 5,600 | 0 | 0% |
| Expanded Polystyrene Packaging | 13,300 | 13,000 | 300 | 2% |
| PE Plastic Bags & Film | 21,600 | 17,900 | 3,700 | 17% |
| Other Plastic Film & Flexible Packaging | 50,600 | 50,600 | 0 | 0% |
| R/C Plastic Packaging | 1,800 | 1,800 | 0 | 0% |
| PLA/Compostable Packaging | 4,100 | 400 | 0 | 0% |
| Flexible Plastics | **72,200** | **68,500** | **3,700** | **5%** |
| All Metals | **62,400** | **32,200** | **28,000** | **47%** |
| Steel Containers | 25,300 | 15,400 | 9,900 | 39% |
| All Aluminum | 37,100 | 16,800 | 18,900 | 53% |
| *Aluminum DRS Eligible* | *16,400* | | | |
| *Aluminum Not DRS Eligible* | *20,700* | | | |
| All Paper and Card | **683,000** | **298,900** | **384,100** | **56%** |
| Container Glass | **129,400** | **48,200** | **81,200** | **63%** |
| *Container Glass DRS Eligible* | *104,400* | 104,400 | 0 | |
| *Container Glass Not DRS Eligible* | *25,000* | 25,000 | 0 | |
| **Total** | **1,067,900** | **538,100** | **524,700** | 49% |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

**Figure 12: PPP Recycling Rates by Region**



## PPP Collection, Transfer and Sorting Costs

The estimated total cost of PPP recycling in Washington, along with the cost of disposing of PPP, is included in Table 9. A cost per ton recycled as well as per household is also included in the table, along with the cost per household for the tons of PPP disposed in the trash.

PPP collected in the trash stream is also a cost to households. While this cost has not been modeled, it is a cost especially when recycling rates are low. While the cost of collecting PPP in curbside trash has not been calculated, the cost of disposing of PPP has, and is included in the cost table as a benefit to municipalities.

More cost information is provided in the Technical Appendix. For the purposes of comparing the FSs against the current system, a cost per ton of material recycled has been calculated at $471. The total cost of recycling 49% of residential PPP in Washington is $247M, with a further $70M spent on disposing of the PPP that is not separated out for recycling, which equates to a total cost of $317M. The biggest cost of recycling is the cost of collection which accounts for 53% of the net total costs (excluding material revenue). The total collection, drop-off and sorting cost excluding material revenue is $179M.

**Table 9: Cost of PPP Collection and Transfer in Washington in 2019**

| Cost Element | Current System Cost |
|---|---:|
| Recycling Collection Cost ($M) | 141.994 |
| Drop-off Costs ($M) | 2.272 |
| Sorting Costs ($M) | 54.729 |
| Sorting Material Revenue ($M) | -19.658 |
| MRF Residue Disposal Cost ($M) | 7.613 |

| Cost Element | Current System Cost |
|---|---|
| Management, Supervision and Administration ($M) | 17.769 |
| Overhead and Profit ($M) | 20.253 |
| Taxes ($M) | 22.145 |
| PRO Costs ($M) | N/A |
| Education Costs ($M) | N/A |
| Secondary Plastic Processing Revenue ($M) | N/A |
| EPR Governance Costs ($M) | N/A |
| DRS Costs (including revenue) ($M) | N/A |
| **Total Cost** ($M) | **247.118** |
| **Total Cost per Ton Recycled (incl. DRS where applicable)** | **471** |
| Cost of PPP Disposal ($M) | 70.374 |

*Source: Eunomia Modelling, Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver, Washington Department of Ecology Landfill fees, CSSA Annual Cost Reports, Correspondence with Washington MRF Haulers, Correspondence with Washington MRF Operators, RecyclingMarkets.net*

## Benefits

### Jobs

The total number of direct, indirect and induced jobs associated with the current service is provided in Table 10. 1,502 full-time equivalent (FTE) resources are employed in delivery services, with a further 2,373 indirect and induced FTE employees, for a total of 3,874 jobs created across the state.

**Table 10: Direct, Indirect and Induced Jobs Associated with the Current Residential PPP Recycling System**

| Job Category | Jobs from Current Residential PPP Recycling System |
|---|---|
| Direct | |
| Collections Operations | 773 |
| Collections Support & Management | 288 |
| Sorting | 419 |
| Secondary Sorting | N/A |
| Drop-off Jobs | 22 |
| DRS | N/A |

| Job Category | Jobs from Current Residential PPP Recycling System |
|---|---|
| Governance | N/A |
| PRO | N/A |
| Subtotal direct | 1,502 |
| Subtotal indirect and induced | 2,373 |
| **Total** | **3,874** |

*Source: Eunomia, U.S Economic Policy Institute (2019), Bureau of Economic Analysis*

### Gross Value Added (GVA)

The total direct, indirect and induced GVA to the Washington economy resulting from the current residential PPP recycling service is over $497M, as shown in Table 11.

**Table 11: Direct, Indirect and Induced GVA Generated from Current Residential PPP Recycling Services**

| GVA Category | GVA from Current Residential PPP Recycling System |
|---|---|
| Direct GVA ($M) | 201.129 |
| Indirect GVA ($M) | 166.412 |
| Induced GVA ($M) | 129.335 |
| **Total ($M)** | **496.875** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017)*

### GHG Impact including Social Cost of Carbon

The EPA's WARM model[45] has been used to assess the amount of GHG avoided from recycling rather than landfilling the quantity of PPP currently recycled. The GHG impact associated with the recyclables has not been included due to a lack of data.

The $MTCO_2e$ avoided from the current residential PPP recycling activities in Washington is 1.399M a year which is the equivalent of taking more than 297,000 vehicles off the road.

### Litter

Litter reduction calculations have only been assessed for beverage containers as a result of the DRS under FSs 1, 5, 6 and 7.

## Costs and Benefits Summary

Table 12 provides an overarching view of the cost benefit of the current system, when the GVA has been netted off the cost of service as well as the social cost of carbon. These are very real benefits and should be included when calculating the cost or, as is the case, net benefit of recycling. Table 12 shows that for every ton recycled, there is a net societal benefit of $542.

**Table 12: Net Cost Benefit of Current Residential PPP Recycling System in Washington**

| Cost Category | Cost of Current Residential PPP Recycling System |
|---|---|
| System Costs ($M) | 247.1 |
| Disposal Costs ($M) | 70.4 |
| Monetized Cost of Carbon ($M) | -104.9 |
| GVA ($M) | -496.9 |
| **Total Net ($M)** | **-284.3** |
| **Net Benefit per Ton Recycled ($)** | **-542** |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019)[46], Bureau of Economic Analysis[47]*

A summary of the environmental and social benefits is provided in Table 13.

**Table 13: Environmental and Social Benefits of Current Residential PPP Recycling System in Washington**

| Benefit Category | Value in Current Residential PPP Recycling System |
|---|---|
| Recycling Rate | 49% |
| Tons Recycled | 524,700 |
| $MTCO_2e$ Avoided | 1.399M |
| Jobs Direct, Indirect and Induced | 3,874 |

*Source: Eunomia, EPA Warm Model, Indices from Economic Policy Institute (2019)[48], Bureau of Economic Analysis[49], Institute for Scrap Recycling Industries (2017)[50], Cost of Carbon metric from Washington Utilities and Transportation Commission (2019)[51]*

## Stakeholder Impact

Table 14 below elaborates on the impact to relevant stakeholders under the current system.

**Table 14: Impacts on Stakeholders from the Current Mechanisms for Providing Residential PPP recycling Services**

| Stakeholder | Impacts and Mitigation |
|---|---|
| Municipalities/ jurisdictions | Municipalities are currently subject to material markets for which they have no control, which impacts on the cost of providing services. In order to manage these costs, services either have to be reduced or rates increased. |
| Waste Haulers | Waste haulers are required to contract with jurisdictions for the provision of services and, in some cases, take on a proportion of the risk, when material values fluctuate due to changing market conditions. |
| MRF operators | MRFs are required to contract for services with jurisdictions. MRFs also take on a proportion of the risk when material values fluctuate. |
| State | The state is trying to stimulate markets for recycled materials. The Washington State Legislature established the Recycling Development Center in July 2019,[52] but it has no control over the material that is collected, making it difficult to provide any guarantee to future investors that material will be available.<br><br>The lower the recycling rate, the fewer jobs are generated in the sector and, by not seeking to drive up PPP recycling, there is a missed economic opportunity. |
| Households | Cost increases or service reductions resulting from fluctuating material markets are ultimately borne by individual households.<br><br>Currently, 21% of households do not have automatic access to curbside services due to either the cost or complexity of providing services to rural areas or multifamily households. |
| Low income households | The cost of trash and recycling services has a greater impact on low income families. |
| Households in rural areas | Proportionally fewer households in rural areas have access to curbside services caused in part to the greater cost of collection. |
| Homeless | The homeless, while not impacted by PPP services, are impacted by litter. |
| Producers | Producers that place PPP in the market currently do not shoulder any of the costs of managing PPP at the end of its life. |
| Retailers | Retailers currently have no obligated involvement in the cost or provision of services to recycle the PPP that they sell. |

*Source: Eunomia*

# Section 5: Future Systems Costs and Benefits

## Future System 1: Current System with DRS

### Service Overview

Under this FS, all conditions remain the same as with the current system, but a DRS for beverage containers is added. In the DRS, producers of beverages are required to individually meet legislated targets for redemption rates and geographic coverage and are required to pay for the cost of the system that will ensure that these targets can be met. The DRS design and policy considerations are detailed in Phase II report *A Beverage Container Deposit Return System for Washington - Qualitative Research and Recommendations.* In this report, an overview of how the system would operate alongside the existing curbside and drop-off system is described in *DRS Design* within *Section 2: Summary of* Potential Future System Scenarios. The costs and benefits are detailed below.

In order to meet the geographic coverage targets (80% of the population within 5 miles of a redemption point and one redemption point per 5,000 people), the type and number of redemption points modeled is included in Table 15, along with the volume that has been assumed to flow each type. Retail stores under 5,000sq ft are not required to accept containers. The location of the redemption points by type is provided in Figure 13, which also shows Washington State Department of Transportation fixed transit, including bus routes and light transit.[53]

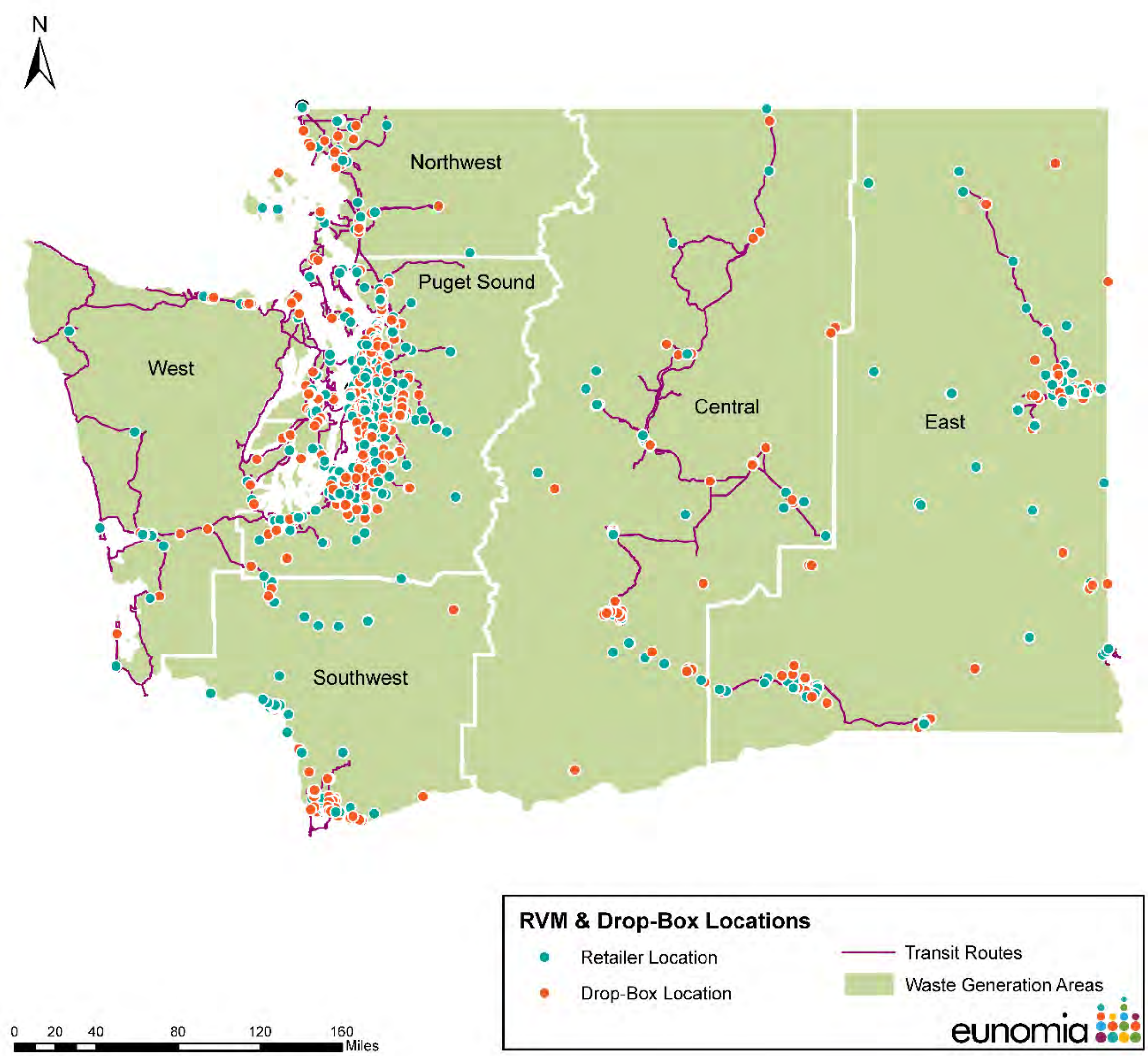
**Table 15: Redemption Points, by Type, Number and Volume Handled**

| Infrastructure | Number of Locations | % of Volume Handled | Units (Million) |
|---|---|---|---|
| Return to Retail Automated Collection (RVMs – only stores over 5,000 sq ft)[X] | 1,715 | 48% | 2,018 |
| Dedicated Redemption Centers | 25 | 15% | 644 |
| Bag Drop – Return-at-Retail (Parking lot stand-alone containers) and other stand-alone locations | 727 | 37% | 1,585 |
| **Total** | **2,442** | **100%** | **4,247** |

*Source: Eunomia, assessment to meet geographical coverage target*

[X] Retail stores below 5,000 sq ft assumed not to have a requirement to redeem unless they chose to.

**Figure 13: DRS RVM and Drop-Box Locations**




*Source: Eunomia, Washington State Department of Transportation, and NAICS.*

The system design and costs assume that every unit redeemed is verified according to its existing product bar code. Under this system, producers are required to provide these bar codes to both the PRO and the state government or government-appointed agency as a condition for selling their products in the state.

Not all DRSs use bar code verification to count and record every unit, some only verify a percentage while others only count the units. The benefit of verifying every unit is that it is easier to identify fraud through several areas. Free-riding in the system can be easily identified with bar code verification. Also, when redemption rates are high, it is possible for redemption rates to actually exceed 100% due to cross border fraud or producers underreporting the units that they place on the market. Verification of the bar codes can identify those containers that were not sold in Washington and prevent any container from being redeemed more than once.

Bar code verification will also help identify any potential under-reporting of units by individually verifying each container redeemed against those sold. Verifying every unit is more expensive than just counting containers, but provides better system integrity and information. RVMs use bar code verification; however, bag drop programs do not. The model assumes three counting centers are required to count and consolidate the material redeemed through bag drops before it is sold to market.

Information technology (IT) systems that allow for consumers to have an online account to access their deposits and through which information can be provided is integral to the bag drop system but can also be linked to RVM. The cost of IT associated with this has been included in the cost of the program.

### PPP Generated, Recycled and Disposed

4.702B beverage containers are POM every year, the *Technical Appendix*, contains the number of containers by material type, along with the average weight of each container and the total tons. A summary of PPP generated in the residential sector is provided in Table 16.

When the redemption rate is set to meet 90%, the additional tonnage of material recycled as a result of a DRS being operated alongside existing curbside and drop-off services is included in Table 16. Implementing a DRS increases the overall recycling rate by over 6%, resulting in an overall PPP recycling rate of 55% and increases the tons recycled by 61,700 for a total of 590,700. The rigid plastic recycling rate increases from 22% to over 40% with over 22,000 additional tons of plastics recycled.

**Table 16: Tons of PPP Generated, Disposed and Recycled for FS 1**

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XI] | Recycling Rate |
|---|---|---|---|---|
| **All Plastic** | **193,080** | **137,080** | **52,300** | **27%** |
| Rigid Plastics | **120,880** | **68,580** | **48,600** | **40%** |
| #1 PET Bottles | 34,100 | 5,600 | 28,500 | 84% |
| *#1 PET Bottles DRS Eligible* | *27,300* | *1,400* | *25,900* | 95% |
| *#1 PET Bottles Not DRS Eligible* | *6,800* | *4,200* | *2,600* | 38% |
| #1 PET Other Packaging | 20,000 | 17,500 | 2,500 | 13% |
| #2 HDPE Natural Bottles | 9,700 | 1,700 | 8,000 | 83% |
| *#2 HDPE Natural Bottles DRS Eligible* | *7,800* | *500* | *7,300* | 94% |
| *#2 HDPE Natural Bottles Not DRS Eligible* | *1,900* | *1,100* | *800* | 42% |
| #2 HDPE Colored Bottles | 12,800 | 7,800 | 5,000 | 39% |

[XI] MRF sorting facility tons to market

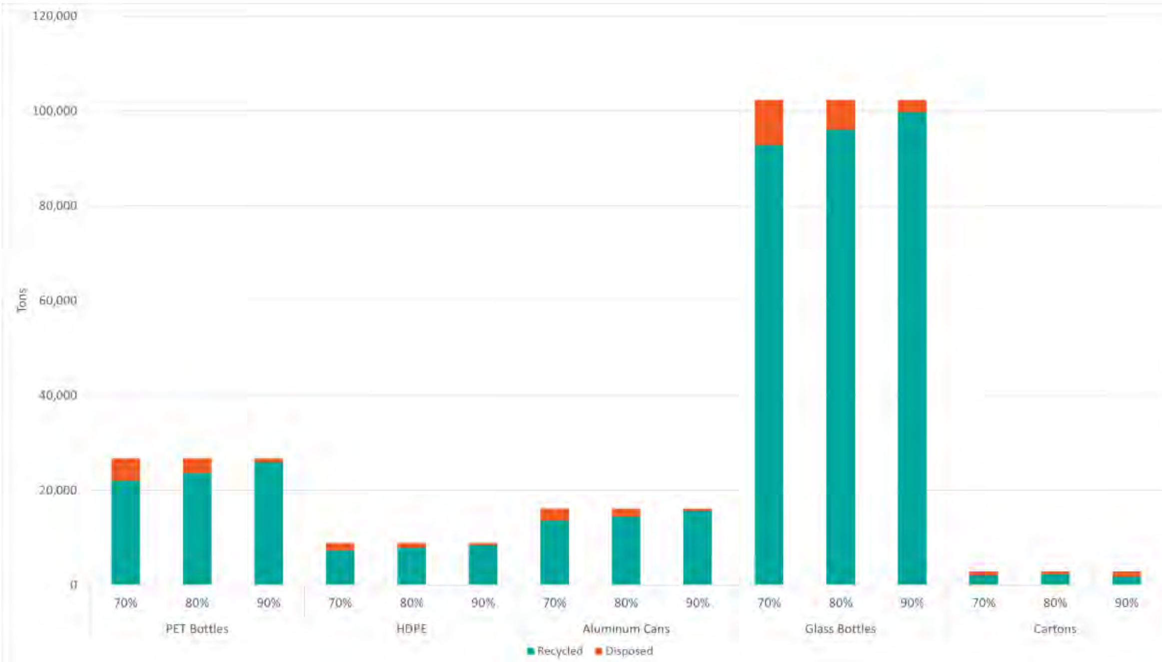
| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XI] | Recycling Rate |
|---|---|---|---|---|
| *#2 HDPE Colored Bottles DRS Eligible* | *1,300* | *100* | *1,200* | 92% |
| *#2 HDPE Colored Bottles Not DRS Eligible* | *11,500* | *7,700* | *3,800* | 33% |
| # 2 Other HDPE Packaging | 4,600 | 3,600 | 1,000 | 22% |
| #3 PVC Packaging | 110 | 110 | 0 | 0% |
| #4 LDPE Packaging | 70 | 70 | 0 | 0% |
| #5 PP Packaging | 13,000 | 10,100 | 2,900 | 22% |
| #6 PS Packaging | 1,700 | 1,300 | 400 | 24% |
| #7 Other Packaging | 5,600 | 5,600 | 0 | 0% |
| Expanded Polystyrene Packaging | 13,300 | 13,000 | 300 | 2% |
| PE Plastic Bags & Film | 21,600 | 17,900 | 3,700 | 17% |
| Other Plastic Film & Flexible Packaging | 50,600 | 50,600 | 0 | 0% |
| R/C Plastic Packaging | 1,800 | 1,800 | 0 | 0% |
| PLA/Compostable Packaging | 4,100 | 400 | 0 | 0% |
| Flexible Plastics | **72,200** | **68,500** | **3,700** | **5%** |
| All Metals | **62,400** | **25,800** | **36,600** | **59%** |
| Steel Containers | 25,300 | 15,400 | 9,900 | 39% |
| All Aluminum | 37,100 | 10,400 | 26,700 | 72% |
| *Aluminum DRS Eligible* | *16,400* | *800* | *15,600* | 95% |
| *Aluminum Not DRS Eligible* | *20,700* | *9,600* | *11,100* | 54% |
| All Paper and Card | **683,000** | **297,100** | **385,900** | **57%** |
| Container Glass | **129,400** | **13,500** | **115,900** | **90%** |
| *Container Glass DRS Eligible* | 104,400 | 4,500 | 99,900 | 96% |
| *Container Glass Not DRS Eligible* | 25,000 | 9,000 | 16,000 | 64% |
| **Total** | **1,067,900** | **473,500** | **590,700** | **55%** |

*Source*: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling

While cost modeling has been carried out for a system where the DRS results in a 90% redemption rate, this target is unlikely to be met in the first year of DRS implementation. To illustrate the potential transition to this rate, Figure 14 shows the tons of residential beverage containers that are currently collected through curbside and drop-off facilities as well as the amount that is disposed and littered, alongside a DRS that achieves a 70% redemption rate in year one, 80% in year two and 90% in year three. Containers migrate from the curbside recycling system as well the trash stream. There is a migration of material from the curbside recycling to the DRS stream, but an even greater amount of material moves to the DRS from the trash, as a greater number of beverage containers are currently disposed of in the trash than recycled through the existing curbside services. The cost impact of this material migration is discussed below for curbside residential PPP recycling.

The DRS will also capture a large percentage of the 4,873 tons of material estimated to be littered, as the financial incentive ensures that most containers will not go uncollected. Litter rate assumptions are detailed below.

**Figure 14. Tons Recycled Currently versus with DRS at 70%, 80% and 90% Redemption for PET, HDPE, Aluminum and Glass**




*Source: Eunomia, CRI*[54]

## PPP Collection, Transfer, Sorting and DRS Costs

### DRS Costs

The DRS has its own costs associated with each element of the system. Eunomia's DRS is a bottom-up model that is driven by a 90% target redemption rate which is assumed to be achieved with a $0.10 deposit and the set geographical coverage. The DRS model uses beverage unit numbers, weights and bulk densities resulting from different redemption and transport mechanisms along with unit costs for collection and sorting infrastructure and transportation to calculate the costs of the system by container type. The costs modeled:

- Redemption infrastructure:
    - Capital costs associated with RVMs and bag drops and in-store kiosks for printing labels, bulk sorting machines, balers.
    - Maintenance costs for redemption infrastructure and property costs for bag drops and redemption centers, including leasing costs and electricity.
- Operating costs:

  - Labor: Retail staff time to service instore redemption options, maintenance staff for machines, redemption center staff, sorting center staff, PRO staff (i.e. management team, administration, fraud protection and monitoring, information technology, etc.)
  - IT systems: Real time data systems report on units redeemed and verified through RVM's as well as those counted through counting centers. This information is fed back to central accounts teams as well as maintenance teams that will service machines as well as schedule collections.
  - Transport: Collection from redemption locations to sorting and consolidation centers

- Oversight:
  - Includes an allowance for costs to cover the role of the government agency.

Table 17 summarizes the cost of operating the DRS as a whole when the system is achieving a 90% redemption rate. A breakdown of each system cost is provided in the technical appendix. The cost per unit placed on the market is the cost of the system divided by the total number of containers that are sold in Washington. The total DRS costs is just over $59M which equates to a cost per beverage POM of $0.0126, this is based on a highly technology driven system with mechanism to mitigate fraud.

**Table 17: Cost Summary of DRS System**

| Item | Total Cost, $ (M) | Cost/Unit POM, ¢ (Cent) |
|---|---|---|
| PRO | 1.902 | 0.04 |
| Handling Fees - Retail | 33.500 | 0.71 |
| Handling Fees - Redemption Centers | 17.988 | 0.38 |
| Transport Costs | 43.752 | 0.93 |
| Counting Centre Costs | 26.722 | 0.57 |
| Bag Drop Costs | 24.702 | 0.53 |
| Bag Drop Convenience Fee | -9.056 | -0.19 |
| Materials Income | -45.122 | -0.96 |
| Unclaimed Deposits | -39.675 | -0.84 |
| Fraudulently Claimed Deposits | 4.306 | 0.09 |

| Item | Total Cost, $ (M) | Cost/Unit POM, ¢ (Cent) |
|---|---|---|
| **Net Cost** | **59.018** | **1.26** |

*Source: Eunomia, OBRC Data, CLYNK Data, TOMRA Data*

The cost of the system net of revenue is effectively the cost that the producers will pay in producer fees. As stated previously, producer fees should not be flat, but should be based on the volume that they POM as well as the value that the container has in the system and the cost of managing the container through the system.

Eunomia's model assesses the cost differences in containers of various materials, for example: the extent to which a container can be compacted will reduce transport and storage costs, the containers of heavier materials will be more costly to transport, etc. Table 18 shows the estimated producer fee by material type, taking into account all of these factors. Since aluminum cans have a high market value and can be compacted through RVMs, which reduces storage and transport costs, there is a net benefit to the system when 90% of aluminum cans are redeemed. Producers of beverages in aluminum cans therefore receive a credit from the system when fees are modulated. The same is true of HDPE unlike PET, glass, cartons and aseptic containers, all of which have a cost to recycle. The producer fee varies from year to year depending on the cost of the system, but most critically on the value of the material.

**Table 18: Producer Fee by Beverage Type**

| | **Cost/Unit POM, ¢** (cent) | | | | |
|---|---|---|---|---|---|
| **Item** | **Aluminum Cans** | **PET Bottles** | **HDPE Bottles** | **Glass Bottles** | **Cartons, Aseptic** |
| **PRO** | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 |
| **Handling Fees** | 0.83 | 1.05 | 1.02 | 0.57 | 0.67 |
| **Transport Costs** | 0.27 | 0.34 | 1.12 | 5.26 | 0.29 |
| **Counting Centre Costs** | 0.06 | 0.08 | 0.27 | 1.27 | 0.07 |
| **Materials Income** | -1.82 | -0.38 | -2.28 | -0.34 | 0.00 |
| **Unclaimed Deposits** | -0.83 | -0.83 | -0.83 | -0.83 | -0.83 |
| **Fraudulently Claimed Deposits** | 0.09 | 0.09 | 0.09 | 0.09 | 0.06 |
| **Net Cost** | **-1.35** | **0.40** | **-0.58** | **11.91** | **0.13** |

*Source: Eunomia, OBRC Data, CLYNK Data, TOMRA Data*

*Retailer and Redemption Center Costs*

There is a cost to retailers for managing containers redeemed through RVMs in-store and to a lesser extent through bag drops in parking lots, when serviced by the PRO. There is also a cost for operating redemption centers, whether provided directly by the PRO or through contracted services. Handling fees have been calculated based on a bottom up approach, taking into consideration:

- The space requirement for RVMs and the associated cost of real estate in urban and rural areas;
- Labor costs and time required to empty and clean RVMs and process receipts;
- Cost of equipment, including: RVMs, counting machines and balers at redemption centers that provide some bulk counting and consolidation;

The container handling fee is calculated based on a full cost recovery mechanism and ranges from $0.0156 per container to $0.0279, depending on the redemption type.

*Transport Costs*

Transport costs have been calculated based on a bottom-up approach considering:

- Volumes and bulk densities of containers when collected by compacting and non-compacting redemption mechanisms;
- Collection frequency, based on volume to be collected and storage capacity;
- Working times, including time spent traveling, time to service each redemption point, time to unload at counting centers;
- Number of pick-up locations per route, considering volume to be collected;
- Labor costs, drivers plus supervisors and managers;
- Vehicle specification (capacity) and assumed fill rates;
- Vehicle costs, capital and operating.

*PRO Costs*

A summary of the PRO costs, capital and operating assumed in the model is provided in the *Technical Appendix.*

### Curbside and Drop-off Recycling Service Costs

*Curbside Collection*

Under this system, there is the cost of the DRS plus a revised cost for the curbside residential PPP service that results from less material being collected and sorted. The benefit of using Eunomia's *Hermes* model is that it calculates the impact from reducing the number of collection routes and, therefore, collection costs, if the volume reduction is sufficient to warrant a reduction in resources. Based on the revised material flows, the number of routes required to deliver the services drops only minimally – by just 1% from the existing system – because the volume is spread across the whole state.

*Sorting Facility*

Table 19 details the cost impacts on sorting facilities from reduced tipping fee income resulting from less material being collected at the curbside and reduced material revenue when redemption rates are at 70%, 80% and 90%. The system design has been developed to mitigate these costs as follows and as detailed in Table 19:

- Access to deposit for units returned through curbside
- Access to infrastructure funding resulting from producers not achieving target in first two years of the program
- Ability to provide the counting center function under contract to PRO. This potential benefit is not included in the table but should taken into consideration as an option for MRFs.
- The DRS will capture about 73% of the glass in the residential stream, less glass in the system may reduce maintenance costs and improve the quality of the paper/card stream depending on the sorting facility. These benefits are difficult to quantify so have not been included in the table below.

Assuming that the DRS return rates scale up over time, the first year DRS is implemented there will be a net benefit to the sorting facilities of almost $55M, this will be reduced to $29M in year two. Only in year three, once there has been significant investment in existing sorting facilities, will there be a cost, by which time the investments will enable the sorting facilities to maximize the efficiency and effectiveness in order to mitigate any costs that may be incurred in year three. The total net benefit to sorting facilities estimated over the three-year DRS implementation timeline set out in Figure 8 is almost $73M.

**Table 19: Losses and Gains to Sorting Facilities Recycling from a DRS**

| Redemption of Deposit Revenue/Cost | Amount ($) at 70% Redemption | Amount ($) at 80% Redemption | Amount ($) at 90% Redemption |
|---|---|---|---|
| Loss tipping fees (cost) | 6,872,000 | 8,014,000 | 9,425,000 |
| Loss in material revenue (cost) | 6,425,000 | 7,716,000 | 9,614,000 |
| Deposits from units recycled through curbside (revenue) | -37,570,000 | -25,049,000 | -7,296,000 |
| Access to unclaimed deposit fund (revenue) | -30,571,000 | 20,514,000 | 0 |

| | | | |
|---|---|---|---|
| **Net Costs** | **-54,844,000[XII]** | **29,833,000** | **11,743,000** |

*Source: Eunomia Modelling, Washington Department of Ecology Landfill Tipping Rates, RecyclingMarkets.net, CRI 2017 BMDA Data*

Tipping fee and material revenue losses are greatest under this system compared to other FSs that include a DRS because under those systems, more PPP is being collected as a whole, so the loss of material to the DRS is to an extent offset by other PPP material revenues. Also, all other FSs have full EPR, so sorting facilities would not be taking on the risk of lost material revenues, they would be paid for sorting the material, with the producers taking all material revenue risk.

The movement of beverage containers will also reduce the amount of material collected and disposed of as trash. The cost difference due to disposal savings between FS 1 and the baseline equate to $7.3M, which is a savings that should be passed on to the ratepayer. The revised costs of managing residential PPP through a system that adds a DRS to current recycling activities is summarized in Table 20, against the costs of the current system. The cost of the system increased as a whole and per ton recycled, but more material is recycled, less is littered and the recycling rate increases to 55% from 40%, without the requirement for any increase in household rates.

**Table 20: System 1: PPP Cost of DRS, Curbside and Drop-off Collection and Sorting and PPP Disposed**

| Cost Element | Current System Cost | FS 1 Cost |
|---|---:|---:|
| Recycling Collection Cost ($M) | 141.994 | 140.550 |
| Drop-off Costs ($M) | 2.272 | 1.681 |
| Sorting Costs ($M) | 54.729 | 47.711 |
| Sorting Material Revenue ($M) | -9.658 | -9.918 |
| MRF Residue Disposal Cost ($M) | 7.613 | 7.069 |
| Management, Supervision and Administration ($M) | 17.769 | 17.592 |
| Overhead and Profit ($M) | 20.253 | 22.257 |
| Taxes ($M) | 22.145 | 22.141 |
| PRO Costs (included in DRS cost below) ($M) | N/A | N/A |
| Education Costs ($M) | N/A | N/A |
| Secondary Plastic Processing Revenue ($M) | N/A | N/A |
| EPR Governance Costs ($M) | N/A | N/A |

[XII] Negative costs indicate a net benefit

| Cost Element | Current System Cost | FS 1 Cost |
|---|---|---|
| DRS Costs (including revenue) ($M) | N/A | 59.018 |
| **Total Cost** ($M) | **247.118** | **308.001** |
| **Total Cost per Ton Recycled (incl. DRS where applicable) ($)** | **471** | **523** |
| Cost of PPP Disposed ($M) | 70.374 | 63.097 |

*Source: Eunomia Modelling, Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver, Washington Department of Ecology Landfill fees, CSSA Annual Cost Reports, Correspondence with Washington MRF Haulers, Correspondence with Washington MRF Operators, RecyclingMarkets.net*

## Benefits

### *Jobs*

FS 1 creates 5,699 total direct, indirect and induced jobs, with 2,289 of these being direct jobs created by the system. Of the total, 1,985 jobs are related to the DRS system. Jobs are associated with the collection of containers from retailer, bag drop locations and redemption centers, operating of redemption centers, servicing of RVMs and bag drops and retailer time to empty RVMs. Since material is moving from the curbside recycling system into the DRS, there is a reduction of jobs in the areas associated with that system, as shown in Table 21 below, but there is a net gain of additional 1,825 jobs over the current system baseline. A breakdown of the DRS jobs is provided in the *Technical Appendix.*

**Table 21: Direct, Indirect and Induced Jobs Resulting from adding a DRS to the Current Recycling System**

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 1 Residential PPP Recycling System |
|---|---|---|
| Direct | | |
| Collections Operations | 773 | 765 |
| Collections Support & Management | 288 | 284 |
| Sorting | 419 | 365 |
| Secondary Sorting | N/A | N/A |
| Drop-off Jobs | 22 | 14 |
| DRS | N/A | 860 |
| Governance | N/A | N/A |
| PRO | N/A | N/A |
| Subtotal direct | 1,501 | 2,289 |

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 1 Residential PPP Recycling System |
|---|---|---|
| Subtotal indirect and induced | 2,373 | 3,410 |
| **Total** | **3,874** | **5,699** |

*Source: Eunomia, Indices from Economic Policy Institute (2019)[55], Bureau of Economic Analysis*

### *Gross Value Added (GVA)*

The total direct, indirect and induced GVA to the Washington economy resulting from the FS 1 residential PPP recycling service is over $847M, including approximately $343M in direct benefits. The total GVA for FS 1 is over $350M greater than the current system baseline, as shown in Table 22. This is a result of a greater number of people being employed in recycling services.

**Table 22: Gross Value Added from Current System and FS 1**

| GVA Category | GVA from Current Residential PPP Recycling System | GVA from FS 1 Residential PPP Recycling System |
|---|---|---|
| Direct GVA ($M) | 201.129 | 343.079 |
| Indirect GVA ($M) | 166.412 | 283.860 |
| Induced GVA ($M) | 129.335 | 220.615 |
| **Total ($M)** | **496.875** | **847.554** |

*Source: Eunomia, Indices from Economic Policy Institute (2019)[56], Bureau of Economic Analysis[57], Institute for Scrap Recycling Industries (2017)[58]*

### *GHG Impact:*

The $MTCO_2e$ avoided from FS 1 residential PPP recycling activities in Washington is 1.488M a year, or 89,000 more than the baseline system. This is the equivalent of taking a further 19,000 vehicles off the road every year above the current system.

### *Litter*

An 80% reduction in litter is also assumed following implementation of the DRS. This is a conservative estimate based on a comparative review of the effect of DRSs on littering behavior.[59]

The amount of beverage-related litter calculated to be mitigated as a result of a DRS is 4,180 tons, 44% of which is plastic bottles.

## Costs and Benefits Summary

Table 23 provides an overview of the cost benefit of FS 1 compared to the current system, when the GVA and the social cost of carbon have been factored into the total cost. These are very real benefits and should be included when calculating the cost or, as is the case here, net benefit of recycling. Table 23 shows that there is a net societal benefit of $998 per ton recycled.

**Table 23: Net Cost Benefit of FS 1 Residential PPP Recycling System in Washington**

| Cost Category | Cost of Current Residential PPP Recycling System | Cost of FS 1 Residential PPP Recycling System |
|---|---|---|
| System Costs ($M) | 247.1 | 308.0 |
| Disposal Costs ($M) | 70.4 | 63.1 |
| Monetized Cost of Carbon ($M) | -104.9 | -111.6 |
| GVA ($M) | -496.9 | -847.6 |
| **Total Net ($M)** | **-284.3** | **-588.0** |
| **Net Benefit per Ton Recycled ($)** | **-542** | **-998** |

*Source: Eunomia, EPA Warm Model, Indices from Economic Policy Institute (2019)[60], Bureau of Economic Analysis[61], Institute for Scrap Recycling Industries (2017)s[62], Cost of Carbon metric from Washington Utilities and Transportation Commission (2019)[63]*

A summary of the environmental and social benefits is provided in Table 24.

**Table 24: Summary of Environmental and Social Benefits from FS1 Compared to Current Residential PPP Service**

| Benefits | Value in Current Residential PPP Recycling | Value in FS 1 Residential PPP Recycling |
|---|---|---|
| Recycling Rate | 49% | 55% |
| Tons Recycled | 562,100 | 590,700 |
| $MTCO_2e$ Avoided | 1.399M | 1.488M |
| Jobs Direct, Indirect and Induced | 3,877 | 5,699 |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019)[64], Bureau of Economic Analysis[65]*

## Stakeholder Impact

Table 25 below elaborates on the impact to relevant stakeholders under FS 1.

**Table 25: Impacts on Stakeholders from the FS 1 for Providing Residential PPP recycling Services**

| Stakeholder | Impacts and Mitigation |
|---|---|
| Municipalities/ jurisdictions | Less material collected at the curbside in both recycling and trash streams, potential to review collection frequencies and container sizes to reduce costs. |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | Potential for reduced MRF tipping fees if less material collected at the curbside (~$7M)<br><br>Disposal cost tipping fee savings (~$7M)<br><br>**6% increase in recycling rate** without the need for jurisdictions to increase household rates (waste management fees). |
| Waste Haulers | Waste haulers will have the opportunity to provide services to the DRS PRO as well as to continue to provide services to municipalities. The PRO will have over ~$43M of collection-related service to procure from the market to service the redemption network. |
| Sorting facilities/ MRF Operators | While there will be a loss resulting in reduced tipping fees and material revenues, the value of the deposits that will still be recycled through curbside services and access to the unclaimed deposits, when targets are met, will result in a **net financial benefit over the three-year DRS implementation period of over ~$73M**.<br><br>Option for MRF to also provide counting center function under contract to the PRO, providing an addition opportunity to increase revenue. Counting center function costs estimated at almost $47M. |
| State | Significant increase in direct, indirect and induced **jobs (~+1,830)** and associated annual **GVA (~+$351M)** resulting from the DRS.<br><br>More high value materials captured for recycling, supporting a circular economy **(~+64k tpa)**<br><br>Reduction in GHG emissions (**additional ~0.089M MTCO$_2$e over baseline**)<br><br>80% reduction in beverage related litter. |
| Households | **Access to two recycling systems**, greater incentive to recycle.<br><br>**Reduction in litter** increase public amenity of local environment<br><br>**No increase in household rates** (waste management fees). |
| Low income households | All impacts associated with all households, plus:<br><br>The potential impact at the start of a DRS on low income families who are reliant on bottled water is that they will be required to pay $0.10 on top of the current price of these beverages for the deposit on each container. If the empty container is returned, this outlay is only temporary, as the deposit could be recovered once the container returned. However, there is potential |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | burden associated with this initial payment. This payment could be mitigated by implementing a "deposit holiday" for the first week of the DRS program for non-carbonated water only. This would work as follows:<br>▪ Day 1 of DRS: Deposit initiated on all beverages, but not paid by the consumer on non-carbonated water.<br>▪ Day 8 of DRS: Deposit paid on non-carbonated water.<br>This would allow low income households to purchase essential beverages during the first week of the new program without the burden of the deposit, but still be able to claim the deposit on return of the container, as if they had paid it. The producers would cover the cost of the deposit on all non-carbonated water sold in the first week. The cost of this to producers would be just over $3.2M, assuming all of those containers are returned. If only 70% are returned, then the cost would only be $2.3M and only $1.6M if only half redeemed. This program would alleviate the burden of an initial outlay of the deposit with the implementation of the DRS for non-carbonated water.<br>Redemption locations located on transit routes and at retailer and other commonly visited locations will make redemption convenient and easy. |
| Households in rural areas | All impacts associated with all households, plus:<br>Redemption locations located on transit routes and at retailers and other commonly visited locations will make redemption convenient and easy.<br>Other impacts the same and for "households" above. |
| Homeless | Ability to collect containers that are littered, providing a **source of income**. |
| Producers | Producers required to meet redemption targets and are required to fund and coordinate the recycling (i.e. collection, transportation, sorting, and marketing) of beverage containers materials to ensure the redemption and geographical targets are met.<br>Producers are effectively responsible for the end of life management of their PPP. **Estimated cost to producers of ~$59M**<br>**Reduction in litter, reducing reputational damage** associated with littered containers in the environment. |
| Retailers large and small | **Options for involvement** in the DRS either: return-in-retail; return-at-retail (parking lot bag drops); or exemption, if it can be demonstrated that there are sufficient redemption points to meet geographical coverage target. Handling fee, calculated based on cost coverage, paid to retailers for their |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | role in supporting redemption. Increase in foot traffic through stores as the value of the deposit will mean that redeemers are also consumers. Technology driven redemption routes reduced retailer time. Bag drop program reduces direct retailer involvement under the system.<br><br>**Small businesses, under 5,000 sq ft not required to redeem under the system and can choose to opt-in.** |

*Source: Eunomia*

## Future System 2 EPR + Enhanced Collection, Coverage and Capture

### Service Overview

FS 2 is the first true EPR for PPP system. It assumes 100% coverage and a common set of materials collected curbside with EPS and film to drop-off. It assumes that services continue to be delivered at the current frequency using the same collection methodologies, which vary from jurisdiction to jurisdiction. It also assumes that due to increased education and engagement, which is necessary to drive up the amount of PPP collected, the capture rate for each material from single family households increases to match the capture rate in single family households in the City of Seattle, seen as one of the highest recycling jurisdictions in the US. Additionally, the multifamily capture rates for each material were assumed on average slightly above 70% of the capture rates for single family households. The capture rates in multi-family households for fibers were assumed to be equal to the multi-family households in the City of Seattle. This FS assumes that while material continues to be sorted through existing MRF infrastructure, material outputs from facilities are managed through the PRO. Therefore, there is a combined volume of #3-#7 plastics that could be baled with adequate output to enable the PP and PS to be sorted at a secondary sorting facility.

### PPP Generated, Recycled and Disposed

Table 26 shows the estimated tons of each PPP material generated, disposed and recycled[XIII] for FS 2. Due to the enhanced coverage and collection of materials across the state, FS includes a 40% increase in the amount of material recycled over the baseline, from 49% to 69%. The alignment between collection methodologies and extended collection to all household's accounts for the increase in the overall recycling rate. Flexible plastics have the greatest percentage increase, from 5% recycled to 12%, an increase of 141% due to a standardized film drop-off program being

[XIII] Measured as the material sold from the sorting facility to a reprocessor. The actual quantity of material that will be recycled will be less than this amount, as additional contaminants will be removed at the reprocessor. However, for the purposes of this study, the sorting facility outputs are used as the point of measurement to calculate the recycling rate across all systems.

implemented across the state. The plastic recycling rate increases 130% to 36%, but aluminum only increases 9% to 57% recycled. 9,880 tons of the additional material has been calculated to be recycled, primarily resulting from increased PP and PS recycling as a result of the secondary reprocessing of #3-#7 plastics bales.

**Table 26: Tons of PPP Generated, Disposed and Recycled for FS 2**

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XIV] | Recycling Rate |
|---|---|---|---|---|
| **All Plastic** | **193,080** | **119,010** | **70,480** | **37%** |
| Rigid Plastics | **120,880** | **55,710** | **61,580** | **51%** |
| #1 PET Bottles | 34,100 | 11,800 | 22,290 | 65% |
| *#1 PET Bottles DRS Eligible* | *27,300* | *27,300* | *0* | *0%* |
| *#1 PET Bottles Not DRS Eligible* | *6,800* | *6,800* | *0* | *0%* |
| #1 PET Other Packaging | 20,000 | 7,800 | 12,240 | 61% |
| #2 HDPE Natural Bottles | 9,700 | 3,200 | 6,540 | 67% |
| *#2 HDPE Natural Bottles DRS Eligible* | *7,800* | *7,800* | *0* | *0%* |
| *#2 HDPE Natural Bottles Not DRS Eligible* | *1,900* | *1,900* | *0* | *0%* |
| #2 HDPE Colored Bottles | 12,800 | 5,100 | 7,700 | 60% |
| *#2 HDPE Colored Bottles DRS Eligible* | *1,300* | *1,300* | *0* | *0%* |
| *#2 HDPE Colored Bottles Not DRS Eligible* | *11,500* | *11,500* | *0* | *0%* |
| # 2 Other HDPE Packaging | 4,600 | 2,900 | 1,740 | 38% |
| #3 PVC Packaging | 110 | 40 | 70 | 64% |
| #4 LDPE Packaging | 70 | 70 | 50 | 71% |
| #5 PP Packaging | 13,000 | 4,800 | 8,200 | 63% |
| #6 PS Packaging | 1,700 | 600 | 1,100 | 65% |
| #7 Other Packaging | 5,600 | 5,600 | 0 | 0% |
| Expanded Polystyrene Packaging | 13,300 | 11,800 | 1,500 | 11% |
| PE Plastic Bags & Film | 21,600 | 16,300 | 5,300 | 25% |
| Other Plastic Film & Flexible Packaging | 50,600 | 47,000 | 3,600 | 7% |
| R/C Plastic Packaging | 1,800 | 1,600 | 200 | 11% |
| PLA/Compostable Packaging | 4,100 | 400 | 0 | 0% |
| Flexible Plastics | **72,200** | **63,300** | **8,900** | **12%** |
| All Metals | **62,400** | **26,100** | **36,290** | **58%** |
| Steel Containers | 25,300 | 9,600 | 15,700 | 62% |
| All Aluminum | 37,100 | 16,500 | 20,590 | 56% |
| *Aluminum DRS Eligible* | *16,400* | *16,400* | *0* | 0% |

[XIV] MRF sorting facility and secondary reprocessor tons to market

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled XIV | Recycling Rate |
|---|---|---|---|---|
| *Aluminum Not DRS Eligible* | *20,700* | *20,700* | *0* | 0% |
| All Paper and Card | **683,000** | **138,500** | **544,500** | **80%** |
| Container Glass | **129,400** | **43,900** | **85,500** | **66%** |
| *Container Glass DRS Eligible* | *104,400* | 104,400 | 0 | 0% |
| *Container Glass Not DRS Eligible* | *25,000* | 25,000 | 0 | 0% |
| **Total** | **1,067,900** | **327,500** | **736,800** | **69%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

## PPP Collection, Transfer and Sorting Costs

The enhanced collection and coverage of FS 2 will reduce the amount of material collected and disposed of as trash. The disposal cost savings resulting from this system compared to the current system, the cost of which is borne by the ratepayer decreases from the baseline from over $70M to less than $44M, as shown in Table 27, a saving of 37%. While the cost of the system increases as a whole, more material is recycled under FS 2 and the recycling rate increases to 69% from 49% in the baseline. **The cost per ton recycled in FS 2 decreases from the baseline by 4%, from $471 to $454**. Despite the collection costs increasing in this scenario, increased material revenue resulting from sorting additional material and revenue assumed from secondary reprocessing of the #3-#7 offsets these costs, resulting in a reduced cost per ton recycled.

**Table 27: Cost Summary of FS 2 Residential PPP Recycling System in Washington**

| Cost Element | Current System Cost | FS 2 Cost |
|---|---|---|
| Recycling Collection Cost ($M) | 141.994 | 176.295 |
| Drop-off Costs ($M) | 2.272 | 3.097 |
| Sorting Costs ($M) | 54.729 | 82.904 |
| Sorting Material Revenue ($M) | -19.658 | -36.952 |
| MRF Residue Disposal Cost ($M) | 7.613 | 12.551 |
| Management, Supervision and Administration ($M) | 17.769 | 23.741 |
| Overhead and Profit ($M) | 20.253 | 30.869 |
| Taxes ($M) | 22.145 | 28.349 |
| PRO Costs ($M) | N/A | 7.863 |
| Education Costs ($M) | N/A | 5.559 |

| Cost Element | Current System Cost | FS 2 Cost |
|---|---|---|
| Secondary Plastic Processing Revenue ($M) | N/A | -0.436 |
| EPR Governance Costs ($M) | N/A | 0.288 |
| DRS Costs (including revenue) ($M) | N/A | N/A |
| **Total Cost** ($M) | **247.118** | **334.129** |
| **Total Cost per Ton Recycled (incl. DRS where applicable)** | **471** | **454** |
| Cost of PPP Disposed ($M) | 70.374 | 44.428 |

*Source: Eunomia Modelling, Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver, Washington Department of Ecology Landfill fees, CSSA Annual Cost Reports, Correspondence with Washington MRF Haulers, Correspondence with Washington MRF Operators, RecyclingMarkets.net*

## Benefits

### *Jobs*

FS 2 creates 5,532 total direct, indirect and induced jobs, with 2,155 of these being direct jobs created by the system, as shown in below. There is a net gain of additional 1,658 jobs over the current system baseline. The assumptions associated with the PRO and government agency governance is provided in the *Technical Appendix.*

**Table 28: Jobs from Current System and FS 2**

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 2 Residential PPP Recycling System |
|---|---|---|
| Direct | | |
| Collections Operations | 773 | 1,066 |
| Collections Support & Management | 288 | 394 |
| Sorting | 419 | 635 |
| Secondary Sorting | N/A | 8 |
| Drop-off Jobs | 22 | 13 |
| DRS | N/A | N/A |
| Governance | N/A | 4 |
| PRO | N/A | 35 |
| Subtotal direct | 1,501 | 2,155 |

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 2 Residential PPP Recycling System |
|---|---|---|
| Subtotal indirect and induced | 2,373 | 3,376 |
| **Total** | **3,874** | **5,532** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis,*

### *Gross Value Added (GVA)*

The total direct, indirect and induced GVA to the Washington economy resulting from the FS 2 residential PPP recycling service is over $704M, including approximately $285M in direct benefits. The total GVA for FS 2 is over $207M greater than the current system baseline, as shown in

Table 29.

**Table 29: Gross Value Added from FS 2**

| GVA Category | GVA from Current Residential PPP Recycling System | GVA from FS 2 Residential PPP Recycling System |
|---|---|---|
| Direct GVA ($M) | 201.129 | 285.278 |
| Indirect GVA ($M) | 166.412 | 236.037 |
| Induced GVA ($M) | 129.335 | 183.447 |
| **Total ($M)** | **496.875** | **704.762** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017)*

### *GHG Impact:*

The $MTCO_2e$ avoided from FS 2 residential PPP recycling activities in Washington is 1.964M a year, or 565,000 more than the baseline system. This is the equivalent of taking a further 120,000 vehicles off the road every year above the current system.

### *Litter*

Litter reduction calculations have only been carried out for beverage containers as a result of the DRS under FSs 1, 5, 6 and 7.

## Costs and Benefits Summary

Table 30 provides an overarching view of the cost benefit of FS 2 compared to the current system, when the GVA has been netted off the cost of service as well as the social cost of carbon. These are very real benefits and should be included when calculating the cost or, as is the case, net benefit of recycling. Table 30 shows that for every ton recycled, there is a net societal benefit of $643.

**Table 30: Net Cost Benefit of FS 2 Residential PPP Recycling System in Washington**

| Cost Category | Cost of Current Residential PPP Recycling System | Cost of FS 2 Residential PPP Recycling System |
|---|---|---|
| System Costs ($M) | 247.1 | 334.1 |
| Disposal Costs ($M) | 70.4 | 44.4 |
| Monetized Cost of Carbon ($M) | -104.9 | -147.3 |
| GVA ($M) | -496.9 | -704.8 |
| **Total Net ($M)** | **-284.3** | **-473.5** |
| **Net Benefit per Ton Recycled ($)** | **-542** | **-643** |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute, Bureau of Economic Analysis, Institute for Scrap Recycling Industries, Cost of Carbon metric from Washington Utilities and Transportation Commission*

A summary of the environmental and social benefits is provided in Table 31.

**Table 31: Environmental and Social Benefits of FS 2**

| Benefits | Value in Current Residential PPP Recycling | Value in FS 2 Residential PPP Recycling |
|---|---|---|
| Recycling Rate | 49% | 69% |
| Tons Recycled | 562,100 | 736,800 |
| $MTCO_2e$ Avoided | 1.399M | 1.964M |
| Jobs Direct, Indirect and Induced | 3,877 | 5,532 |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Cost of Carbon metric from Washington Utilities and Transportation Commission (2017)*

## Stakeholder Impact

Table 32 below elaborates on the impact to relevant stakeholders under FS 2.

**Table 32: Impacts on Stakeholders from FS 2 for Providing Residential PPP Recycling Services**

| Stakeholder | Impacts and Mitigation |
|---|---|
| Municipalities/ jurisdictions | **Producers cover the cost of recycling** based on agreed cost recovery mechanisms so municipality no longer have to recover the cost of PPP services from households. |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | **Option to manage, provide directly or contract the services** allowing PPP services to be aligned with streams - trash and organics.<br><br>**Disposal cost tipping fee savings (~$26M)** |
| Waste Haulers | **Continue to provide services** to jurisdictions under contract.<br><br>More properties to collect from as a result of 100% coverage and more material to collected as a result wider range of materials targeted at the curbside. |
| MRF operators | **Greater quantity of material will be collected at the curbside (~+212k tpa)** which will require sorting resulting in a potential increase in tipping fees (~+$28M).<br><br>Under EPR one option is that producers own the material collected and sorted, under this assumption MRF operators will no longer have to shoulder the material risk associated with fluctuating markets.<br><br>Level of uncertainty as to how PRO may contract for services over long term. **Opportunity to provide broader range of services** to PRO including transfer and secondary processing. |
| State | More direct, indirect and induced **jobs (~+1,660)** and associated annual **GVA (~+$208M)** resulting from increase in the amount of PPP collected and recycled.<br><br>**More high value materials captured for recycling**, supporting a circular economy (~+212k tpa)<br><br>**Reduction in GHG emissions** (additional ~0.565M $MTCO_2e$ over baseline).<br><br>When material specific targets are set high, **producers will invest in developing material markets** and infrastructure necessary to meet the targets. |
| Households | **No longer required to pay for PPP recycling services**, total cost of FS 2 recycling estimated at ~$334M equating to a per household annual saving of approximately ~$105 per annum.<br><br>**Ability to recycle a broader range of materials**.<br><br>Increased spending on recycling education to ensure householders can correctly participate in recycling programs. |

| Stakeholder | Impacts and Mitigation |
|---|---|
| Low income households | All impacts associated with all households. |
| Households in rural areas | All impacts associated with all households, plus:<br><br>**Coverage of curbside services extending to all households** ensuring all rural households receive a service. |
| Homeless | No change in impacts compared to the baseline. |
| Producers | **Producers of PPP are required to fund and coordinate recycling** (i.e. collection, transportation, sorting, and marketing) of materials from the residential sector and to ensure material specific targets are met and to educate households on the services offered. Producers are effectively responsible for the end of life management of their PPP.<br><br>**Estimated cost to** producers ~$334M |
| Retailers including small retailers | No change in impacts compared to the baseline. |

*Source: Eunomia*

## Future System 3: EPR + Aligned Collection Methodology and Frequency – single stream recycling (excluding glass) every other week with separate glass collection every fourth week

### Service Overview

FS 3 builds upon FS 2 in that EPR is applied to the PPP residential recycling system. However, in FS3, all households receive the same service at the same frequency, providing consistency across the state. This FS provides the convenience of curbside collection services for all materials. By removing glass from the recycling stream, which often breaks during collection and contaminates other materials, this FS helps maintain the quality and capture rates of glass as well as other PPP materials.

This structure assumes that producers will create an optimized system of recycling collection without the restrictions of jurisdictional borders. Therefore, contracts with haulers can be renegotiated to create consistency across jurisdictions, allowing for more optimized routes. These changes should allow for additional reductions in collection costs, though this probable cost savings was not included in the modeling.

## PPP Generated, Recycled and Disposed

Table 32 shows the estimated tons of each PPP material generated, disposed and recycled[XV] for FS 3. FS 3 has a similar increase in the overall recycling rate to FS 2, an increase over the baseline of 44%, from 49% to 71%. Due to the similarities between FS 2 and FS 3, the increases in most materials are the similar. The greatest contributing factor to the overall increase in recycling rate is through the separate collection of glass, which allows for a greater percentage to be recycled. The glass recycled increases 26% over the baseline, from 63% to nearly 80%.

**Table 33: Tons of PPP Generated, Disposed and Recycled for FS 3**

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XVI] | Recycling Rate |
|---|---|---|---|---|
| **All Plastic** | **193,080** | **119,010** | **70,480** | **37%** |
| Rigid Plastics | **120,880** | **55,710** | **61,580** | **51%** |
| #1 PET Bottles | 34,100 | 11,800 | 22,290 | 65% |
| *#1 PET Bottles DRS Eligible* | *27,300* | *27,300* | *0* | *0%* |
| *#1 PET Bottles Not DRS Eligible* | *6,800* | *6,800* | *0* | *0%* |
| #1 PET Other Packaging | 20,000 | 7,800 | 12,240 | 61% |
| #2 HDPE Natural Bottles | 9,700 | 3,200 | 6,540 | 67% |
| *#2 HDPE Natural Bottles DRS Eligible* | *7,800* | *7,800* | *0* | *0%* |
| *#2 HDPE Natural Bottles Not DRS Eligible* | *1,900* | *1,900* | *0* | *0%* |
| #2 HDPE Colored Bottles | 12,800 | 5,100 | 7,700 | 60% |
| *#2 HDPE Colored Bottles DRS Eligible* | *1,300* | *1,300* | *0* | *0%* |
| *#2 HDPE Colored Bottles Not DRS Eligible* | *11,500* | *11,500* | *0* | *0%* |
| # 2 Other HDPE Packaging | 4,600 | 2,900 | 1,740 | 38% |
| #3 PVC Packaging | 110 | 40 | 70 | 64% |
| #4 LDPE Packaging | 70 | 20 | 50 | 71% |
| #5 PP Packaging | 13,000 | 4,800 | 8,200 | 63% |
| #6 PS Packaging | 1,700 | 600 | 1,100 | 65% |
| #7 Other Packaging | 5,600 | 5,600 | 0 | 0% |
| Expanded Polystyrene Packaging | 13,300 | 11,800 | 1,500 | 11% |
| PE Plastic Bags & Film | 21,600 | 16,300 | 5,300 | 25% |
| Other Plastic Film & Flexible Packaging | 50,600 | 47,000 | 3,600 | 7% |
| R/C Plastic Packaging | 1,800 | 1,600 | 200 | 11% |

[XV] Measured as the material sold from the sorting facility to a reprocessor. The actual quantity of material that will be recycled will be less than this amount, as additional contaminants will be removed at the reprocessor. However, for the purposes of this study, the sorting facility outputs are used as the point of measurement to calculate the recycling rate across all systems.
[XVI] MRF sorting facility tons to market

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XVI] | Recycling Rate |
|---|---|---|---|---|
| PLA/Compostable Packaging | 4,100 | 400 | 0 | 0% |
| Flexible Plastics | **72,200** | **63,300** | **8,900** | **12%** |
| All Metals | **62,400** | **26,300** | **36,150** | **58%** |
| Steel Containers | 25,300 | 9,600 | 15,700 | 62% |
| All Aluminum | 37,100 | 16,700 | 20,450 | 55% |
| *Aluminum DRS Eligible* | *16,400* | *16,400* | *0* | 0% |
| *Aluminum Not DRS Eligible* | *20,700* | *20,700* | *0* | 0% |
| All Paper and Card | **683,000** | **138,500** | **544,500** | **80%** |
| Container Glass | **129,400** | **27,000** | **102,400** | **79%** |
| *Container Glass DRS Eligible* | 104,400 | 104,400 | 0 | 0% |
| *Container Glass Not DRS Eligible* | 25,000 | 25,000 | 0 | 0% |
| **Total** | **1,067,900** | **310,800** | **753,500** | **71%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

## PPP Collection, Transfer and Sorting Costs

The separate glass collection of FS 3 reduces the costs of the drop-off facilities from the baseline by 57%, as it provides a reduction in glass at drop-offs due to the curbside collection every fourth week. However, this separate collection increases the overall cost of the system, as seen in Table 34. In FS 3, the cost per ton recycled also increases, from $471 to $503.

**Table 34: Cost Summary of FS 3 Residential PPP Recycling System in Washington**

| Cost Element | Current System Cost | FS 3 Cost |
|---|---|---|
| Recycling Collection Cost ($M) | 141.994 | 212.175 |
| Drop-off Costs ($M) | 2.272 | 1.065 |
| Sorting Costs ($M) | 54.729 | 87.105 |
| Sorting Material Revenue ($M) | -19.658 | -36.206 |
| MRF Residue Disposal Cost ($M) | 7.613 | 12.984 |
| Management, Supervision and Administration ($M) | 17.769 | 24.336 |
| Overhead and Profit ($M) | 20.253 | 31.237 |
| Taxes ($M) | 22.145 | 32.657 |
| PRO Costs ($M) | N/A | 7.863 |

| Cost Element | Current System Cost | FS 3 Cost |
|---|---|---|
| Education Costs ($M) | N/A | 5.559 |
| Secondary Plastic Processing Revenue ($M) | N/A | -0.436 |
| EPR Governance Costs ($M) | N/A | 0.288 |
| DRS Costs (including revenue) ($M) | N/A | N/A |
| **Total Cost** ($M) | **247.118** | **378.627** |
| **Total Cost per Ton Recycled (incl. DRS where applicable)** | **471** | **503** |
| Cost of PPP Disposed ($M) | 70.374 | 42.432 |

*Source: Eunomia Modelling, Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver, Washington Department of Ecology Landfill fees, CSSA Annual Cost Reports, Correspondence with Washington MRF Haulers, Correspondence with Washington MRF Operators, RecyclingMarkets.net*

## Benefits

### *Jobs*

FS 3 creates 5,415 total direct, indirect and induced jobs, with 2,121 of these being direct jobs created by the system, as shown in Table 35 below. There is a net gain of additional 1,541 jobs over the current system baseline.

**Table 35: Jobs from Current System and FS 3**

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 3 Residential PPP Recycling System |
|---|---|---|
| Direct | | |
| Collections Operations | 773 | 1,007 |
| Collections Support & Management | 288 | 397 |
| Sorting | 419 | 667 |
| Secondary Sorting | N/A | 8 |
| Drop-off Jobs | 22 | 3 |
| DRS | N/A | N/A |
| Governance | N/A | 4 |
| PRO | N/A | 35 |

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 3 Residential PPP Recycling System |
|---|---|---|
| Subtotal direct | 1,505 | 2,121 |
| Subtotal indirect and induced | 2,373 | 3,293 |
| **Total** | **3,874** | **5,415** |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

### *Gross Value Added (GVA)*

The total direct, indirect and induced GVA to the Washington economy resulting from the FS 3 residential PPP recycling service is over $693M, including approximately $281M in direct benefits. The total GVA for FS 3 is over $197M greater than the current system baseline, as shown in Table 36.

**Table 36: Gross Value Added from FS 3**

| GVA Category | GVA from Current Residential PPP Recycling System | GVA from FS 3 Residential PPP Recycling System |
|---|---|---|
| Direct GVA ($M) | 201.129 | 280.887 |
| Indirect GVA ($M) | 166.412 | 232.403 |
| Induced GVA ($M) | 129.335 | 180.623 |
| **Total ($M)** | **496.875** | **693.914** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017)*

### *GHG Impact*

The $MTCO_2e$ avoided from FS 3 residential PPP recycling activities in Washington is 1.970M a year, or 571,000 more than the baseline system. This is the equivalent of taking a further 121,000 vehicles off the road every year above the current system.

### *Litter*

Litter reduction calculations have only been carried out for beverage containers as a result of the DRS under FSs 1, 5, 6 and 7.

## Costs and Benefits Summary

Table 37 provides an overarching view of the cost benefit of FS 3 compared to the current system, when the GVA has been netted off the cost of service as well as the social cost of carbon. These are very real benefits and should be included when calculating the cost or, as is the case, net benefit of recycling. Table 37 shows that for every ton recycled, there is a net societal benefit of $558.

**Table 37: Net Cost Benefit of FS 3 Residential PPP Recycling System in Washington**

| Cost Category | Cost of Current Residential PPP Recycling System | Cost of FS 3 Residential PPP Recycling System |
|---|---|---|
| System Costs ($M) | 247.1 | 378.6 |
| Disposal Costs ($M) | 70.4 | 42.4 |
| Monetized Cost of Carbon ($M) | -104.9 | -147.7 |
| GVA ($M) | -496.9 | -694.0 |
| **Total Net ($M)** | **-284.3** | **-420.6** |
| **Net Benefit per Ton Recycled ($)** | **-542** | **-558** |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017), Cost of Carbon metric from Washington Utilities and Transportation Commission (2019)*

A summary of the environmental and social benefits is provided in Table 38.

**Table 38: Environmental and Social Benefits of FS 3**

| Benefits | Value in Current Residential PPP Recycling | Value in FS 3 Residential PPP Recycling |
|---|---|---|
| Recycling Rate | 49% | 71% |
| Tons Recycled | 562,100 | 753,500 |
| $MTCO_2e$ Avoided | 1.399M | 1.970M |
| Jobs Direct, Indirect and Induced | 3,877 | 5,415 |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

## Stakeholder Impact

The impacts on stakeholders under FS 3 is the same as under FS 2 except that households will be required to separate out glass for a separate collection and will need to accommodate an additional container for this material, which could either be a bin, box or a cart.

**Table 39: Impacts on Stakeholders from the FS 3 for Providing Residential PPP recycling Services**

| Stakeholder | Impacts and Mitigation |
|---|---|
| Municipalities/ jurisdictions | **Producers cover the cost of recycling** based on agreed cost recovery mechanisms so municipality no longer have to recover the cost of PPP services from households.<br><br>**Option to manage, provide directly or contract services** to ensure PPP services can be aligned with streams - trash and organics.<br><br>Education campaign required to ensure residents know how to use new system to be funded by producers.<br><br>**Disposal cost tipping fee savings (~$28M)** |
| Waste Haulers | May need to renegotiate contracts to facilitate and transition to dual stream. **Continue to provide services to municipalities under contract.**<br><br>**More properties to collect from** as a result of 100% coverage and more material to collected as a result wider range of materials targeted at the curbside. |
| MRF operators | Level of uncertainty as to how PRO may contract for services over long term especially if there is desire to move towards a dual stream system which will require a new sorting facility network.<br><br>**Opportunity to provide broader range of services** to PRO including transfer and secondary processing.<br><br>Greater quantity of material will be collected at the curbside and as such require sorting resulting in **increase in revenue from tipping fees (~$32M).**<br><br>Under EPR, one option is that producers own the material collected and sorted, MRF operators will no longer have to shoulder the material risk associated with fluctuating markets and will contract for sorting services. |
| State | Additional direct indirect and induced **jobs (~+1,550)** and associated annual **GVA (~+$197M)** resulting from increase in the amount of PPP collected and recycled.<br><br>**More high value materials captured for recycling**, supporting a circular economy (~+228k tpa)<br><br>**Reduction in GHG emissions** (additional ~0.571M $MTCO_2e$ over baseline) |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | When material specific targets are set high, **producers will invest in developing material markets** and infrastructure necessary to meet the targets. |
| Households | **No longer required to pay for PPP recycling services**, estimated at ~$378M for this system equating to per household annual saving of approximately ~$119 per annum.<br><br>Need to separate PPP into two streams and accommodate two containers.<br><br>**Ability to recycle a broader range of materials**.<br><br>Increased spending on recycling education to ensure householders can correctly participate in recycling programs. |
| Low income households | All impacts associated with all households. |
| Households in rural areas | **Coverage of curbside services extending to all households** ensuring all rural households receive a service.<br><br>All impacts associated with all households. |
| Homeless | No change in impacts compared to the baseline. |
| Producers | **Producers of PPP are required to fund and coordinate recycling** (i.e. collection, transportation, sorting, and marketing) of materials from the residential sector and to ensure material specific targets are met and to educate households on the services offered. Producers are effectively responsible for the end of life management of their PPP.<br><br>Estimated cost to producers $378M. |
| Retailers including small retailers | No change in impacts compared to the baseline. |

## Future System 4: EPR+ Aligned Collection Methodology and Frequency - dual stream, fibers and metal/glass/plastic (MGP)

### Service Overview

Under this FS, households receive a weekly recycling collection that alternates materials collected by week for a dual stream system. Therefore, fibers (i.e. paper and carboard) are collected one week and MPG is collected the next. This structure allows for a regular schedule of recycling collection, but separates materials to enhance their quality, leading to higher material values.

This system would be an increase frequency to most households in Washington. This system would be an increase in frequency to most households in Washington. No increase in capture rate has been assumed under this FS, although such an increase is very possible, if trash collections were moved to every other week as well, which encourages more recycling.

The modeled performance benefits of this system are: increased capture, as there is reduced loss currently associated with containers being lost to the paper stream, for example; and, increased bale purity levels, attracting higher and more stable material sale prices.

## PPP Generated, Recycled and Disposed

Table 40 shows the estimated tons of each PPP material generated, disposed and recycled[XVII] for FS 4. FS 3 has a similar increase in the overall recycling rate to FS 2, an increase over the baseline of 46%, from 49% to 72%. Due to the similarities of FS 4 to FS 3, the increases in many materials are similar. However, the alternate weekly recycling collection of fibers and MGP allows for slightly higher increases in those materials: a 44% increase in the amount of paper and card recycled, from 56% in the baseline to 81% and a 129% increase in the amount of rigid plastics recycled, from 22% to 52%.

**Table 40: Tons of PPP Generated, Disposed and Recycled for FS 4**

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XVIII] | Recycling Rate |
|---|---|---|---|---|
| **All Plastic** | **193,080** | **117,010** | **72,370** | **38%** |
| Rigid Plastics | **120,880** | **53,710** | **63,470** | **53%** |
| #1 PET Bottles | 34,100 | 10,800 | 23,300 | 68% |
| *#1 PET Bottles DRS Eligible* | *27,300* | *27,300* | *0* | 0% |
| *#1 PET Bottles Not DRS Eligible* | *6,800* | *6,800* | *0* | 0% |
| #1 PET Other Packaging | 20,000 | 7,100 | 12,900 | 65% |
| #2 HDPE Natural Bottles | 9,700 | 3,200 | 6,500 | 67% |
| *#2 HDPE Natural Bottles DRS Eligible* | *7,800* | *7,800* | *0* | 0% |
| *#2 HDPE Natural Bottles Not DRS Eligible* | *1,900* | *1,900* | *0* | 0% |
| #2 HDPE Colored Bottles | 12,800 | 5,000 | 7,800 | 61% |
| *#2 HDPE Colored Bottles DRS Eligible* | *1,300* | *1,300* | *0* | 0% |

[XVII] Measured as the material sold from the sorting facility to a reprocessor. The actual quantity of material that will be recycled will be less than this amount, as additional contaminants will be removed at the reprocessor. However, for the purposes of this study, the sorting facility outputs are used as the point of measurement to calculate the recycling rate across all systems.
[XVIII] MRF sorting facility tons to market

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled XVIII | Recycling Rate |
|---|---|---|---|---|
| *#2 HDPE Colored Bottles Not DRS Eligible* | *11,500* | *11,500* | *0* | 0% |
| # 2 Other HDPE Packaging | 4,600 | 2,900 | 1,700 | 37% |
| #3 PVC Packaging | 110 | 40 | 70 | 64% |
| #4 LDPE Packaging | 70 | 20 | 50 | 71% |
| #5 PP Packaging | 13,000 | 4,600 | 8,400 | 65% |
| #6 PS Packaging | 1,700 | 600 | 1,100 | 65% |
| #7 Other Packaging | 5,600 | 5,600 | 0 | 0% |
| Expanded Polystyrene Packaging | 13,300 | 11,800 | 1,500 | 11% |
| PE Plastic Bags & Film | 21,600 | 16,300 | 5,300 | 25% |
| Other Plastic Film & Flexible Packaging | 50,600 | 47,000 | 3,600 | 7% |
| R/C Plastic Packaging | 1,800 | 1,600 | 200 | 11% |
| PLA/Compostable Packaging | 4,100 | 400 | 0 | 0% |
| Flexible Plastics | **72,200** | **63,300** | **8,900** | **12%** |
| All Metals | **62,400** | **22,600** | **39,800** | **64%** |
| Steel Containers | 25,300 | 9,500 | 15,800 | 63% |
| All Aluminum | 37,100 | 13,100 | 24,000 | 65% |
| *Aluminum DRS Eligible* | *16,400* | *16,400* | *0* | 0% |
| *Aluminum Not DRS Eligible* | *20,700* | *20,700* | *0* | 0% |
| All Paper and Card | **683,000** | **129,800** | **553,200** | **81%** |
| Container Glass | **129,400** | **28,300** | **101,100** | **78%** |
| *Container Glass DRS Eligible* | *104,400* | 104,400 | 0 | 0% |
| *Container Glass Not DRS Eligible* | *25,000* | 25,000 | 0 | 0% |
| **Total** | **1,067,900** | **297,700** | **766,500** | **72%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

## PPP Collection, Transfer and Sorting Costs

In FS 4, the recycling collection increases from every other week in FS 3 to weekly, with a dual stream collection that alternates materials by week. Due to this increased collection, the collection costs increase, by 70% over the baseline and 14% over FS 3. Table 41 illustrates the costs for FS 4, which increase the cost per ton recycled from the baseline by 12% from $471 to $529. However, there is a 46% increase in tons recycled over the baseline, from 49% to 71%.

**Table 41: Cost Summary of FS 4 Residential PPP Recycling System in Washington**

| Cost Element | Current System Cost | FS 4 Cost |
|---|---|---|
| Recycling Collection Cost ($M) | 141.994 | 241.117 |
| Drop-off Costs ($M) | 2.272 | 1.065 |

| Cost Element | Current System Cost | FS 4 Cost |
|---|---|---|
| Sorting Costs ($M) | 54.729 | 87.105 |
| Sorting Material Revenue ($M) | -19.658 | -44.692 |
| MRF Residue Disposal Cost ($M) | 7.613 | 11.695 |
| Management, Supervision and Administration ($M) | 17.769 | 27.097 |
| Overhead and Profit ($M) | 20.253 | 33.46 |
| Taxes ($M) | 22.145 | 34.993 |
| PRO Costs ($M) | N/A | 7.863 |
| Education Costs ($M) | N/A | 5.559 |
| Secondary Plastic Processing Revenue ($M) | N/A | N/A |
| EPR Governance Costs ($M) | N/A | 0.288 |
| DRS Costs (including revenue) ($M) | N/A | N/A |
| **Total Cost** ($M) | **247.118** | **405.550** |
| **Total Cost per Ton Recycled (incl. DRS where applicable)** | **471** | **529** |
| Cost of PPP Disposed ($M) | 70.374 | 42.431 |

*Source: Eunomia Modelling, Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver, Washington Department of Ecology Landfill fees, CSSA Annual Cost Reports, Correspondence with Washington MRF Haulers, Correspondence with Washington MRF Operators, RecyclingMarkets.net*

## Benefits

### *Jobs*

FS 4 creates 6,491 total direct, indirect and induced jobs, with 2,495 of these being direct jobs created by the system, as shown in Table 42 below. There is a net gain of additional 2,617 jobs over the current system baseline.

**Table 42: Jobs from Current System and FS 4**

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 4 Residential PPP Recycling System |
|---|---|---|
| Direct | | |
| Collections Operations | 773 | 1,328 |

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 4 Residential PPP Recycling System |
|---|---|---|
| Collections Support & Management | 288 | 493 |
| Sorting | 419 | 632 |
| Secondary Sorting | N/A | N/A |
| Drop-off Jobs | 22 | 3 |
| DRS | N/A | N/A |
| Governance | N/A | 4 |
| PRO | N/A | 35 |
| Subtotal direct | 1,505 | 2,495 |
| Subtotal indirect and induced | 2,373 | 3,994 |
| **Total** | **3,874** | **6,491** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

### *Gross Value Added (GVA)*

The total direct, indirect and induced GVA to the Washington economy resulting from the FS 4 residential PPP recycling service is over $833M, including approximately $337M in direct benefits. The total GVA for FS 4 is over $336M greater than the current system baseline, as shown in Table 43.

**Table 43: Gross Value Added from FS 4**

| GVA Category | GVA from Current Residential PPP Recycling System | GVA from FS 4 Residential PPP Recycling System |
|---|---|---|
| Direct GVA ($M) | 201.129 | 337.459 |
| Indirect GVA ($M) | 166.412 | 279.211 |
| Induced GVA ($M) | 129.335 | 217.002 |
| **Total ($M)** | **496.875** | **833.672** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017)*

### *GHG Impact*

The $MTCO_2e$ avoided from FS 4 residential PPP recycling activities in Washington is 2.050M a year, or 652,000 more than the baseline system. This is the equivalent of taking a further 138,000 vehicles off the road every year above the current system.

### *Litter*

Litter reduction calculations have only been carried out for beverage containers as a result of the DRS under FSs 1, 5, 6 and 7.

## Costs and Benefits Summary

Table 44 provides an overarching view of the cost benefit of FS 4 compared to the current system, when the GVA has been netted off the cost of service as well as the social cost of carbon. These are very real benefits and should be included when calculating the cost or, as is the case, net benefit of recycling. Table 44 shows that for every ton recycled, there is a net societal benefit of $704.

**Table 44: Net Cost Benefit of FS 4 Residential PPP Recycling System in Washington**

| Cost Category | Cost of Current Residential PPP Recycling System | Cost of FS 4 Residential PPP Recycling System |
|---|---:|---:|
| System Costs ($M) | 247.1 | 405.6 |
| Disposal Costs ($M) | 70.4 | 42.4 |
| Monetized Cost of Carbon ($M) | -104.9 | -153.8 |
| GVA ($M) | -496.9 | -833.7 |
| **Total Net ($M)** | **-284.3** | **-539.5** |
| **Net Benefit per Ton Recycled ($)** | **-542** | **-704** |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017), Cost of Carbon metric from Washington Utilities and Transportation Commission (2019)*

A summary of the environmental and social benefits is provided in Table 45.

**Table 45: Environmental and Social Benefits of FS 4**

| Benefits | Value in Current Residential PPP Recycling | Value in FS 4 Residential PPP Recycling |
|---|---:|---:|
| Recycling Rate | 49% | 71% |
| Tons Recycled | 562,100 | 766,500 |
| $MTCO_2e$ Avoided | 1.399M | 2.050M |
| Jobs Direct, Indirect and Induced | 3,877 | 6,491 |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

## Stakeholder Impact

Table 46 below elaborates on the impact to relevant stakeholders under FS 4, while these are most the same as with FSs 2 and 3, there are some slight changes resulting from collecting PPP through a dual stream system.

**Table 46: Impacts on Stakeholders from the FS 4 for Providing Residential PPP recycling Services**

| Stakeholder | Impacts and Mitigation |
|---|---|
| Municipalities/ jurisdictions | **Producers cover the cost of recycling** based on agreed cost recovery mechanisms so municipalities no longer have to recover the cost of PPP services from households.<br><br>**Option to manage, provide directly or contract services** to ensure PPP services can be aligned with streams - trash and organics.<br><br>Due to dual stream, if services contracted, will need to either break, renegotiate or wait until contract ends to switch to dual stream<br><br>If services provided directly, likely to be able to use existing assets as the system is not based on using a split bodied vehicle but alternating collected weeks, fiber week one and MPG week two.<br><br>Education campaign required to ensure residents know how to use new system to be funded by producers.<br><br>Disposal cost tipping fee savings (~28M) |
| Waste Haulers | May need to renegotiate contracts to facilitate and transition to dual stream. **Continue to provide services to municipalities under contract.**<br><br>**More properties to collect from** as a result of 100% coverage and more material to collected as a result wider range of materials targeted at the curbside. |
| MRF operators | **Potential for stranded assets and/or the need to reconfigure sorting lines to accommodate dual stream material.**<br><br>Level of uncertainty as to how PRO may contract for services over long term especially if there is desire to move towards a dual stream system which will require a new sorting facility network.<br><br>**Opportunity to provide broader range of services** to PRO including transfer and secondary processing. |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | Greater quantity of material will be collected at the curbside and as such require sorting resulting in **increase in revenue from tipping fees (~$28M).**<br><br>Under EPR one option is that producers own the material collected and sorted, MRF operators will no longer have to shoulder the material risk associated with fluctuating markets and will contract for sorting services. |
| State | Additional direct indirect and induced **jobs (~+2,620)** and associated annual **GVA (~+$337M)** resulting from increase in the amount of PPP collected and recycled.<br><br>**More high value materials captured for recycling**, supporting a circular economy (~+242k tpa)<br><br>**Reduction in GHG emissions** (additional ~711M $MTCO_2e$ over baseline)<br><br>When material specific targets are set high, producers will invest in developing material markets and infrastructure necessary to meet the targets. |
| Households | **No longer required to pay for PPP recycling services**, estimated at ~$405M for this system equating to per household annual saving of in the region of ~$128 per annum.<br><br>**Ability to recycle a broader range of materials.**<br><br>Increased spending on recycling education to ensure householders can correctly participate in recycling programs. |
| Low income households | All impacts associated with all households. |
| Households in rural areas | Coverage of curbside services extending to all households ensuring all rural households receive a service.<br><br>All impacts associated with all households. |
| Homeless | No change in impacts compared to baseline. |
| Producers | **Producers of PPP are required to fund and coordinate recycling** (i.e. collection, transportation, sorting, and marketing) of materials from the residential sector and to ensure material specific targets are met and to educate households on the services offered. Producers are effectively responsible for the end of life management of their PPP. |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | **Estimated cost to producers** ~ $405M |
| Retailers including small retailers | No change in impacts compared to baseline. |

*Source: Eunomia*

## Future System 5: EPR + Enhanced Collection, Coverage and Capture with DRS

### Service Overview

FS 5 includes the same conditions are FS 2, but also models the addition of a DRS. A DRS is included in order to maximize the capture rates of beverage containers. This FS also assumes 100% coverage and a common set of materials collected curbside with EPS and film to drop-off. It assumes that services continue to be delivered at the current frequency using the same collection methodologies, which vary from jurisdiction to jurisdiction.

### PPP Generated, Recycled and Disposed

Table 47 shows the estimated tons of each PPP material generated, disposed and recycled[XIX] for FS 5. FS 5 has the same curbside structure as FS 2, but with the addition of a DRS, which increases the amount recycled for covered materials. FS 5 has a 50% increase in the overall amount of material recycled over the baseline, from 49% to 74%. This is a 7% increase over the overall recycling rate in FS 2. The materials covered under the DRS include a greater increase, with a 173% increase in rigid plastics recycled over the baseline, at 61% (compared to 60% in FS 2), 72% for aluminum (compared to 58% in FS 2), and 91% for glass (compared to 66% in FS 2) and which is a 42% increase over the baseline, compared to just 5% in FS 2.

**Table 47: Tons of PPP Generated, Disposed and Recycled for FS 5**

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XX] | Recycling Rate |
|---|---|---|---|---|
| **All Plastic** | **193,080** | **107,310** | **82,150** | **43%** |
| Rigid Plastics | **120,880** | **44,010** | **73,250** | **61%** |

[XIX] Measured as the material sold from the sorting facility to a reprocessor. The actual quantity of material that will be recycled will be less than this amount, as additional contaminants will be removed at the reprocessor. However, for the purposes of this study, the sorting facility outputs are used as the point of measurement to calculate the recycling rate across all systems.
[XX] MRF sorting facility tons to market

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [xx] | Recycling Rate |
|---|---|---|---|---|
| #1 PET Bottles | 34,100 | 3,000 | 31,080 | 91% |
| *#1 PET Bottles DRS Eligible* | *27,300* | *1,400* | *25,900* | 95% |
| *#1 PET Bottles Not DRS Eligible* | *6,800* | *1,800* | *5,000* | 74% |
| #1 PET Other Packaging | 20,000 | 7,800 | 12,240 | 61% |
| #2 HDPE Natural Bottles | 9,700 | 900 | 8,830 | 91% |
| *#2 HDPE Natural Bottles DRS Eligible* | *7,800* | *600* | *7,200* | 92% |
| *#2 HDPE Natural Bottles Not DRS Eligible* | *1,900* | *300* | *1,600* | 84% |
| #2 HDPE Colored Bottles | 12,800 | 4,500 | 8,290 | 65% |
| *#2 HDPE Colored Bottles DRS Eligible* | *1,300* | *100* | *1,200* | 92% |
| *#2 HDPE Colored Bottles Not DRS Eligible* | *11,500* | *4,200* | *7,300* | 64% |
| # 2 Other HDPE Packaging | 4,600 | 2,900 | 1,740 | 38% |
| #3 PVC Packaging | 110 | 40 | 70 | 64% |
| #4 LDPE Packaging | 70 | 20 | 50 | 71% |
| #5 PP Packaging | 13,000 | 4,800 | 8,200 | 63% |
| #6 PS Packaging | 1,700 | 600 | 1,100 | 65% |
| #7 Other Packaging | 5,600 | 5,600 | 0 | 0% |
| Expanded Polystyrene Packaging | 13,300 | 11,800 | 1,500 | 11% |
| PE Plastic Bags & Film | 21,600 | 16,300 | 5,300 | 25% |
| Other Plastic Film & Flexible Packaging | 50,600 | 47,000 | 3,600 | 7% |
| R/C Plastic Packaging | 1,800 | 1,600 | 200 | 11% |
| PLA/Compostable Packaging | 4,100 | 400 | 0 | 0% |
| Flexible Plastics | **72,200** | **63,300** | **8,900** | **12%** |
| All Metals | **62,400** | **21,100** | **41,350** | **66%** |
| Steel Containers | 25,300 | 9,600 | 15,700 | 62% |
| All Aluminum | 37,100 | 11,500 | 25,650 | 69% |
| *Aluminum DRS Eligible* | *16,400* | *800* | *15,600* | 95% |
| *Aluminum Not DRS Eligible* | *20,700* | *10,700* | *10,000* | 48% |
| All Paper and Card | **683,000** | **136,700** | **546,300** | **80%** |
| Container Glass | **129,400** | **11,900** | **117,500** | **91%** |
| *Container Glass DRS Eligible* | *104,400* | 4,400 | 100,000 | 96% |
| *Container Glass Not DRS Eligible* | *25,000* | 7,500 | 17,500 | 70% |
| **Total** | **1,067,900** | **277,000** | **787,300** | **74%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

## PPP Collection, Transfer, Sorting and DRS Costs

FS 5 has the second highest cost per ton recycled at $532, but includes a recycling rate of 73.7%. Table 48 illustrates the costs for FS 5, which have lower collection costs than either FS 3 or FS 4, due to less material going through the curbside system as it shifts into the DRS. The addition of a DRS system is approximately $59M.

**Table 48: Cost Summary of FS 5 Residential PPP Recycling System in Washington**

| Cost Element | Current System Cost | FS 5 Cost |
|---|---|---|
| Recycling Collection Cost ($M) | 141.994 | 193.575 |
| Drop-off Costs ($M) | 2.486 | 1.620 |
| Sorting Costs ($M) | 54.883 | 73.691 |
| Sorting Material Revenue ($M) | -18.929 | -17.647 |
| MRF Residue Disposal Cost ($M) | 7.633 | 11.271 |
| Management, Supervision and Administration ($M) | 17.769 | 23.346 |
| Overhead and Profit ($M) | 22.932 | 30.722 |
| Taxes ($M) | 22.145 | 30.872 |
| PRO Costs ($M) | N/A | 7.863 |
| Education Costs ($M) | N/A | 5.652 |
| Secondary Plastic Processing Revenue ($M) | N/A | -0.436 |
| EPR Governance Costs ($M) | N/A | .288 |
| DRS Costs (including revenue) ($M) | N/A | 59.018 |
| **Total Cost** ($M) | **247.118** | **418.749** |
| **Total Cost per Ton Recycled (incl. DRS where applicable)** | **471** | **533** |
| Cost of PPP Disposed ($M) | 70.374 | 38.923 |

*Source: Eunomia Modelling, Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver, Washington Department of Ecology Landfill fees, CSSA Annual Cost Reports, Correspondence with Washington MRF Haulers, Correspondence with Washington MRF Operators, RecyclingMarkets.net*

### Benefits

#### *Jobs*

FS 5 creates 7,306 total direct, indirect and induced jobs, with 2,920 of these being direct jobs created by the system. Of the total, 1,985 jobs are related to the DRS system. Since material is moving from the curbside recycling system into the DRS, there is a reduction of jobs in the areas associated with that system, as shown in Table 49 below, but there is a net gain of additional 3,432 jobs over the current system baseline.

**Table 49: Jobs from Current System and FS 5**

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 5 Residential PPP Recycling System |
|---|---|---|
| Direct | | |
| Collections Operations | 773 | 1,054 |
| Collections Support & Management | 288 | 390 |
| Sorting | 419 | 564 |
| Secondary Sorting | N/A | 7 |
| Drop-off Jobs | 22 | 6 |
| DRS | N/A | 860 |
| Governance | N/A | 4 |
| PRO | N/A | 35 |
| Subtotal direct | 1,505 | 2,920 |
| Subtotal indirect and induced | 2,373 | 4,386 |
| **Total** | **3,874** | **7,306** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

#### *Gross Value Added (GVA)*

The total direct, indirect and induced GVA to the Washington economy resulting from the FS 5 residential PPP recycling service is over $1,049M, including approximately $425M in direct benefits. The total GVA for FS 5 is over $552M greater than the current system baseline, as shown in Table 50.

**Table 50: Gross Value Added from FS 5**

| GVA Category | GVA from Current Residential PPP Recycling System | GVA from FS 5 Residential PPP Recycling System |
|---|---|---|
| Direct GVA ($M) | 201.129 | 424.843 |
| Indirect GVA ($M) | 166.412 | 351.511 |
| Induced GVA ($M) | 129.335 | 273.193 |
| **Total ($M)** | **496.875** | **1049.547** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017)*

### *GHG Impact*

The $MTCO_2e$ avoided from FS 5 residential PPP recycling activities in Washington is 1.967M a year, or 569,000 more than the baseline system. This is the equivalent of taking a further 123,000 vehicles off the road every year above the current system.

### *Litter*

A reduction of 4,100 tons of beverage container litter, or 80% of the total beverage container litter at baseline, is realized in FS5.

## Costs and Benefits Summary

Table 51 provides an overarching view of the cost benefit of FS 5 compared to the current system, when the GVA has been netted off the cost of service as well as the social cost of carbon. These are very real benefits and should be included when calculating the cost or, as is the case, net benefit of recycling. Table 51 shows that for every ton recycled, there is a net societal benefit of $939.

**Table 51: Net Cost Benefit of FS 5 Residential PPP Recycling System in Washington**

| Cost Category | Cost of Current Residential PPP Recycling System | Cost of FS 5 Residential PPP Recycling System |
|---|---|---|
| System Costs ($M) | 247.1 | 418.2 |
| Disposal Costs ($M) | 70.4 | 38.5 |
| Monetized Cost of Carbon ($M) | -104.9 | -147.6 |
| GVA ($M) | -496.9 | -1,049.5 |
| **Total Net ($M)** | **-284** | **-739.5** |
| **Net Benefit per Ton Recycled ($)** | **-541** | **-939** |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019)[66], Bureau of Economic Analysis[67], Institute for Scrap Recycling Industries (2017)[68], Cost of Carbon metric from Washington Utilities and Transportation Commission (2019)[69]*

A summary of the environmental and social benefits is provided in Table 52.

**Table 52: Environmental and Social Benefits of FS 5**

| Benefits | Value in Current Residential PPP Recycling | Value in FS 5 Residential PPP Recycling |
|---|---|---|
| Recycling Rate | 49% | 74% |
| Tons Recycled | 562,100 | 787,300 |
| $MTCO_2e$ Avoided | 1.399M | 1.967M |
| Jobs Direct, Indirect and Induced | 3,877 | 7,306 |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

## Stakeholder Impact

Table 53 below elaborates on the impact to relevant stakeholders under FS 5, these include impacts associated with a DRS plus with EPR so a combination of FS 1 with FS 2.

**Table 53: Impacts on Stakeholders from the FS 5 for Providing Residential PPP recycling Services**

| Stakeholder | Impacts and Mitigation |
|---|---|
| Municipalities/ jurisdictions | **Producers cover the cost of recycling** based on agreed cost recovery mechanisms so municipalities no longer have to recover the cost of PPP services from households.<br><br>Option to manage, provide directly or contract the services allowing PPP services to be aligned with streams - trash and organics.<br><br>**Disposal cost tipping fee savings (~31M)**<br><br>Potential for municipalities with drop-off facilities to be a bag drop location and as such to receive a handling fee. |
| Waste Haulers | **Continue to provide services to municipalities under contract. More properties to collect from** as a result of 100% coverage and more material to collected as a result wider range of materials targeted at the curbside.<br><br>Waste haulers will have the opportunity to provide DRS related collection services to the PRO. The PRO will have over $43M of collection related services to procure from the market to service the redemption network. |
| MRF operators | Greater quantity of material will be collected at the curbside and as such require sorting resulting in **increase in revenue from tipping fees (~19M)**. |

| | |
|---|---|
| | Under EPR it is assumed that producers will own the material collected and sorted, MRF operators will no longer have to shoulder the material risk associated with fluctuating markets.<br><br>Level of uncertainty as to how PRO may contract for services over long term. Opportunity to provide broader range of services to PRO including transfer and secondary processing as well as sorting center function for DRS.<br><br>Impact of DRS is mitigated when part of full EPR if MRFs are contracted to provide sorting service and not take risk on material income. If MRF still takes material risk, then the benefit of access deposit of containers they process as well as the unclaimed deposits when producers do not meet the beverage specific targets equates to an estimated **$73M financial benefit over the three-year DRS implementation period.** |
| State | Significant increase in direct, indirect and induced **jobs (+3,440)** and associated annual **GVA (~+$552M)** resulting from the DRS.<br><br>**More high value materials captured for recycling**, supporting a circular economy (~+263k tpa)<br><br>**Reduction in GHG emissions** (additional ~0.628M MT$CO_2$e over baseline)<br><br>80% reduction in beverage related litter. |
| Households | **No longer required to pay for PPP recycling services**, estimated for this FS as ~$419M equating to per household annual saving of in the region of ~$132.<br><br>**Ability to recycle a broader range of materials.**<br><br>Increased spending on recycling education to ensure householders can correctly participate in recycling programs. |
| Low income households | All impacts associated with all households, plus:<br><br>Access to two recycling systems, greater incentive to recycle, reduction in litter increase public amenity of local environment<br><br>The mechanism summarized under FS 1 whereby the deposit is waivered at the start of the DRS for non-carbonated water will ensure that households reliant on bottled water will be able to claim back the deposit on water during the first week of the DRS but not have to pay it as this would be covered by producers.<br><br>Redemption locations located on transit routes and at retailer and other commonly visited locations will make redemption convenient and easy. |

| | |
|---|---|
| Households in rural areas | All impacts associated with all households, plus:<br><br>Coverage of curbside services extending to all households ensuring all rural households receive a service.<br><br>Access to two recycling systems, greater incentive to recycle, reduction in litter increase public amenity of local environment.<br><br>Redemption locations located on transit routes and at retailer and other commonly visited locations will make redemption convenient and easy. |
| Homeless | Ability to collect containers that are littered, providing a **source of income** |
| Producers | Producers of PPP are required to fund and coordinate the recycling (i.e. collection, transportation, sorting, and marketing) of materials from the residential sector and to ensure material specific targets are met and to educate households on the services offered. Producers are effectively responsible for the end of life management of their PPP.<br><br>**Cost to producers estimated at ~$419M.** |
| Retailers including small retailers | **Options for involvement in the DRS** either: return at retail; return to retail (parking lot bag-drops); or exemption if it can be demonstrated that there are sufficient redemption points to meet geographical coverage target. Handling fee, calculated based on cost coverage, paid to retailers for their role in supporting redemption. Increase in footfall through stores as the value of the deposit will mean that redeemers are also consumers. Technology driven redemption routes reduced retailer time. Bag drop program reducing retailer involvement under the system.<br><br>**Small businesses, under 5,000 sq ft not required to redeem under the system and can chose to opt-in.** |

*Source: Eunomia*

## Future System 6: EPR + Aligned Collection Methodology and Frequency – single stream with glass to drop-off plus DRS

### Service Overview

FS 6 includes similar conditions to FS 3, but with the addition of a DRS and without the glass collection every fourth week. A DRS is included in order to maximize the capture rates of beverage containers. In FS 6, all households receive the same service at the same frequency, providing consistency across the state. This FS provides the convenience of curbside collection services for all materials. By removing glass from the recycling stream, which often breaks during collection and contaminates other materials, this FS helps maintain the quality and capture rates of glass as well as other PPP materials.

This structure assumes that producers will create an optimized system of recycling collection without the restrictions of jurisdictional borders. Therefore, contracts with haulers can be renegotiated to create consistency across jurisdictions, allowing for more optimized routes. These changes should allow for additional reductions in collection costs, though this probable cost savings was not included in the modeling.

## PPP Generated, Recycled and Disposed

Table 54 shows the estimated tons of each PPP material generated, disposed, and recycled[XXI] for FS 6. FS 6 has the same curbside structure as FS 3, but with the addition of a DRS, which increases the amount recycled for covered materials. FS 6 has a 49% increase in the overall amount of material recycled over the baseline, from 49% to 73%. This is a 4% increase over the overall recycling rate in FS 3. The materials covered under the DRS include a greater increase, with a 173% increase in rigid plastics recycled over the baseline, at 61% (compared to 50% in FS 3), 72% for aluminum (compared to 57% in FS 3), and 87% for glass (compared to 79% in FS 3) and which is a 39% increase over the baseline, compared to 26% in FS 3.

**Table 54: Tons of PPP Generated, Disposed and Recycled for FS 6**

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XXII] | Recycling Rate |
|---|---|---|---|---|
| **All Plastic** | **193,080** | **107,310** | **82,150** | **43%** |
| Rigid Plastics | **120,880** | **44,010** | **73,250** | **61%** |
| #1 PET Bottles | 34,100 | 3,000 | 31,080 | 91% |
| *#1 PET Bottles DRS Eligible* | *27,300* | *1,400* | *25,900* | 95% |
| *#1 PET Bottles Not DRS Eligible* | *6,800* | *1,900* | *4,900* | 72% |
| #1 PET Other Packaging | 20,000 | 7,800 | 12,240 | 61% |
| #2 HDPE Natural Bottles | 9,700 | 900 | 8,830 | 91% |
| *#2 HDPE Natural Bottles DRS Eligible* | *7,800* | *600* | *7,200* | 92% |
| *#2 HDPE Natural Bottles Not DRS Eligible* | *1,900* | *300* | *1,600* | 84% |
| #2 HDPE Colored Bottles | 12,800 | 4,500 | 8,290 | 65% |
| *#2 HDPE Colored Bottles DRS Eligible* | *1,300* | *100* | *1,200* | 92% |

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XXI Measured as the material sold from the sorting facility to a reprocessor. The actual quantity of material that will be recycled will be less than this amount, as additional contaminants will be removed at the reprocessor. However, for the purposes of this study, the sorting facility outputs are used as the point of measurement to calculate the recycling rate across all systems.
XXII MRF sorting facility tons to market

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XXII] | Recycling Rate |
|---|---|---|---|---|
| *#2 HDPE Colored Bottles Not DRS Eligible* | *11,500* | *4,600* | *6,900* | 60% |
| # 2 Other HDPE Packaging | 4,600 | 2,900 | 1,740 | 38% |
| #3 PVC Packaging | 110 | 40 | 70 | 64% |
| #4 LDPE Packaging | 70 | 20 | 50 | 71% |
| #5 PP Packaging | 13,000 | 4,800 | 8,200 | 63% |
| #6 PS Packaging | 1,700 | 600 | 1,100 | 65% |
| #7 Other Packaging | 5,600 | 5,600 | 0 | 0% |
| Expanded Polystyrene Packaging | 13,300 | 11,800 | 1,500 | 11% |
| PE Plastic Bags & Film | 21,600 | 16,300 | 5,300 | 25% |
| Other Plastic Film & Flexible Packaging | 50,600 | 47,000 | 3,600 | 7% |
| R/C Plastic Packaging | 1,800 | 1,600 | 200 | 11% |
| PLA/Compostable Packaging | 4,100 | 400 | 0 | 0% |
| Flexible Plastics | **72,200** | **63,300** | **8,900** | **12%** |
| All Metals | **62,400** | **21,100** | **41,350** | **66%** |
| Steel Containers | 25,300 | 9,600 | 15,700 | 62% |
| All Aluminum | 37,100 | 11,500 | 25,650 | 69% |
| *Aluminum DRS Eligible* | *16,400* | *800* | *15,600* | 95% |
| *Aluminum Not DRS Eligible* | *20,700* | *10,800* | *9,900* | 48% |
| All Paper and Card | **683,000** | **136,700** | **546,300** | **80%** |
| Container Glass | **129,400** | **16,600** | **112,800** | **87%** |
| *Container Glass DRS Eligible* | *104,400* | 4,400 | 100,000 | 96% |
| *Container Glass Not DRS Eligible* | *25,000* | 12,200 | 12,800 | 51% |
| **Total** | **1,067,900** | **281,700** | **782,600** | **73%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

## PPP Collection, Transfer, Sorting and DRS Costs

Table 55 illustrates the cost for collection in FS 6, which has the **lowest cost per ton recycled**, at $442. This cost per ton is 6% lower than the baseline and 12% less than the similar system without a DRS, FS 3, despite the $59M in costs associated with the DRS. Though the total cost of the system is 40% higher than the baseline, there is 49% more material recycled, with an overall recycling rate of 73.3%.

**Table 55: Cost Summary of FS 6 Residential PPP Recycling System in Washington**

| Cost Element | Current System Cost | FS 6 Cost |
|---|---|---|
| Recycling Collection Cost ($M) | 141.994 | 140.171 |
| Drop-off Costs ($M) | 2.486 | 2.860 |
| Sorting Costs ($M) | 54.883 | 72.024 |
| Sorting Material Revenue ($M) | -18.929 | -18.900 |
| MRF Residue Disposal Cost ($M) | 7.633 | 11.461 |
| Management, Supervision and Administration ($M) | 17.769 | 17.282 |
| Overhead and Profit ($M) | 22.932 | 24.656 |
| Taxes ($M) | 22.145 | 24.375 |
| PRO Costs ($M) | N/A | 7.863 |
| Education Costs ($M) | N/A | 5.652 |
| Secondary Plastic Processing Revenue ($M) | N/A | -.436 |
| EPR Governance Costs ($M) | N/A | .288 |
| DRS Costs (including revenue) ($M) | N/A | 59.018 |
| **Total Cost** ($M) | **247.118** | **346.221** |
| **Total Cost per Ton Recycled (incl. DRS where applicable)** | **471** | **442** |
| Cost of PPP Disposed ($M) | 70.374 | 39.647 |

*Source: Eunomia Modelling, Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver, Washington Department of Ecology Landfill fees, CSSA Annual Cost Reports, Correspondence with Washington MRF Haulers, Correspondence with Washington MRF Operators, RecyclingMarkets.net*

## Benefits

### *Jobs*

FS 6 creates 6,414 total direct, indirect and induced jobs, with 2,612 of these being direct jobs created by the system. Of the total, 1,985 jobs are related to the DRS system. Since material is moving from the curbside recycling system into the DRS, there is a reduction of jobs in the areas associated with that system, as shown in Table 56 below, but there is a net gain of additional 2,540 jobs over the current system baseline.

**Table 56: Jobs from Current System and FS 6**

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 6 Residential PPP Recycling System |
|---|---|---|
| Direct | | |
| Collections Operations | 773 | 752 |
| Collections Support & Management | 288 | 390 |
| Sorting | 419 | 552 |
| Secondary Sorting | N/A | 7 |
| Drop-off Jobs | 22 | 12 |
| DRS | N/A | 860 |
| Governance | N/A | 4 |
| PRO | N/A | 35 |
| Subtotal direct | 1,505 | 2,612 |
| Subtotal indirect and induced | 2,373 | 3,802 |
| **Total** | **3,874** | **6,414** |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017), Cost of Carbon metric from Washington Utilities and Transportation Commission (2019)*

### *Gross Value Added (GVA)*

The total direct, indirect and induced GVA to the Washington economy resulting from the FS 6 residential PPP recycling service is over $927M, including approximately $375M in direct benefits. The total GVA for FS 6 is over $430M greater than the current system baseline, as shown in Table 57.

**Table 57: Gross Value Added from FS 6**

| GVA Category | GVA from Current Residential PPP Recycling System | GVA from FS 6 Residential PPP Recycling System |
|---|---|---|
| Direct GVA ($M) | 201.129 | 375.439 |
| Indirect GVA ($M) | 166.412 | 310.635 |
| Induced GVA ($M) | 129.335 | 241.425 |
| **Total ($M)** | **496.875** | **927.499** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017)*

#### *GHG Impact:*

The $MTCO_2e$ avoided from FS 6 residential PPP recycling activities in Washington is 2.024M a year, or 625,000 more than the baseline system. This is the equivalent of taking a further 135,000 vehicles off the road every year above the current system.

#### *Litter*

A reduction of 4,100 tons of beverage container litter, or 80% of the total beverage container litter at baseline, is realized in FS 6.

## Costs and Benefits Summary

Table 58 provides an overarching view of the cost benefit of FS 6 compared to the current system, when the GVA has been netted off the cost of service as well as the social cost of carbon. These are very real benefits and should be included when calculating the cost or, as is the case, net benefit of recycling. Table 58 shows that for every ton recycled, there is a net societal benefit of $886.

**Table 58: Net Cost Benefit of FS 6 Residential PPP Recycling System in Washington**

| Cost Category | Cost of Current Residential PPP Recycling System | Cost of FS 6 Residential PPP Recycling System |
|---|---|---|
| System Costs ($M) | 247.1 | 346.2 |
| Disposal Costs ($M) | 70.4 | 39.6 |
| Monetized Cost of Carbon ($M) | -104.9 | -151.8 |
| GVA ($M) | -496.9 | -927.5 |
| **Total Net ($M)** | **-284.3** | **-693.5** |
| **Net Benefit per Ton Recycled ($)** | **-541** | **-886** |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017), Cost of Carbon metric from Washington Utilities and Transportation Commission (2019)*

A summary of the environmental and social benefits is provided in Table 59.

**Table 59: Environmental and Social Benefits of FS 6**

| Benefits | Value in Current Residential PPP Recycling | Value in FS 6 Residential PPP Recycling |
|---|---|---|
| Recycling Rate | 49% | 73% |
| Tons Recycled | 562,100 | 782,600 |
| $MTCO_2e$ Avoided | 1.399M | 2.024M |
| Jobs Direct, Indirect and Induced | 3,877 | 6,414 |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

## Stakeholder Impact

The stakeholder impacts under this scenario are the same as under FS 5 except that households will be required to bring glass containers to drop-off facilities or recycle them through the DRS, reducing the convenience of curbside collection for this material.

Table 60 below elaborates on the impact to relevant stakeholders under FS 6.

**Table 60: Impacts on Stakeholders from the FS 6 for Providing Residential PPP recycling Services**

| Stakeholder | Impacts and Mitigation |
|---|---|
| Municipalities/ jurisdictions | **Producers cover the cost of recycling** based on agreed cost recovery mechanisms so municipalities no longer have to recover the cost of PPP services from households.<br><br>Option to manage, provide directly or contract the services allowing PPP services to be aligned with streams - trash and organics.<br><br>**Disposal cost tipping fee savings (~31M)**<br><br>Potential for municipalities with drop-off facilities to be a bag drop location and as such to receive a handling fee. |
| Waste Haulers | **Continue to provide services to municipalities under contract. More properties to collect from** as a result of 100% coverage and more material to collected as a result wider range of materials targeted at the curbside.<br><br>Waste haulers will have the opportunity to provide DRS related collection services to the PRO. The PRO will have over $43M of collection related services to procure from the market to service the redemption network. |
| MRF operators | Greater quantity of material will be collected at the curbside and as such require sorting resulting in **increase in revenue from tipping fees (~17M)**.<br><br>**No longer required sort glass as part of single stream.**<br><br>Under EPR it is assumed that producers will own the material collected and sorted, MRF operators will no longer have to shoulder the material risk associated with fluctuating markets.<br><br>Level of uncertainty as to how PRO may contract for services over long term. Opportunity to provide broader range of services to PRO including transfer and secondary processing as well as sorting center function for DRS. |

| | |
|---|---|
| | Impact of DRS is mitigated when part of full EPR if MRFs are contracted to provide sorting service and not take risk on material income. If MRF still takes material risk, then the benefit of access deposit of containers they process as well as the unclaimed deposits when producers do not meet the beverage specific targets equates to an estimated **\$73M financial benefit over the three-year DRS implementation period.** |
| State | Significant increase in direct, indirect and induced **jobs (+2,540)** and associated annual **GVA (~+\$430M)** resulting from the DRS.<br><br>**More high value materials captured for recycling**, supporting a circular economy (~+255k tpa)<br><br>**Reduction in GHG emissions** (additional ~0.625M MTCO$_2$e over baseline)<br><br>80% reduction in beverage related litter. |
| Households | **No longer required to pay for PPP recycling services**, estimated for this FS as ~\$346M equating to per household annual saving of in the region of ~\$109<br><br>**Ability to recycle a broader range of materials.**<br><br>Increased spending on recycling education to ensure householders can correctly participate in recycling programs. |
| Low income households | All impacts associated with all households, plus:<br><br>Access to two recycling systems, greater incentive to recycle, reduction in litter increase public amenity of local environment.<br><br>The mechanism summarized under FS 1, whereby the deposit is waived at the start of the DRS for non-carbonated water will ensure that households reliant on bottled water will be able to claim back the deposit on water during the first week of the DRS. but not have to pay it, as it would be covered by producers.<br><br>Redemption locations located on transit routes and at retailer and other commonly visited locations will make redemption convenient and easy. |
| Households in rural areas | All impacts associated with all households, plus:<br><br>**Coverage of curbside services extending to all households** ensuring all rural households receive a service.<br><br>Access to two recycling systems, greater incentive to recycle, reduction in litter increase public amenity of local environment. |

| | |
|---|---|
| | Redemption locations located on transit routes and at retailer and other commonly visited locations will make redemption convenient and easy. |
| Homeless | Ability to collect containers that are littered, providing a **source of income.** |
| Producers | **Producers of PPP are required to fund and coordinate recycling** (i.e. collection, transportation, sorting, and marketing) of materials from the residential sector and to ensure material specific targets are met and to educate households on the services offered. Producers are effectively responsible for the end of life management of their PPP.<br><br>**Cost to producers estimated at ~346M.** |
| Retailers | **Options for involvement in the DRS,** either: return-at-retail; return-to-retail (parking lot bag-drops); or exemption if it can be demonstrated that there are sufficient redemption points to meet geographical coverage target. Handling fee, calculated based on cost coverage, paid to retailers for their role in supporting redemption. Increase in footfall through stores as the value of the deposit will mean that redeemers are also consumers. Technology driven redemption routes reduced retailer time. Bag drop program reducing retailer involvement under the system.<br><br>**Small businesses, under 5,000 sq ft not required to redeem under the system and can chose to opt-in.** |

*Source: Eunomia*

## Future System 7: EPR +Aligned Collection Methodology and Frequency – dual stream plus DRS

### Service Overview

FS 7 includes the same conditions are FS 4, but also models the addition of a DRS. A DRS is included in order to maximize the capture rates of beverage containers. Under this FS, households receive a weekly recycling collection that alternates materials collected by week for a dual stream system. Therefore, fibers (i.e. paper and carboard) are collected one week and MPG is collected the next. This structure allows for a regular schedule of recycling collection, but separates materials to enhance their quality, leading to higher material values.

This system would be an increase in frequency to most households in Washington. As there are now two streams of material, it is assumed that material will be processed through regional sorting facilities. Despite this FS increasing the frequency of collection for many households, no increase in capture rate has been assumed. However, such an increase is very possible, if trash collections move to every other week collection, which encourages more recycling.

The modeled performance benefits of this system are: increased capture, as there is reduced loss currently associated with containers being lost to the paper stream, for example; and, increased bale purity levels, attracting higher and more stable material sale prices.

## PPP Generated, Recycled and Disposed

Table 61 shows the estimated tons of each PPP material generated, disposed and recycled[XXIII] for FS 7. FS 7 has the same curbside structure as FS 4, but with the addition of a DRS, which increases the amount recycled for covered materials. FS 7 has a 53% increase in the overall amount of material recycled over the baseline, from 49.2% to 75.4%, which is the greatest increase of all the FSs modeled and a 4% increase over the overall recycling rate in FS 4. The materials covered under the DRS include the greatest increase, with a 177% increase in rigid plastics recycled over the baseline, at 61.5% (compared to 52.5% in FS 4), 81.8% for aluminum (compared to 67.9% in FS 4), and 93.7% for glass (compared to 78.1% in FS 3) and which is a 49% increase over the baseline, compared to 25% in FS 4.

**Table 61: Tons of PPP Generated, Disposed and Recycled for FS 7**

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XXIV] | Recycling Rate |
|---|---|---|---|---|
| **All Plastic** | **193,080** | **106,080** | **83,300** | **43%** |
| Rigid Plastics | **120,880** | **42,780** | **74,400** | **62%** |
| #1 PET Bottles | 34,100 | 2,700 | 31,400 | 92% |
| *#1 PET Bottles DRS Eligible* | *27,300* | *1,300* | *26,000* | *95%* |
| *#1 PET Bottles Not DRS Eligible* | *6,800* | *1,400* | *5,400* | 79% |
| #1 PET Other Packaging | 20,000 | 7,100 | 12,900 | 65% |
| #2 HDPE Natural Bottles | 9,700 | 900 | 8,800 | 91% |
| *#2 HDPE Natural Bottles DRS Eligible* | *7,800* | *600* | *7,200* | 92% |
| *#2 HDPE Natural Bottles Not DRS Eligible* | *1,900* | *300* | *1,600* | 84% |
| #2 HDPE Colored Bottles | 12,800 | 4,500 | 8,300 | 65% |
| *#2 HDPE Colored Bottles DRS Eligible* | *1,300* | *100* | *1,200* | 92% |

[XXIII] Measured as the material sold from the sorting facility to a reprocessor. The actual quantity of material that will be recycled will be less than this amount, as additional contaminants will be removed at the reprocessor. However, for the purposes of this study, the sorting facility outputs are used as the point of measurement to calculate the recycling rate across all systems.
[XXIV] MRF sorting facility tons to market

| Material | Residential PPP Generated | Tons Disposed | Total Tons Recycled [XXIV] | Recycling Rate |
|---|---|---|---|---|
| *#2 HDPE Colored Bottles Not DRS Eligible* | *11,500* | *4,400* | *7,100* | 62% |
| # 2 Other HDPE Packaging | 4,600 | 2,900 | 1,700 | 37% |
| #3 PVC Packaging | 110 | 10 | 100 | 91% |
| #4 LDPE Packaging | 70 | 20 | 50 | 71% |
| #5 PP Packaging | 13,000 | 4,600 | 8,400 | 65% |
| #6 PS Packaging | 1,700 | 600 | 1,100 | 65% |
| #7 Other Packaging | 5,600 | 5,600 | 0 | 0% |
| Expanded Polystyrene Packaging | 13,300 | 11,800 | 1,500 | 11% |
| PE Plastic Bags & Film | 21,600 | 16,300 | 5,300 | 25% |
| Other Plastic Film & Flexible Packaging | 50,600 | 47,000 | 3,600 | 7% |
| R/C Plastic Packaging | 1,800 | 1,600 | 200 | 11% |
| PLA/Compostable Packaging | 4,100 | 400 | 0 | 0% |
| Flexible Plastics | **72,200** | **63,300** | **8,900** | **12%** |
| All Metals | **62,400** | **17,600** | **44,800** | **72%** |
| Steel Containers | 25,300 | 9,500 | 15,800 | 63% |
| All Aluminum | 37,100 | 8,100 | 29,000 | 78% |
| *Aluminum DRS Eligible* | *16,400* | *700* | *15,700* | 96% |
| *Aluminum Not DRS Eligible* | *20,700* | *7,400* | *13,300* | 64% |
| All Paper and Card | **683,000** | **128,300** | **554,700** | **81%** |
| Container Glass | **129,400** | **8,200** | **121,200** | **94%** |
| *Container Glass DRS Eligible* | *104,400* | 4,600 | 99,800 | 96% |
| *Container Glass Not DRS Eligible* | *25,000* | 3,600 | 21,400 | 86% |
| **Total** | **1,067,900** | **260,200** | **804,000** | **75%** |

*Source*: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling

## PPP Collection, Transfer, Sorting and DRS Costs

FS 7 has the highest costs of all the FSs, in terms of total cost, but also has the highest recycling overall recycling rate of all systems compared, at 75%. The cost per ton recycled is greater than that of FS 1, at $542, as seen in Table 62. Like FS 4, this system has higher collection costs due to an increase to weekly recycling collection, but those costs in FS 7 are 14% less than those in FS 4, due to material shifting from the curbside recycling system to the DRS.

**Table 62: Cost Summary of FS 7 Residential PPP Recycling System in Washington**

| Cost Element | Current System Cost | FS 7 Cost |
|---|---:|---:|
| Recycling Collection Cost ($M) | 141.994 | 206.822 |
| Drop-off Costs ($M) | 2.486 | 1.194 |
| Sorting Costs ($M) | 54.729 | 75.071 |
| Sorting Material Revenue ($M) | -19.658 | -26.167 |
| MRF Residue Disposal Cost ($M) | 7.633 | 4.565 |
| Management, Supervision and Administration ($M) | 17.769 | 29.297 |
| Overhead and Profit ($M) | 22.932 | 34.023 |
| Taxes ($M) | 22.145 | 32.079 |
| PRO Costs ($M) | N/A | 7.863 |
| Education Costs ($M) | N/A | 5.652 |
| Secondary Plastic Processing Revenue ($M) | N/A | N/A |
| EPR Governance Costs ($M) | N/A | .288 |
| DRS Costs (including revenue) ($M) | N/A | 59.018 |
| **Total Cost** ($M) | **247.118** | **436.000** |
| **Total Cost per Ton Recycled (incl. DRS where applicable)** | **471** | **542** |
| Cost of PPP Disposed ($M) | 70.374 | 38.483 |

*Source: Eunomia Modelling, Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver, Washington Department of Ecology Landfill fees, CSSA Annual Cost Reports, Correspondence with Washington MRF Haulers, Correspondence with Washington MRF Operators, RecyclingMarkets.net*

## Benefits

### *Jobs*

FS 7 creates 7,845 total direct, indirect and induced jobs, with 3,086 of these being direct jobs created by the system. This is the greatest number of jobs created of any of the FSs, with over 500 jobs more than the second most, FS 5.

Of the total, 1,985 jobs are related to the DRS system. Since material is moving from the curbside recycling system into the DRS, there is a reduction of jobs in the areas associated with that system, as shown in Table 63 below, but there is a net gain of additional 4,797 jobs over the current system baseline.

**Table 63: Jobs from Current System and FS 7**

| Job Category | Estimated Jobs from Current Residential PPP Recycling System | Estimated Jobs from FS 7 Residential PPP Recycling System |
|---|---|---|
| Direct | | |
| Collections Operations | 773 | 1,328 |
| Collections Support & Management | 288 | 281 |
| Sorting | 419 | 575 |
| Secondary Sorting | N/A | N/A |
| Drop-off Jobs | 22 | 3 |
| DRS | N/A | 860 |
| Governance | N/A | 4 |
| PRO | N/A | 35 |
| Subtotal direct | 1,505 | 3,086 |
| Subtotal indirect and induced | 2,373 | 4,758 |
| **Total** | **3,874** | **7,845** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

### *Gross Value Added (GVA)*

The total direct, indirect and induced GVA to the Washington economy resulting from the FS 7 residential PPP recycling service is over $1,132M, including approximately $458M in direct benefits. The total GVA for FS 7 is over $635M greater than the current system baseline, as shown in Table 64. This is the greatest GVA of any of the FSs, with over $83M more added to the economy than the second most, FS 5.

**Table 64: Gross Value Added from FS 7**

| GVA Category | GVA from Current Residential PPP Recycling System | GVA from FS 7 Residential PPP Recycling System |
|---|---|---|
| Direct GVA ($M) | 201.129 | 458.293 |
| Indirect GVA ($M) | 166.412 | 379.187 |
| Induced GVA ($M) | 129.335 | 294.704 |
| **Total ($M)** | **496.875** | **1132.184** |

*Source: Eunomia, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017)*

*GHG Impact:*

The $MTCO_2e$ avoided from FS 7 residential PPP recycling activities in Washington is 2.088M a year, or 689,000 more than the baseline system. This is the equivalent of taking a further 149,000 vehicles off the road every year above the current system.

*Litter*

A reduction of 4,100 tons of beverage container litter, or 80% of the total beverage container litter at baseline, is realized in FS 7.

## Costs and Benefits Summary

Table 65 provides an overarching view of the cost benefit of FS 7 compared to the current system, when the GVA has been netted off the cost of service as well as the social cost of carbon. These are very real benefits and should be included when calculating the cost or, as is the case, net benefit of recycling. Table 65 shows that for every ton recycled, there is a net societal benefit of $1,012.

Though it is the most expensive system, FS 7 provides the greatest benefits as well, with 2% more material recycled overall than the closest system to providing as great benefits, FS 5.

**Table 65: Net Cost Benefit of FS 7 Residential PPP Recycling System in Washington**

| Cost Category | Cost of Current Residential PPP Recycling System | Cost of FS 7 Residential PPP Recycling System |
|---|---|---|
| System Costs ($M) | 247.1 | 436.0 |
| Disposal Costs ($M) | 70.4 | 38.5 |
| Monetized Cost of Carbon ($M) | -104.9 | -156.6 |
| GVA ($M) | -496.9 | -1,132.2 |
| **Total Net ($M)** | **-284.3** | **-814.3** |
| **Net Benefit per Ton Recycled ($)** | **-541** | **-1,012** |

Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis, Institute for Scrap Recycling Industries (2017), Cost of Carbon metric from Washington Utilities and Transportation Commission

A summary of the environmental and social benefits is provided in Table 66.

**Table 66: Environmental and Social Benefits of FS 7**

| Benefits | Value in Current Residential PPP Recycling | Value in FS 7 Residential PPP Recycling |
|---|---|---|
| Recycling Rate | 49% | 75% |
| Tons Recycled | 562,100 | 804,000 |

| Benefits | Value in Current Residential PPP Recycling | Value in FS 7 Residential PPP Recycling |
|---|---|---|
| $MTCO_2e$ Avoided | 1.399M | 2.088M |
| Jobs Direct, Indirect and Induced | 3,877 | 7,845 |

*Source: Eunomia, EPA Warm Model v15, Indices from Economic Policy Institute (2019), Bureau of Economic Analysis*

## Stakeholder Impact

Table 67 below elaborates on the impact to relevant stakeholders under FS 7.

**Table 67: Impacts on Stakeholders from the FS 7 for Providing Residential PPP recycling Services**

| Stakeholder | Impacts and Mitigation |
|---|---|
| Municipalities/ jurisdictions | **Producers cover the cost of recycling** based on agreed cost recovery mechanisms so municipalities no longer have to recover the cost of PPP services from households.<br><br>Option to manage, provide directly or contract the services allowing PPP services to be aligned with streams - trash and organics.<br><br>Due to dual stream, if services contracted, will need to either break, renegotiate or wait until contract ends to switch to dual stream<br><br>If services provided directly, likely to be able to use existing assets as the system is not based on using a split bodied vehicle but alternating collected weeks, fiber week one and MPG week two.<br><br>**Disposal cost tipping fee savings (~$32M)**<br><br>Potential for municipalities with drop-off facilities to be a bag drop location and as such to receive a handling fee. |
| Waste Haulers | **Continue to provide services to municipalities under contract. More properties to collect from** as a result of 100% coverage and more material to collected as a result wider range of materials targeted at the curbside.<br><br>Waste haulers will have the opportunity to provide DRS related collection services to the PRO. The PRO will have over $43M of collection related services to procure from the market to service the redemption network. |
| MRF operators | Greater quantity of material will be collected at the curbside and as such require sorting resulting in **increase in revenue from tipping fees (~$20M)**. |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | Potential for stranded assets and/or the need to reconfigure sorting lines to accommodate dual stream material.<br><br>Level of uncertainty as to how PRO may contract for services over long term especially if there is desire to move towards a dual stream system which will require a new sorting facility network.<br><br>**Opportunity to provide broader range of services** to PRO including transfer and secondary processing.<br><br>Under EPR it is possible that producers will own the material collected and sorted, MRF operators will no longer have to shoulder the material risk associated with fluctuating markets.<br><br>Level of uncertainty as to how PRO may contract for services over long term. Opportunity to provide broader range of services to PRO including transfer and secondary processing as well as sorting center function for DRS.<br><br>Impact of DRS is mitigated when part of full EPR if MRFs are contracted to provide sorting service and not take risk on material income. If MRF still takes material risk then the benefit of access deposit of containers they process as well as the unclaimed deposits when producers do not meet the beverage specific targets equates to an estimated **$73M financial benefit over the three-year DRS implementation period.** |
| State | Significant increase in direct, indirect and induced **jobs (+3,970)** and associated annual **GVA (~+$635M)** resulting from the DRS.<br><br>**More high value materials captured for recycling**, supporting a circular economy (~+280k tpa)<br><br>**Reduction in GHG emissions** (additional ~0.689M MTCO$_2$e over baseline)<br><br>80% reduction in beverage related litter. |
| Households | **No longer required to pay for PPP recycling services**, estimated for this FS as ~$436 equating to per household annual saving of in the region of ~137<br><br>**Ability to recycle a broader range of materials.**<br><br>Requirements to separate materials into two streams and accommodate two containers.<br><br>Increased spending on recycling education to ensure householders can correctly participate in recycling programs. |

| Stakeholder | Impacts and Mitigation |
|---|---|
| Low income households | All impacts associated with all households, plus:<br><br>Access to two recycling systems, greater incentive to recycle, reduction in litter increase public amenity of local environment<br><br>The mechanism summarized under FS 1 whereby the deposit is waivered at the start of the DRS for non-carbonated water will ensure that households reliant on bottled water will be able to claim back the deposit on water during the first week of the DRS but not have to pay it as this would be covered by producers.<br><br>Redemption locations located on transit routes and at retailer and other commonly visited locations will make redemption convenient and easy. |
| Households in rural areas | All impacts associated with all households, plus:<br><br>**Coverage of curbside services extending to all households** ensuring all rural households receive a service.<br><br>Access to two recycling systems, greater incentive to recycle, reduction in litter increase public amenity of local environment.<br><br>Redemption locations located on transit routes and at retailer and other commonly visited locations will make redemption convenient and easy. |
| Homeless | Ability to collect containers that are littered, providing a **source of income** |
| Producers | **Producers of PPP are required to fund and coordinate recycling** (i.e. collection, transportation, sorting, and marketing) of materials from the residential sector and to ensure material specific targets are met and to educate households on the services offered. Producers are effectively responsible for the end of life management of their PPP.<br><br>**Cost to producers estimated at ~$436M.** |
| Retailers | **Options for involvement in the DRS** either: return at retail; return to retail (parking lot bag-drops); or exemption if it can be demonstrated that there are sufficient redemption points to meet geographical coverage target. Handling fee, calculated based on cost coverage, paid to retailers for their role in supporting redemption. Increase in footfall through stores as the value of the deposit will mean that redeemers are also consumers. Technology driven redemption routes reduced retailer time. Bag drop program reducing retailer involvement under the system. |

| Stakeholder | Impacts and Mitigation |
|---|---|
| | **Small businesses, under 5,000 sq ft not required to redeem under the system and can chose to opt-in.** |

*Source: Eunomia*

# Section 6: Comparison of Systems and Conclusion

In this study, the baseline existing system has the lowest overall system cost (but not lowest per ton recycled cost) but is otherwise the lowest preforming system of those modeled and delivers the least benefits compared to other scenarios. This outcome indicates that the introduction of EPR for PPP and DRS, together or separately, can both result in a considerable increase in the amount of material recycled and—as a result—the net benefits generated from residential recycling of PPP in Washington, even using conservative assumptions. This is evident in every future system modeled, where the overall recycling rate increases over the baseline.

**FS 1 which adds a DRS to current services and captures 90% of beverage containers, will increase the recycling rate by 6% without the need for a full EPR system or any increase in residential recycling fees or rates**.

**FS 7 which is a full EPR system and collects PPP from all households via a dual stream curbside collection system that alternates fiber and MPG on a weekly basis and includes a DRS, will deliver the greatest environmental and social benefits of the systems modeled with an overall recycling rate above 75%,** 2.088M MTCO$_2$e of GHG emissions avoided, 7,860 jobs created with a GVA to the Washington economy $1.1 billion.

**FS 6 which operates a DRS alongside EPR for other PPP is estimated to deliver a recycling rate of 74% and also delivers a lower cost per ton compared to baseline.** In general, the direct cost of recycling, presented as the cost per ton recycled, increases as more material is collected from all households, urban and rural. In FS 6, much of the glass is captured by the DRS and the remaining glass can be collected through drop-off locations. Some of the drop-offs can be co-located with the DRS infrastructure resulting in a reduction in overall costs. FS 6 delivers a lower cost per ton recycled and delivers a total societal benefit of $683M.

Performance targets set under an EPR policy should be aware of what is currently achievable, but also seek to drive investment and create future systems that can maximize the amount of material recycled and, in doing so, reduce GHG emissions. Targets should go beyond what is presented here as possible, they should be increasing over time and phased to enable the development of improved infrastructure .Specific performance targets for beverage containers should be implemented as well, since a DRS is proven to be able to deliver a recycling rate of 90%. Without a DRS, recycling rates in excess of 75% are less likely to be achieved.

While there are impacts of a DRS and EPR on a range of stakeholders, some of these impacts can be mitigated such that in all cases there is substantial societal benefits from both a DRS and wider EPR for all PPP. Table 68 broadly summarizes the impacts of EPR and DRS systems on stakeholders and suggests possible ways to mitigate negative impacts.

The future system that collectively delivers high recycling rates, creates jobs, delivers the most material back to the circular economy and, in doing so delivers maximum reductions in MTCO$_2$e, is one that includes both a DRS and an improved, expanded, and harmonized curbside recycling system for all residents provided under an EPR policy framework. In this study, the greatest net benefits are achieved through FS 7, but the largest increase in recycling per dollar spent is in FS 6. Implementing any of the FSs modeled will provide a large increase in the benefits of the recycling system for Washington, but a combination of EPR and DRS provides the most optimal system possible. Washington should consider its priorities and the current economic, social and environmental benefits that are possible, as demonstrated through this study, when determining the future of recycling services in the state.

**Figure 15: Overview of Environment and Social Benefits**

| | BASELINE Current System | FUTURE SYSTEM 1 Current System + DRS | FUTURE SYSTEM 2 EPR + Enhanced Collection and Coverage | FUTURE SYSTEM 3 EPR + Aligned Universal Collection Option 1 | FUTURE SYSTEM 4 EPR + Aligned Universal Collection Option 2 | FUTURE SYSTEM 5 EPR + Enhanced Collection + DRS | FUTURE SYSTEM 6 EPR + Aligned Universal Collection Option 1 + DRS | FUTURE SYSTEM 7 EPR + Aligned Universal Collection Option 2 + DRS |
|---|---|---|---|---|---|---|---|---|
| **PPP Recycling Rate** | 49% | 55% | 69% | 71% | 72% | 74% | 73% | 75% ★ |
| **PPP Recycled (Thousand Tons)** | 525K | 589K | 737K | 753K | 767K | 787K | 783K | 804K ★ |
| **MT CO2e Avoided (Millions)** | -1.399M | -1.488M | -1.964M | -1.970M | -2.050M | -1.967M | -2.024M | -2.088M ★ |
| **Beverage Related Litter Reduction from Baseline (%)** | | 80% | | | | 80% | 80% | 80% |
| **Jobs (Direct, Indirect and induced)** | 3,870 | 5,700 | 5,530 | 5,420 | 6,490 | 7,310 | 6,410 | 7,850 ★ |

★ = Best Performer in Category

**Figure 16: Overview of Costs and Monetized Benefits**

| | BASELINE Current System | FUTURE SYSTEM 1 Current System + DRS | FUTURE SYSTEM 2 EPR + Enhanced Collection and Coverage | FUTURE SYSTEM 3 EPR + Aligned Universal Collection Option 1 | FUTURE SYSTEM 4 EPR + Aligned Universal Collection Option 2 | FUTURE SYSTEM 5 EPR + Enhanced Collection + DRS | FUTURE SYSTEM 6 EPR + Aligned Universal Collection Option 1 + DRS | FUTURE SYSTEM 7 EPR + Aligned Universal Collection Option 2 + DRS |
|---|---|---|---|---|---|---|---|---|
| Cost per Ton Recycled (USD) | $471 | $523 | $454 | $503 | $529 | $532 | $442 ★ | $542 |
| Total Cost of System (Millions, USD) | $247M ★ | $308M | $334M | $379M | $406M | $419M | $346M | $436M |
| PPP Disposal Cost Savings (Millions, USD) | $0 | $7.3M | $25.9M | $27.9M | $27.9M | $31.4M | $30.7M | $31.9M ★ |
| Material Value (Millions, USD) | -$21.5M | -$50.7M | -$37.4M | -$36.9M | -$44.9M | -$64.3M | -$64.6M | -$71.4M ★ |
| GVA (Millions USD) (Direct, Indirect, Induced) | -$497M | -$848M | -$705M | -$694M | -$834M | -$1,050M | -$928M | -$1,132M ★ |
| Social Cost of Carbon (Millions, USD) | -$105M | -$112M | -$147M | -$148M | -$154M | -$148M | -$152M | -$157M ★ |
| Net Benefit per Ton Recycled (USD) | -$542 | -$998 | -$643 | -$558 | -$704 | -$939 | -$886 | -$1,012 ★ |

★ = Best Performer in Category

**Table 68: Stakeholder Impacts for EPR and DRS Systems**

| Stakeholder | DRS for Beverage Containers[XXV] | Full EPR for all PPP |
|---|---|---|
| Municipalities | Less material collected at the curbside in both recycling and trash streams, potential to review collection frequencies and container sizes to reduce costs.<br><br>Potential for **reduced MRF tipping fees** if less material collected at the curbside (~$7M)<br><br>**Disposal cost tipping fee savings (~$7M)**<br><br>**6% increase in recycling rate** without the need for jurisdictions to increase household rates. | **Producers cover the cost of recycling** based on agreed cost recovery mechanisms so municipalities no longer have to recover the cost of PPP services from households.<br><br>Option to manage, provide directly or contract the services allowing PPP services to be aligned with streams - trash and organics.<br><br>Disposal cost tipping fee savings (FS 7 ~$32M) |
| Waste Haulers | Waste haulers will have the **opportunity to provide services** to the DRS PRO as well as to continue to provide services to municipalities. The PRO will have over $43M annually of collection related service to procure from the market to service the redemption network. | Continue to provide services to municipalities under contract.<br><br>**More properties to collect from** as a result of 100% coverage and more material to collected as a result wider range of materials targeted at the curbside. |
| MRF operators | While there will be a loss to the MRF from reduced tipping fees and material revenues, the value of the deposit containers passing through the MRF, which can be redeemed, can make up for some or all of this loss. Additionally, MRFs can be provided | **Greater quantity of material will be collected at the curbside** and as such require sorting, resulting in a potential |

[XXV] DRS is a form of EPR for beverage containers, as producers have a financial and operational responsibility to support the system

| Stakeholder | DRS for Beverage Containers[XXV] | Full EPR for all PPP |
|---|---|---|
| | **access to the unclaimed deposits** when targets are met, which will deliver ~$73M over the three-year DRS implementation period. Unclaimed deposit available when producers do meet target in initial years will be available for investment in existing sorting facilities to maximize capture and value of other PPP. Revenue losses from reduced tipping fees and material sales only relevant when DRS implemented without wider EPR (see EPR impacts on the right).<br><br>**Option for MRF to also provide counting center function** under contract to the PRO providing an addition opportunity to increase revenue. Counting center function costs estimated at almost ~$47M. | increase in revenue from tipping fees (FS 7 ~$20M).<br><br>Under EPR, one option is that producers own the material collected and sorted, under this assumption MRF operators will no longer have to shoulder the material risk associated with fluctuating markets.<br><br>Level of uncertainty as to how PRO may contract for services over long term especially if there is desire to move towards a dual stream system which will require a new sorting facility network. Opportunity to provide broader range of services to PRO including transfer and secondary processing. |
| Washington State | **Significant increase in direct, indirect and induced jobs** (+1,830) and associated annual GVA (~+$351M) resulting from the DRS.<br><br>**More high value materials captured for recycling**, supporting a circular economy (~+64k tons per annum (tpa))<br><br>**Reduction in GHG emissions** (additional ~89M $MTCO_2e$ over baseline)<br><br>**80% reduction in beverage related litter**. | **Additional direct indirect and induced jobs** (FS 7 ~+3,970) and associated annual GVA (FS7 ~+$635M) resulting from increase in the amount of PPP collected and recycled.<br><br>**More high value materials captured for recycling**, supporting a circular economy (FS 7 ~+280k tpa)<br><br>When material specific targets are set high, **producers will invest in developing material markets** and infrastructure necessary to meet the targets. |
| Producers | Producers required to meet **redemption targets** and are required to fund and coordinate the recycling (i.e. collection, | **Producers of PPP are required to fund and coordinate recycling** (i.e. collection, |

| Stakeholder | DRS for Beverage Containers[XXV] | Full EPR for all PPP |
|---|---|---|
| | transportation, sorting, and marketing) of beverage containers materials to ensure the redemption and geographical targets are met.<br><br>Producers are effectively responsible for the end-of-life management of their beverage containers. Estimated cost to producers of ~$59M.<br><br>Reduction in litter, reducing reputational damage associated with littered containers in the environment. | transportation, sorting, and marketing) of materials from the residential sector and to ensure material specific targets are met and to educate households on the services offered. Producers are effectively responsible for the end of life management of their PPP. Estimated cost to producers ranging from $346M to $436M per annum. |
| Retailers, large and small | **Options for involvement in the DRS**, either: return at retail; return to retail (parking lot bag-drops); or exemption if it can be demonstrated that there are sufficient redemption points to meet geographical coverage target. Handling fee, calculated based on cost coverage, paid to retailers for their role in supporting redemption. Increase in footfall through stores as the value of the deposit will mean that redeemers are also consumers. Technology driven redemption routes reduced retailer time. Bag drop program reducing retailer involvement under the system.<br><br>**Small businesses, under 5,000 sq ft not required to redeem under the system and can chose to opt-in.** | No impact. |
| Households | **Access to two recycling systems, greater incentive to recycle.**<br><br>**Reduction in litter** increase public amenity of local environment.<br><br>No increase in household rates (waste management fees). | **No longer required to pay for PPP recycling services**, currently total cost of recycling estimated at ~$247M equating to per |

| Stakeholder | DRS for Beverage Containers[XXV] | Full EPR for all PPP |
|---|---|---|
| | | household annual saving of in the region of ~$78.[XXVI]<br><br>**Ability to recycle a broader range of materials**.<br><br>Increased spending on recycling education to ensure householders can correctly participate in recycling programs. |
| Low income | The potential impact at the start of a DRS on low income families who are reliant on bottled water is that they will be required to pay $0.10 on top of the current price of these beverages for the deposit on each container. If the empty container is returned, this outlay is only temporary, as the deposit could be recovered once the container returned. However, there is potential burden associated with this initial payment. This payment could be mitigated by implementing a "deposit holiday" for the first week of the DRS program for non-carbonated water only. This would work as follows:<br><br>▪ Day 1 of DRS: Deposit initiated on all beverages but not paid by the consumer on non-carbonated water.<br><br>▪ Day 8 of DRS: Deposit paid on non-carbonated water. | **No longer required to pay for PPP recycling services**. Average per household saving per annum of ~$78.[XXVII] |

[XXVI] It is possible that producers may pass on some or all costs to consumers through price increases, which would reduce the savings to residents if they purchased those products.
[XXVII] It is possible that producers may pass on some or all costs to consumers through price increases, which would reduce the savings to residents if they purchased those products.

| Stakeholder | DRS for Beverage Containers[XXV] | Full EPR for all PPP |
|---|---|---|
| | This would allow low income households to purchase essential beverages during the first week of the new program without the burden of the deposit, but still be able to claim the deposit on return of the container, as if they had paid it. The producers would cover the cost of the deposit on all non-carbonated water sold in the first week. The cost of this to producers would be just over $3.2M, assuming all of those containers are returned. If only 70% are returned, then the cost would only be $2.3M and only $1.6M if only half redeemed. This program would alleviate the burden of an initial outlay of the deposit with the implementation of the DRS for non-carbonated water.<br><br>Redemption locations located on transit routes and at retailer and other commonly visited locations will make redemption convenient and easy. | |
| Rural areas | Able to recycle beverage containers at local redemption points that will be on transit routes. | **Coverage of curbside services extending to all households** ensuring all rural households receive a service. |
| Homeless | Ability to collect containers that are littered, providing a **source of income**. | No impact. |

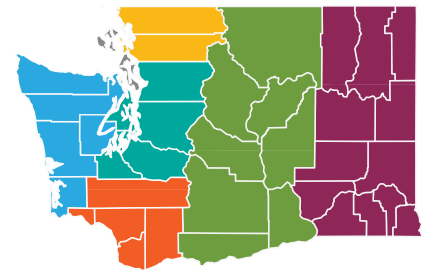
# Technical Appendix

See next page.

# Modeling of Current System - Technical Assumptions and Calculations

## Service Overview

**Figure 17: Six Waste Generation Areas in Washington**



The number of single family and multifamily households currently eligible for a curbside or on-site PPP recycling service and the type of service offered is provided in Table 69. The areas referred to are pictured in Figure 17. The table also sets out the assumption regarding the number of households that have an active service. This number accounts for areas where services are not automatically provided; and as such, households may elect not to receive a service. The table shows that there are eight different recycling system configurations operating across Washington.

**Table 69: Current Level of Service and Service Type by Region**

| Area | Recycling Collection System | Recycling Frequency | Number of Eligible Households | Number of Eligible Single Family | Number of Eligible Multi Family | Households with Active Service Single Family | Households with Active Service Multifamily | Total HH With Active Service |
|---|---|---|---|---|---|---|---|---|
| Central | Single - W/Glass | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| East | Single - W/Glass | Weekly | 99,308 | 65,038 | 34,270 | 65,038 | 9,253 | 74,291 |
| Northwest | Single - W/Glass | Weekly | 20,051 | 18,414 | 1,637 | 18,073 | 0 | 18,073 |
| Puget Sound | Single - W/Glass | Weekly | 205,944 | 113,638 | 92,306 | 113,638 | 92,306 | 205,944 |
| Southwest | Single - W/Glass | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Single - W/Glass | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| Central | Single - W/Glass | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| East | Single - W/Glass | Alternate | 42,435 | 26,498 | 15,937 | 26,498 | 4,303 | 30,801 |
| Northwest | Single - W/Glass | Alternate | 66,151 | 58,582 | 7,569 | 36,230 | 1,597 | 37,827 |

| Area | Recycling Collection System | Recycling Frequency | Number of Eligible Households | Number of Eligible Single Family | Number of Eligible Multi Family | Households with Active Service Single Family | Households with Active Service Multifamily | Total HH With Active Service |
|---|---|---|---|---|---|---|---|---|
| Puget Sound | Single - W/Glass | Alternate | 1,183,145 | 693,600 | 489,545 | 693,600 | 489,545 | 1,183,145 |
| Southwest | Single - W/Glass | Alternate | 247 | 141 | 106 | 35 | 0 | 35 |
| West | Single - W/Glass | Alternate | 15,464 | 14,133 | 1,331 | 14,133 | 1,331 | 15,464 |
| Central | Single - No Glass | Weekly | 5,462 | 3,396 | 2,066 | 3,396 | 2,066 | 5,462 |
| East | Single - No Glass | Weekly | 1,313 | 1,313 | 0 | 1,313 | 0 | 1,313 |
| Northwest | Single - No Glass | Weekly | 9,847 | 5,974 | 3,873 | 5,974 | 3,873 | 9,847 |
| Puget Sound | Single - No Glass | Weekly | 459 | 377 | 82 | 377 | 82 | 459 |
| Southwest | Single - No Glass | Weekly | 18,155 | 12,482 | 5,673 | 12,482 | 5,673 | 18,155 |
| West | Single - No Glass | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| Central | Single - No Glass | Alternate | 114,479 | 99,350 | 15,129 | 44,543 | 6,319 | 50,862 |
| East | Single - No Glass | Alternate | 118,936 | 81,933 | 37,003 | 81,933 | 9,991 | 91,924 |
| Northwest | Single - No Glass | Alternate | 1,005 | 677 | 328 | 677 | 328 | 1,005 |
| Puget Sound | Single - No Glass | Alternate | 284,109 | 192,107 | 92,002 | 192,107 | 92,002 | 284,109 |
| Southwest | Single - No Glass | Alternate | 35,363 | 23,301 | 12,062 | 23,301 | 12,062 | 35,363 |
| West | Single - No Glass | Alternate | 79,024 | 73,545 | 5,479 | 61,195 | 2,910 | 64,105 |

| Area | Recycling Collection System | Recycling Frequency | Number of Eligible Households | Number of Eligible Single Family | Number of Eligible Multi Family | Households with Active Service Single Family | Households with Active Service Multifamily | Total HH With Active Service |
|---|---|---|---|---|---|---|---|---|
| Central | Dual stream (1) | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| East | Dual stream | Weekly | 31,711 | 20,044 | 11,667 | 20,044 | 3,150 | 23,194 |
| Northwest | Dual stream | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| Puget Sound | Dual stream | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| Southwest | Dual stream | Weekly | 98,556 | 80,888 | 17,668 | 80,888 | 17,668 | 98,556 |
| West | Dual stream | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| Central | Dual stream | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| East | Dual stream | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| Northwest | Dual stream | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| Puget Sound | Dual stream | Alternate | 185,095 | 125,358 | 59,737 | 125,358 | 59,737 | 185,095 |
| Southwest | Dual stream | Alternate | 89,809 | 52,593 | 37,216 | 52,593 | 37,216 | 89,809 |
| West | Dual stream | Alternate | 3,893 | 2,670 | 1,223 | 2,670 | 1,223 | 3,893 |
| Central | Three bin | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| East | Three bin | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| Northwest | Three bin | Weekly | 40,324 | 19,800 | 20,524 | 19,800 | 20,524 | 40,324 |

| Area | Recycling Collection System | Recycling Frequency | Number of Eligible Households | Number of Eligible Single Family | Number of Eligible Multi Family | Households with Active Service Single Family | Households with Active Service Multifamily | Total HH With Active Service |
|---|---|---|---|---|---|---|---|---|
| Puget Sound | Three bin | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| Southwest | Three bin | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Three bin | Weekly | 0 | 0 | 0 | 0 | 0 | 0 |
| Central | Three bin | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| East | Three bin | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| Northwest | Three bin | Alternate | 58,659 | 42,006 | 16,653 | 42,006 | 16,653 | 58,659 |
| Puget Sound | Three bin | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| Southwest | Three bin | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Three bin | Alternate | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | | | 2,808,944 | 1,827,858 | 981,086 | 1,737,902 | 889,812 | 2,627,713 |

*Source: Cascadia and Zero Waste Washington Service Coverage data (2020)*

*(1) dual stream in this table refers to glass collected separately from all other PPP material.*

The number of households serviced by cities, private haulers and UTC haulers is provided in Table 70, by region.

**Table 70: Number of Households Serviced by Different Providers in Washington, by Region**

| Area | Public Sector | Private Hauler | UTC Provider |
|---|---|---|---|
| Central | 1,913 | 52,685 | 65,900 |
| East | 124,147 | 95,036 | 74,520 |
| Northwest | 15,105 | 79,871 | 101,061 |
| Puget Sound | 121,131 | 977,430 | 760,191 |
| Southwest | - | 209,954 | 32,176 |
| West | - | 26,952 | 71,429 |

*Source: Cascadia and Zero Waste Washington Service Coverage Data (2020)*

## Current Service Material Flows and Quantities

### *Total Tons Disposed*

Cascadia Consulting Group provided the tons of PPP disposed, by material category, for single family and multifamily households. The quantity was calculated using the same approach that was detailed in the report *Plastic Packaging in Washington: Assessing Use, Disposal, and Management*.[70] Regional tonnage data published by the Washington State Department of Ecology on municipal solid waste disposal by county for 2017[71] was then split into sectors (residential, commercial, self-haul) by applying sector percentage splits calculated for each region. These splits were determined through vehicle surveys conducted as part of the 2015-16 *Washington Waste Characterization Study* and applied to the 2017 regional tonnage data.[72] Self-haul tons were allocated to the residential and commercial sectors using a split calculated for each region based on the same vehicle survey data. The composition estimates applied to both were the same, based on the overall self-haul composition from the waste characterization study.

Composition of disposed tons was estimated by applying region- and sector-specific composition estimates from the waste characterization study to the region- and sector-specific tons estimated, as described above. For a few categories, composition percentages were combined to create categories that could be comparable to the level of detail available from reference recycling composition data.

### *Total Tons PPP Collected and Sent for Reprocessing*

The Washington State Department of Ecology, via Cascadia Consulting Group, provided data on tons of recyclable materials collected and sent for reprocessing in 2017 (the most recent year for which a complete data set was available), based on facility reports and annual recycling survey responses, refined by Ecology staff as part of the development of the State's annual waste generation and recycling estimates. The data included tonnages sent for reprocessing by material, sector and region. It also included tonnages identified as recycling residuals, also reported by sector and region. It did not differentiate between recyclable materials collected through curbside service versus drop-off; details of how the split was estimated are provided below. The data from Department of Ecology was further disaggregated by Cascadia using composition data from the 2019 King County *MRF Assessment and Single-Stream Recyclables Characterization Study*.[73] This further disaggregation included apportioning the percentage of "compostable paper," "non-recoverable paper" and "other non-ferrous" that was deemed to be PPP and removing all "other ferrous" tonnage, which was assumed not to be PPP.

### *Total Tons of PPP Generated*

Tons generated was calculated by adding the tons of PPP recycled to the tons of PPP disposed.

### *Allocation of Tons to Single Family and Multifamily Collections*

In order to calculate the collection costs, the tons of material generated and collected for recycling was split between single and multifamily households. The single family and multifamily generation and collection split was based on Seattle Public Utilities' *Waste Management Report* (2018)[74] as well as the Recycling Partnership's *State of Curbside* (2020) report.[75]

- The *State of Curbside* report suggests multifamily households generate 75% of the waste that single family households generate, on a per household basis.
- The Seattle Public Utilities report suggests that the collection rates of single family households are 100% higher than multifamily households.
- Using these assumptions, the tons generated by single family and multifamily households were solved for by keeping the total generation constant.

This ratio between single family household and multifamily household generation was used to apportion the total PPP generated in Washington between single family and multifamily households, based on the number of single family (SF) and multifamily (MF) households (HH) in Washington, as follows:

*Total tonnage = generation per SF HH x SF HH + generation per MF HH x MF HH*

*= (1 + MF/SF generation ratio) x generation per SF HH x total HH*

**Table 71: Tons PPP Materials Generated Per Household, By Type**

| PPP Material | Single Family | Multifamily | Total Residential |
|---|---|---|---|
| #1 PET Bottles | 0.012 | 0.009 | 0.011 |
| #1 PET Other Packaging | 0.007 | 0.005 | 0.006 |
| #2 HDPE Natural Bottles | 0.003 | 0.002 | 0.003 |
| #2 HDPE Colored Bottles | 0.004 | 0.003 | 0.004 |
| #2 HDPE Other Packaging | 0.002 | 0.001 | 0.001 |
| #3 PVC Packaging | 0.000 | 0.000 | 0.000 |
| #4 LDPE Packaging | 0.000 | 0.000 | 0.000 |
| #5 PP Packaging | 0.005 | 0.003 | 0.004 |
| #6 PS Packaging | 0.001 | 0.000 | 0.001 |

| PPP Material | Single Family | Multifamily | Total Residential |
|---|---|---|---|
| #7 Other Packaging | 0.002 | 0.001 | 0.002 |
| Expanded Polystyrene Packaging | 0.005 | 0.003 | 0.004 |
| PE Plastic Bags & Film | 0.006 | 0.005 | 0.006 |
| Other Plastic Film & Flexible Packaging | 0.018 | 0.013 | 0.016 |
| R/C Plastic Packaging | 0.001 | 0.000 | 0.001 |
| PLA/Compostable Packaging | 0.001 | 0.001 | 0.001 |

*Source: Eunomia Modelling, Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization Study (2015-2016), Cascadia and Zero Waste Washington Service Coverage data (2020)*

To obtain regional generation quantities, the per household quantitates were multiplied by the number of each household type in the region.

### *Tons Collected for Recycling – Curbside and Drop-Off*

After splitting the generated recyclables into single family and multifamily tons for each material type, the generation tonnages were divided into curbside and drop-off collection.

The tons collected by drop-off and curbside service tons were apportioned into streams using the following equation for each material in each region:

*Coverage Rate Stream X * Capture Rate Stream X * Total Generation of Material*

*= Tons in Stream X*

### *Coverage Rate*

The coverage rate was calculated by taking the material specific "percent of curbside services covering this material" rates obtained from the Zero Waste Washington's *State of Residential Recycling and Organics Collections* report[76] and multiplying them by the total number of households with curbside service in each region. For example, if 10,000 out of 20,000 households in a region had curbside service, and a material was accepted in 50% of all curbside services, the coverage rate would be:

*(50%*10,000)/20,000 = 25%*

This was also done for drop-off services by taking the percentage of households without curbside recycling services, but with access to a drop-off facility, and following the same process for each material. The derived coverage for each material is provided in Table 72.

**Table 72: Percent Coverage by PPP Material Type**

| PPP Material | % of Curbside Services including this Material | % of Households Covered by Drop-off Only | % of Households with no Coverage at Curbside or Drop-off |
|---|---|---|---|
| #1 PET Bottles | 100% | 5% | 4% |
| #1 PET Other Packaging | 90% | 3% | 14% |
| #2 HDPE Natural Bottles | 100.0% | 6% | 3% |
| #2 HDPE Colored Bottles | 100.0% | 6% | 3% |
| #2 HDPE Other Packaging | 90% | 3% | 14% |
| #3 PVC Packaging | 59% | 19% | 26% |
| #4 LDPE Packaging | 90% | 3% | 14% |
| #5 PP Packaging | 90% | 3% | 14% |
| #6 PS Packaging | 46% | 7% | 50% |
| #7 Other Packaging | 0.0% | 0.0% | 0.0% |
| Expanded Polystyrene Packaging | 4% | 17% | 70% |
| PE Plastic Bags & Film | 0% | 24% | 76% |
| Other Plastic Film & Flexible Packaging | 0% | 0% | 0% |
| R/C Plastic Packaging | 0% | 0% | 0% |
| Steel Cans | 56% | 27% | 17% |
| Aluminum Cans | 99% | 8% | 1% |
| Other Nonferrous Metal | 73% | 13% | 20% |
| Newspaper | 100% | 7% | 1% |

| PPP Material | % of Curbside Services including this Material | % of Households Covered by Drop-off Only | % of Households with no Coverage at Curbside or Drop-off |
|---|---|---|---|
| Cardboard | 99% | 7% | 2% |
| High Grade Paper | 100% | 6% | 2% |
| Mixed Paper | 100% | 6% | 3% |
| Cartons | 26% | 5% | 69% |
| Container Glass | 71% | 25% | 10% |

*Source: Cascadia and Zero Waste Washington Service Coverage data (2020)*

### *Capture Rate*

The baseline capture rate was calculated by determining the percentage recovery rate that households with recycling services had to achieve in order for the state to reach the reported statewide recovery rates. This was done by:

- Using the generation, coverage rates and tons collected of each material as constants
- Assuming capture rate from single family households is double the capture rate from multifamily households
- Assuming drop-off capture for single family households is 50% of single family curbside capture, and is 30% for multifamily households.

Using these assumptions, the tons collected in each stream were solved for by determining what percent capture households with coverage of a certain material would have to produce, knowing the relative capture rates of single family and multifamily households, as well as curbside and drop-off, to collect the reported tonnage. The calculated capture rates are provided in Table 73.

**Table 73: 2017 Annual Tons of PPP Collected for Recycling by Curbside and Drop-Off Services**

| | SF Tons of Recycling Collected by Curbside | SF Tons of Recycling Collected by Drop-off | MF Tons of Recycling Collected by Curbside | MF Tons of Recycling Collected by Drop-off | Total Collected |
|---|---|---|---|---|---|
| Central | 6,782 | 4,549 | 623 | 1,454 | 13,408 |
| East | 49,621 | 11,001 | 3,601 | 6,038 | 70,261 |
| Northwest | 26,365 | 2,711 | 4,806 | 1,207 | 35,089 |
| Puget Sound | 279,938 | 6,271 | 96,506 | 1,955 | 384,670 |
| Southwest | 44,935 | 4,529 | 10,081 | 1,040 | 60,585 |

| | SF Tons of Recycling Collected by Curbside | SF Tons of Recycling Collected by Drop-off | MF Tons of Recycling Collected by Curbside | MF Tons of Recycling Collected by Drop-off | Total Collected |
|---|---|---|---|---|---|
| West | 12,808 | 3,311 | 496 | 1,521 | 18,136 |
| **Total** | **420,448** | **32,372** | **116,113** | **13,215** | **582,149** |

*Source: Washington Department of Ecology Waste Generation and Recovery data (2017), Cascadia and Zero Waste Washington Service Coverage data (2020), Eunomia Modelling*

After calculating the tons collected by stream for single family and multifamily households, the total curbside tons were then divided by the number of households served in each region to arrive at a tons per household collected by curbside collection services rate, which could then be used to calculated a recycling rate for households with curbside services (i.e. the rate at which households with service recycle what they generate).

These regional rates were produced in order to scale up the tons collected when services are introduced to households that currently do not have a curbside (single family) or on-site (multifamily) collection. Per household tons by region for single and multifamily are provided below in Table 74, households in this table are assumed to have glass collected curbside.

**Table 74: Tons of PPP Collected per Household by Curbside (2017)**

| Region | SF Curbside Tons PPP Collected for Recycling per Household | MF Tons PPP Collect for Recycling per Household |
|---|---|---|
| Central | 0.12 | 0.07 |
| East | 0.22 | 0.12 |
| Northwest | 0.19 | 0.10 |
| Puget Sound | 0.24 | 0.13 |
| Southwest | 0.24 | 0.12 |
| West | 0.14 | 0.08 |

*Source: Eunomia Modelling, Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Cascadia and Zero Waste Washington Recycling Service Data*

### *Tons Sold to Reprocessors*

The quantity of material collected at the curbside or through drop-offs is not equivalent to the amount of materials that sorting facilities sell to reprocessors due to contamination loss. Material collected can include non-target material, which could potentially be recycled, but for which markets are unpredictable, especially at low volumes. Target materials are also lost due to sorting facility inefficiencies, due in part to changes in PPP composition over time, since sorting facilities were designed for compositions that existed at the times that they were built and may need reinvestment to optimize capture rates.

Target material losses and contamination values were compared from various sources. Contamination values were applied on a percentage basis of total MRF throughput, ranging from 7% to 13%, while target material losses were provided by Cascadia calculations on data obtained from various Washington MRFs.[77]

### Recycling Performance by Region

Table 75 to Table 80 provides the recycling performance by region.

**Table 75: Central Region Quantity of Residential PPP Generated and Recycled and the Recycling Rate by Material**

| Material | Residential Generated | Residential Recycled | Recycling Rate |
|---|---|---|---|
| #1 PET Bottles | 8,200 | 210 | 3% |
| #1 PET Other Packaging | 2,500 | 20 | 1% |
| #2 HDPE Natural Bottles | 1,500 | 50 | 3% |
| #2 HDPE Colored Bottles | 1,700 | 50 | 3% |
| #2 HDPE Other Packaging | 540 | 10 | 2% |
| #3 PVC Packaging | 0 | 0 | 0% |
| #4 LDPE Packaging | 10 | 0 | 0% |
| #5 PP Packaging | 1,700 | 30 | 2% |
| #6 PS Packaging | 100 | 0 | 0% |
| #7 Other Packaging | 1,000 | 0 | 0% |
| Expanded Polystyrene Packaging | 2,900 | 0 | 0% |
| PE Plastic Bags & Film | 3,200 | 20 | 1% |
| Other Plastic Film & Flexible Packaging | 6,800 | 0 | 0% |
| R/C Plastic Packaging | 280 | 0 | 0% |
| PLA/Compostable Packaging | 350 | 0 | 0% |
| Steel Cans | 3,500 | 110 | 3% |
| Aluminum Cans | 2,200 | 330 | 15% |
| Other Nonferrous Metal | 1,100 | 280 | 25% |
| Newspaper | 16,800 | 2,900 | 17% |
| Cardboard | 13,600 | 5,000 | 37% |
| High Grade Paper | 1,200 | 10 | 1% |
| Mixed Paper | 21,400 | 1,900 | 9% |
| Cartons | 90 | 0 | 0% |
| Container Glass | 10,600 | 1,200 | 11% |
| Total PPP | 101,200 | 12,100 | 12% |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

**Table 76: East Region Quantity of Residential PPP Generated and Recycled and the Recycling Rate by Material**

| Material | Residential Generated | Residential Recycled | Recycling Rate |
|---|---|---|---|
| #1 PET Bottles | 4,800 | 1,370 | 29% |
| #1 PET Other Packaging | 2,800 | 330 | 12% |
| #2 HDPE Natural Bottles | 1,600 | 430 | 27% |
| #2 HDPE Colored Bottles | 2,400 | 410 | 17% |
| #2 HDPE Other Packaging | 670 | 130 | 19% |
| #3 PVC Packaging | 20 | 0 | 0% |
| #4 LDPE Packaging | 0 | 0 | 0% |
| #5 PP Packaging | 2,500 | 420 | 17% |
| #6 PS Packaging | 0 | 0 | 0% |
| #7 Other Packaging | 800 | 0 | 0% |
| Expanded Polystyrene Packaging | 1,900 | 20 | 1% |
| PE Plastic Bags & Film | 4,400 | 30 | 1% |
| Other Plastic Film & Flexible Packaging | 10,400 | 0 | 0% |
| R/C Plastic Packaging | 550 | 0 | 0% |
| PLA/Compostable Packaging | 660 | 0 | 0% |
| Steel Cans | 3,900 | 1,180 | 30% |
| Aluminum Cans | 3,500 | 1,490 | 43% |
| Other Nonferrous Metal | 2,900 | 2,030 | 70% |
| Newspaper | 33,500 | 20,300 | 61% |
| Cardboard | 33,000 | 20,000 | 61% |
| High Grade Paper | 900 | 60 | 7% |
| Mixed Paper | 35,900 | 4,200 | 12% |
| Cartons | 140 | 0 | 0% |
| Container Glass | 16,700 | 9,300 | 56% |
| Total PPP | 163,900 | 61,700 | 38% |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

**Table 77: Northwest Region Quantity of Residential PPP Generated and Recycled and the Recycling Rate by Material**

| Material | Residential Generated | Residential Recycled | Recycling Rate |
|---|---|---|---|
| #1 PET Bottles | 1,700 | 1,070 | 63% |
| #1 PET Other Packaging | 900 | 120 | 13% |
| #2 HDPE Natural Bottles | 400 | 120 | 30% |
| #2 HDPE Colored Bottles | 500 | 160 | 32% |
| #2 HDPE Other Packaging | 150 | 50 | 33% |
| #3 PVC Packaging | 10 | 0 | 0% |
| #4 LDPE Packaging | 40 | 0 | 0% |
| #5 PP Packaging | 700 | 150 | 21% |
| #6 PS Packaging | 0 | 0 | 0% |
| #7 Other Packaging | 100 | 0 | 0% |
| Expanded Polystyrene Packaging | 300 | 10 | 3% |
| PE Plastic Bags & Film | 1,000 | 150 | 15% |
| Other Plastic Film & Flexible Packaging | 2,400 | 0 | 0% |
| R/C Plastic Packaging | 70 | 0 | 0% |
| PLA/Compostable Packaging | 430 | 0 | 0% |
| Steel Cans | 1,300 | 560 | 43% |
| Aluminum Cans | 800 | 420 | 53% |
| Other Nonferrous Metal | 400 | 170 | 43% |
| Newspaper | 6,400 | 4,200 | 66% |
| Cardboard | 10,100 | 7,800 | 77% |
| High Grade Paper | 500 | 430 | 86% |
| Mixed Paper | 17,500 | 8,900 | 51% |
| Cartons | 50 | 0 | 0% |
| Container Glass | 8,500 | 6,300 | 74% |
| **Total PPP** | **54,300** | **30,600** | **57%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

**Table 78: Puget Sound Region Quantity of Residential PPP Generated and Recycled and the Recycling Rate by Material**

| Material | Residential Generated | Residential Recycled | Recycling Rate |
|---|---|---|---|
| #1 PET Bottles | 13,500 | 7,210 | 53% |
| #1 PET Other Packaging | 11,300 | 1,780 | 16% |
| #2 HDPE Natural Bottles | 4,400 | 2,040 | 46% |
| #2 HDPE Colored Bottles | 5,800 | 2,310 | 40% |
| #2 HDPE Other Packaging | 1,820 | 700 | 38% |
| #3 PVC Packaging | 40 | 0 | 0% |
| #4 LDPE Packaging | 0 | 0 | 0% |
| #5 PP Packaging | 6,400 | 2,090 | 33% |
| #6 PS Packaging | 1,400 | 380 | 27% |
| #7 Other Packaging | 3,200 | 0 | 0% |
| Expanded Polystyrene Packaging | 6,800 | 320 | 5% |
| PE Plastic Bags & Film | 7,600 | 320 | 4% |
| Other Plastic Film & Flexible Packaging | 21,200 | 0 | 0% |
| R/C Plastic Packaging | 660 | 0 | 0% |
| PLA/Compostable Packaging | 2,250 | 0 | 0% |
| Steel Cans | 11,400 | 5,780 | 51% |
| Aluminum Cans | 8,800 | 3,610 | 41% |
| Other Nonferrous Metal | 9,400 | 6,090 | 65% |
| Newspaper | 137,200 | 106,600 | 78% |
| Cardboard | 127,300 | 88,200 | 69% |
| High Grade Paper | 900 | 220 | 24% |
| Mixed Paper | 131,800 | 64,200 | 49% |
| Cartons | 3,290 | 10 | 0% |
| Container Glass | 76,400 | 55,200 | 72% |
| **Total PPP** | **592,900** | **347,100** | **59%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

**Table 79: Southwest Region Quantity of Residential PPP Generated and Recycled and the Recycling Rate by Material**

| Material | Residential Generated | Residential Recycled | Recycling Rate |
|---|---|---|---|
| #1 PET Bottles | 4,700 | 1,800 | 38% |
| #1 PET Other Packaging | 1,900 | 100 | 5% |
| #2 HDPE Natural Bottles | 1,600 | 750 | 47% |
| #2 HDPE Colored Bottles | 2,000 | 1,040 | 52% |
| #2 HDPE Other Packaging | 1,260 | 40 | 3% |
| #3 PVC Packaging | 20 | 0 | 0% |
| #4 LDPE Packaging | 20 | 0 | 0% |
| #5 PP Packaging | 1,200 | 110 | 9% |
| #6 PS Packaging | 200 | 40 | 20% |
| #7 Other Packaging | 300 | 0 | 0% |
| Expanded Polystyrene Packaging | 1,000 | 0 | 0% |
| PE Plastic Bags & Film | 1,600 | 0 | 0% |
| Other Plastic Film & Flexible Packaging | 7,700 | 0 | 0% |
| R/C Plastic Packaging | 130 | 0 | 0% |
| PLA/Compostable Packaging | 270 | 0 | 0% |
| Steel Cans | 4,100 | 2,050 | 50% |
| Aluminum Cans | 2,000 | 890 | 45% |
| Other Nonferrous Metal | 3,800 | 3,180 | 84% |
| Newspaper | 8,500 | 3,000 | 35% |
| Cardboard | 30,400 | 22,900 | 75% |
| High Grade Paper | 300 | 0 | 0% |
| Mixed Paper | 30,100 | 12,100 | 40% |
| Cartons | 350 | 20 | 6% |
| Container Glass | 12,300 | 6,100 | 50% |
| **Total PPP** | **115,800** | **54,100** | **47%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

**Table 80: West Region Quantity of Residential PPP Generated and Recycled and the Recycling Rate by Material**

| Material | Residential Generated | Residential Recycled | Recycling Rate |
|---|---|---|---|
| #1 PET Bottles | 1,200 | 560 | 47% |
| #1 PET Other Packaging | 700 | 110 | 16% |
| #2 HDPE Natural Bottles | 200 | 120 | 60% |
| #2 HDPE Colored Bottles | 400 | 160 | 40% |
| #2 HDPE Other Packaging | 220 | 40 | 18% |
| #3 PVC Packaging | 20 | 0 | 0% |
| #4 LDPE Packaging | 0 | 0 | 0% |
| #5 PP Packaging | 600 | 130 | 22% |
| #6 PS Packaging | 0 | 0 | 0% |
| #7 Other Packaging | 200 | 0 | 0% |
| Expanded Polystyrene Packaging | 400 | 0 | 0% |
| PE Plastic Bags & Film | 700 | 0 | 0% |
| Other Plastic Film & Flexible Packaging | 2,200 | 0 | 0% |
| R/C Plastic Packaging | 120 | 0 | 0% |
| PLA/Compostable Packaging | 140 | 0 | 0% |
| Steel Cans | 1,000 | 270 | 27% |
| Aluminum Cans | 700 | 220 | 31% |
| Other Nonferrous Metal | 400 | 160 | 40% |
| Newspaper | 4,600 | 2,100 | 46% |
| Cardboard | 6,400 | 4,300 | 67% |
| High Grade Paper | 100 | 60 | 60% |
| Mixed Paper | 10,700 | 4,800 | 45% |
| Cartons | 0 | 0 | 0% |
| Container Glass | 4,900 | 3,000 | 61% |
| **Total PPP** | **35,900** | **16,000** | **45%** |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), Eunomia Modeling*

## Costs

### *Collection*

Service delivery data and costs were provided by a number of jurisdictions and a local waste hauler. The data received from municipalities and waste haulers were fairly consistent, and were appropriate to extrapolate to a statewide average. The data provided was used as an input into *Hermes*, Eunomia's collection options tool, to calculate the number of resources, vehicles, containers and their associated cost for each region by recycling collection system.

For each collection system operating in each region, a number of assumptions were made using the data provided by Washington jurisdictions, these assumptions which impact on cost are provided below.

### Service Data: Pass Rates and Set Out Rates

The pass rate is the number of households on a collection route and the set-out rate is the number of households that will set out bins for each collection. Both factors impact on the number of vehicles and resources necessary to carry out a service and therefore on the costs of that service. The main factors that influence pass rates are:

- housing density, which is linked to rurality;
- average weight of PPP per household;
- the type of collection system operated (e.g. single stream versus manual three-bin system) and the number of resources necessary to service that collection system;
- the vehicle type and capacity;
- time required to collect each container;
- working time per day, effectively the amount of time that actual collections are taking place. For example, if the working day is eight hours, the actual collection time would be eight hours minus the time it takes to:
    - carry out vehicle checks at the start and end of the data;
    - drive to first collection point;
    - travel to and from the tipping location;
    - tip; and
    - return to starting location.

Table 81 provides the number of properties passed in each region by collection system. The set-out rates have been assumed to be 86%, based on the limited data provided.

**Table 81: Modeled Pass Rates and Setout Rates by Collection System and Region**

| Collection System | Central | East | Northwest | Puget Sound | Southwest | West |
|---|---|---|---|---|---|---|
| Single Stream Weekly Recycling | 657 | 807 | 737 | 856 | 851 | N/A |
| Single Stream Alternate Recycling | 626 | 639 | 701 | 678 | 674 | 600 |
| Dual Stream Weekly Recycling* | N/A | N/A | N/A | N/A | N/A | N/A |

| Collection System | Central | East | Northwest | Puget Sound | Southwest | West |
|---|---|---|---|---|---|---|
| Dual Stream Alternate Recycling | N/A | N/A | N/A | N/A | 563 | N/A |
| Three Box Weekly Recycling | N/A | N/A | 397 | N/A | N/A | N/A |
| Three Box Alternate Recycling | N/A | N/A | 363 | N/A | N/A | N/A |
| *Dual stream refers to recycling systems which collect two containers on the same vehicle – in the baseline, this refers to single stream with separate glass in a different compartment | | | | | | |

*Source: Eunomia Modelling and Data from the cities of Olympia, Tacoma and Spokane*

### Service Data: Vehicle Capacities

Table 82 includes details on the vehicle sizes assumed to be used for all collections. There are likely to other, slightly different sized vehicles used across the state, however this data was not available and so these standard sizes have been used.

Costs were provided for a range of vehicles including:

- Single family
  - Automated Side-Loader, Peterbilt 520 / G&H Scorpion
  - Rear Loader, Crane Carrier LET2 / New Way Cobra
- Multi family
  - Rear Loader, Crane Carrier LET2 / New Way Cobra 2
  - Front Loader, Peterbilt 320 / New Way Mammoth
  - Roll-Off, Peterbilt 520 / AA Welding

**Table 82: Average Vehicle Capacities Modeled**

| Collection Type | Typical Vehicle Make and Model | Average Vehicle Capacity (Weight Tons) | Average Vehicle Capacity (Volume Yards$^3$) | Average Vehicle Purchase Cost | Average Vehicle Maintenance Cost |
|---|---|---|---|---|---|
| Single Family (Standard Collection Vehicle) | • Automated Peterbilt, Diesel | 9.6 | 21.5 | $320,000 | $34,100 |

| Collection Type | Typical Vehicle Make and Model | Average Vehicle Capacity (Weight Tons) | Average Vehicle Capacity (Volume Yards$^3$) | Average Vehicle Purchase Cost | Average Vehicle Maintenance Cost |
|---|---|---|---|---|---|
| | • Side loading automated trucks<br>• Automated Side-Loader, Peterbilt 520 / G&H Scorpion<br>• Rear Loader Crane Carrier LET2 / New Way Cobra | | | | |
| Multi Family | • Rear Load Autocar, Diesel<br>• Side loading automated trucks<br>• Rear Loader, Crane Carrier LET2 / New Way Cobra 2<br>• Front Loader, Peterbilt 320 / New Way Mammoth | 11.5 | 32.0 | $330,500 | $26,800 |
| Small Collection Vehicle (Separate Glass) | Automated Side-Loader, Crane Carrier LET2 / Labrie Expert | 7.0 | 18.3 | $291,000 | $41,200 |
| Dual stream | As with single family above | 9.4 | 14.2 | $384,000 | $37,510 |
| Three Box Vehicle | KANN Up And Over Full-Length Trough Recycler | 4.6 | 12.0 | $291,000 | $41,200 |

*Source: Data from the cities of Olympia, Tacoma and Spokane*

### Service Data: Resources

*While the majority of collections are made with a crew of just one resource (the driver), alley collections or multifamily collections sometimes require a driver and a loader. Additional drivers and loaders are required to cover* *sickness and paid time off (PTO). The average number of personnel by collection system is provided in Table 83. Source: Data from the cities of Olympia, Tacoma and Spokane*

Table 84 provides the total number of drivers and loaders needed to collect PPP by region, including staff to cover sickness and PTO.

**Table 83: Average number of Personnel by Collection System Route**

| Collection System | Drivers | | Loaders | |
|---|---|---|---|---|
| | SF | MF | SF | MF |
| Single Stream Recycling | 1 | 1 | 0.5 | 0.8 |
| Single Stream No Glass | 1 | 1 | 0.5 | 0.8 |
| Dual Stream Recycling | 1 | 1 | 0.5 | 0.8 |
| Three Box Recycling | 1 | 1 | 1 | 1 |

*Source: Data from the cities of Olympia, Tacoma and Spokane*

**Table 84: Current Number of Drivers and Loaders Required to Collect PPP by Region**

| Region | Drivers | Loaders | Number |
|---|---|---|---|
| Central | 10 | 5 | 15 |
| East | 46 | 24 | 70 |
| Northwest | 54 | 48 | 101 |
| Puget Sound | 287 | 174 | 461 |
| Southwest | 67 | 37 | 103 |
| West | 15 | 8 | 23 |
| | | Total | 773 |
| | | Total + Average 20% Cover (PTO, Sickness, etc.) | 928 |

*Source: Eunomia Modelling and data from the cities of Olympia, Tacoma and Spokane*

### Service Data: Working Day and Collection Time

Table 85 summarizes the average time spent on different activities necessary to carry out the collection and the total amount of time spent actively collecting from households. It has been assumed for the modeling that collections are made five days per week. This data is the average of that provided by a number of jurisdictions.

**Table 85: Time Spent Collecting, by Collection System Type**

| Collection System | Time Spent Travelling to and from First and Last Collection Point | Time Spent Actively Collecting | Time Spent Going to and from Tipping Location | Breaks |
|---|---|---|---|---|
| Average Single Family | 2.3 | 2.6 | 2.3 | 0.8 |
| Average Multi Family | 2.1 | 1.6 | 3.4 | 0.8 |

*Source: Data from the cities of Olympia, Tacoma and Spokane*

### Service Data: Routes and Numbers

The number of vehicles needed to provide services is greater than the number of actual routes operated, due to the need for extra vehicles in case of maintenance or breakdown. The number of routes required to deliver the services is based on the pass rates, set out rates, quantity of material collected per household and the vehicle capacity. Based on the assumptions above, the total number of routes, by collection system, plus the number of additional vehicles required to cover maintenance and breakdown is provided in Table 86.

**Table 86: Households Covered and Collection Vehicles used to Deliver Current PPP Services in the Baseline**

| Collection System | Households Covered | Number of Vehicles (including 20% for cover) |
|---|---|---|
| Recycling SF (Standard) | 1,565,580 | 297 |
| Recycling MF (Bulk) | 907,187 | 182 |
| Glass Only | 344,583 | 33 |
| Split Body[XXVIII] | 52,593 | 11 |
| Multi Stream | 98,983 | 49 |

*Source: Zero Waste Washington and Cascadia Service Coverage Data, Eunomia Modelling, Vehicle data from the cities of Olympia, Tacoma and Spokane*

[XXVIII] Currently, only Clark County in Washington uses the Split Body system.

### Cost Data: Vehicles

The vehicle cost information assumed in the modeling is provided in Table 87. The table includes capital and financing rates, year over which the asset is depreciated, plus the costs of fuel and maintenance etc. to give an annual vehicle cost.

**Table 87: Annual Vehicle Cost Data**

| | Recycling SF (Standard) | Recycling MF (Bulk) | Glass | Split Body | Multi Stream |
|---|---|---|---|---|---|
| Cost | $320,000 | $330,500 | $291,000 | $384,000 | $291,000 |
| Years Depreciated | 9 | 10 | 8 | 9 | 8 |
| Financing Rate | 5% | 5% | 5% | 5% | 5% |
| Annualized Cost | $43,741 | $42,801 | $45,024 | $52,489 | $45,024 |
| Annual Mileage | 10,700 | 19,263 | 9,300 | 10,700 | 9,300 |
| MPG | 2.44 | 2.44 | 2.57 | 2.44 | 2.57 |
| Fuel Used (Gallons) | 4,385 | 7,894 | 3,619 | 4,385 | 3,619 |
| Fuel Cost | $10,441 | $18,797 | $8,616 | $10,441 | $8,616 |
| Maintenance and other | $34,100 | $26,800 | $41,200 | $37,510 | $41,200 |
| Total Annual Cost Per vehicle | **$88,282** | **$88,398** | **$94,840** | **$100,440** | **$94,840** |
| Number of Vehicles | 297 | 182 | 33 | 11 | 49 |
| Total Vehicle Cost Per annum | $26,219,754 | $16,088,436 | $3,129,720 | $1,104,840 | $4,647,160 |

*Source: Eunomia Modelling and Data from the cities of Olympia, Tacoma and Spokane*

### *Cost: Resources/Staff*

Similar to vehicle costs, staff cost data (including add on costs such as taxes, health insurance, etc.) was provided by a number of jurisdictions. These costs varied depending on a number of factors, including: working hours, benefits provided, etc. To address the variances, costs were reduced to an hourly level for both drivers and loaders before being multiplied by the number of hours worked per day (eight) and days worked per week (five) in the modeled scenarios. Average staff costs on a per-hour basis are shown in Table 88.

**Table 88: Average per Hour Cost for a Driver and a Loader**

| Cost Breakdown | Driver per Hour Costs | Loader per Hour Costs |
|---|---|---|
| Average Salary | $35.38 | $20.42 |
| Average Overtime | $0.50 | $0.44 |
| Average Social Security | $0.69 | $0.60 |
| Average Pension | $2.50 | $2.83 |
| Average Healthcare | $9.44 | $3.67 |
| Taxes | $2.79 | $4.96 |
| Total Cost/Hour | $51.30 | $32.93 |
| Total Hours | 2,080 | 2,080 |
| Cost/Year | $106,700 | $68,500 |

*Source: Eunomia Modelling and Data from the cities of Olympia, Tacoma and Spokane*

In addition to staff directly involved with picking up PPP, there are resources associated with supervision, administration and management of the services. These positions will only spend a portion of their time on PPP-related services. Table 89 summarizes the additional operational resources necessary and apportions the time and cost to determine a cost per route rate. This rate can then be multiplied by the number of routes in Table 89.

**Table 89: Supervision, Administration, and Management Staff Costs**

| Resource Type | Cost per Annum | Average FTE per Route | Cost per Route |
|---|---|---|---|
| Director | $167,000 | 0.016 | $2,700 |
| Supervisor | $92,000 | 0.066 | $6,000 |
| Radio Operator | $43,000 | 0.021 | $910 |
| Analyst/Clerk | $51,00 | 0.029 | $2,400 |

*Source: Eunomia Modelling and Data from the cities of Olympia, Tacoma and Spokane*

### *Costs: Container Replacement*

A wide range of containers are used for PPP collections across Washington, from small boxes to various sized carts to large multifamily dumpsters. There are also differences in who is responsible for the provision and replacement. For the modeling, the number and cost of the containers used is more important than the actual capacity, as all the scenarios have a similar material yields. Therefore, costs were assumed from the average of supplied data for three sizes of cart, a box for certain recycling streams, and dumpster for multifamily. The percentage share of households with each size of container in the baseline was based on data provided and extrapolated across the state. In future scenarios, the same percentage split was assumed when additional households were added (for example, where 10% of service users use 35-gallon carts in the baseline, 10% is also assumed when the service is expanded). The average costs for each container type are shown in Table 90. These represent the ongoing replacement costs and, in future systems where new households are added, the capital costs associated with containers for new service users are listed separately.

**Table 90: Containers Costs and Replacement Rates**

| Container | Container Cost | Replacement Rate | Ongoing Replacement Unit Cost | Number Replaced | Annual Replacement Cost |
|---|---|---|---|---|---|
| 20 Gallon Bin | $60.00 | 3.3% | $1.97 | 141,064 | $ 278,000 |
| 35 Gallon Bin | $45.49 | 3.4% | $1.55 | 987,515 | $ 1,531,000 |
| 65 Gallon Bin | $47.65 | 2.8% | $1.32 | 2,696,641 | $ 3,559,000 |
| 95 Gallon Bin | $53.40 | 3.4% | $1.82 | 1,974,684 | $3,593,00 |
| Box (Estimates) | $10.00 | 25% | $2.50 | 464,301 | $ 1,160,000 |
| Multifamily (Estimates) | $250.00 | 2.0% | $5.00 | 10,831 | 54,200 |

*Source: Eunomia Modelling and Data from the cities of Enumclaw, Olympia, Tacoma, Spokane and Vancouver*

### Drop-off Collection Costs

Drop-off collection costs were calculated by calculating the labor cost of receiving materials at a drop-off facility, the cost of hauling the material from the drop-off facility, and the cost of purchasing and maintaining drop-off containers.

The labor cost of receiving materials at a drop-off was calculated by taking an average employees per ton figure, sourced from previous Eunomia projects, and applying the figure to the number of tons collected via drop-offs. Wage data from interviews with municipalities and hauling companies in the State of Washington was then used to calculate the cost of drop-off facility labor.

A drop-off haulage rate was provided by the City of Olympia on a cost per haul basis. This cost per haul was converted to a cost per ton figure for each material collected at drop-offs by estimating the average payload of each material collected at a drop-off facility, assuming a 20 cubic yard container, and using volume to weight figures from Ontario's Pay-in Model (PIM).

Container costs were calculated by amortizing the purchase price of 20 cubic yard containers by fifteen years. This calculated yielded an annual cost of containers which was added to the total drop-off collection cost. Purchase prices were sourced from previous projects that analyzed drop-off infrastructure.

Container costs were estimated for future scenarios by calculating the number of new drop-off reception sites needed to ensure geographical coverage (one site per 15,000 people), and to ensure new containers were purchased to enable collection of plastic film, EPS and glass bottles. 503 sites were calculated to be necessary to ensure geographical coverage.

Contingency costs of 10% were also calculated to account for spare drop-off containers and annual maintenance costs for drop-off collection.

### Transfer and Sorting

Transfer and processing costs are based on a set $120 per ton rate, total transfer and processing rates under the baseline are set out in Table 91. However, because the rate of $120 per ton includes residue disposal, this percentage of the cost must be backed out of the gross cost of $120, so that the disposal costs are not double counted. Based on Cascadia research, 15% off processing costs are devoted to residue disposal. Therefore, reducing the $120 gross cost per ton by 15% results in a $102 gross cost per ton for processing. This gross processing costs was then used on the throughput of tonnage into a MRF to calculate gross sorting costs.

**Table 91: Transfer and Processing Rates under the Baseline**

| Tons Sent to Reprocessor from Sorting Facility | Transfer Processing Cost per Ton ($) | Total Gross Processing Cost ($M) |
|---|---|---|
| 476,600 | 102 | 48,613,000 |

*Source: Eunomia Modelling, Cascadia MRF Research (2020), Department of Ecology Waste Generation and Recovery Data (2017)*

The revenue by material, based on average monthly mid-point material revenues for 2019, as published for the Pacific Northwest on *Recyclingmarkets.net* were used and are provided in Table 92. These revenues are used on the tons that leave MRFs in bales to calculate the material revenue earned by the MRF for each material.

**Table 92: Per Ton Average Material Revenue 2019 for Pacific Northwest[78]**

| Material | Average Material Revenue 2019 ($/ton) |
|---|---|
| PET | $180 |
| HDPE Natural | $600 |
| HDPE Colored | $200 |
| Plastics 3-7 | -$30 |
| Aluminum Cans | $1,350 |
| Steel Cans | $120 |
| Glass Bottles | -$20 |
| Mixed Paper | $1 |
| Newspaper | $31 |

| Material | Average Material Revenue 2019 ($/ton) |
|---|---|
| OCC | $15 |
| Cartons | $30 |

*Source: RecyclingMarkets.Net and Seattle Public Utilities* data

## Disposal

The per ton disposal costs were used to calculate the cost of disposing of PPP in the trash stream as well as disposing of MRF residues. This was applied to the baseline as well as to the future systems and is provided by region in Table 93.[79]

**Table 93: Landfill Per Ton Tipping by Region in 2017**

| Region | Disposal Cost per Ton |
|---|---|
| Central | $ 77.29 |
| East | $ 102.46 |
| Northwest | $ 179.26 |
| Puget Sound | $ 129.26 |
| South West | $ 116.50 |
| West | $ 139.20 |

*Source: Washington Department of Ecology (2019)*

Tons of PPP are disposed from sorting facility residues as well as from the trash stream. The tons of material disposed and the cost under the baseline is included in Table 94.

**Table 94: Cost of PPP Disposed in Each Region in 2017**

| Region | Sorting Facility PPP Residues Disposed | PPP Disposed in Trash | PPP Disposed in Self-Haul | Disposal Rate[80] | Cost of PPP Disposed |
|---|---|---|---|---|---|
| Central | 1,300 | 86,000 | 2,500 | $ 77.29 | $ 6,941,000 |
| East | 8,500 | 94,500 | 5,300 | $ 102.46 | $ 11,096,000 |
| Northwest | 4,400 | 18,800 | 3,600 | $ 179.26 | $ 4,804,000 |
| Puget Sound | 37,200 | 192,100 | 33,000 | $ 129.26 | $ 33,905,000 |
| South West | 6,500 | 58,900 | 2,200 | $ 116.50 | $ 7,875,000 |

| Region | Sorting Facility PPP Residues Disposed | PPP Disposed in Trash | PPP Disposed in Self-Haul | Disposal Rate[80] | Cost of PPP Disposed |
|---|---|---|---|---|---|
| West | 2,000 | 17,100 | 2,100 | $ 139.20 | $ 2,951,000 |
| Total | 59,900 | 467,400 | 48,700 | | $ 67,572,000 |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017) and Cascadia Statewide Waste Characterization Study (2015-2016), Landfill rates from Department of Ecology (2019)*

### Overhead and Profit

There are additional costs related to operating PPP recycling services including IT, HR, customer services as well as profit margin for those services provided by private haulers. A flat 9% of operating costs has been assumed for these support services, plus contractor profit.

### Taxes

- Taxes: Service-related taxes and fees vary from jurisdiction to jurisdiction, depending on whether the jurisdiction is a city and charges a municipal utility tax and franchise fee, or some other fee. Within the scope of the project, it was not possible to assesses every jurisdiction's tax structure, so a consistent set of tax assumptions were added to the costs of services across all jurisdictions:
- 6% municipal utility tax: this is the highest tax that a utility can charge without approval.
- 1.75% business and operations tax: applied to the percentage of the total services that are provided by private haulers.

## Jobs Created Calculations

### Management and Supervision

Management, supervision and administration jobs associated with managing the PPP curbside services were calculated by dividing the number people in each job, sourced from data provided by the cities of Olympia, Tacoma and Spokane,[81] by the number of routes with which the position is associated. This figure was then multiplied by the percentage of time spent on recycling activities and by the average salary for that position to obtain a cost to service. Table 95 provides the average jobs per route, average salaries and the annual per route cost.

**Table 95: Jobs, Salary, and Cost for Management, Supervision, Administration Roles**

| | Jobs per Route | Average Salary | Cost per Recycling Route per Annum |
|---|---|---|---|
| Director | 0.014 | $167,613 | 2,306 |
| Supervisor | 0.065 | $85,940 | 5,219 |
| Radio Operator | 0.018 | $42,876 | 756 |

| | Jobs per Route | Average Salary | Cost per Recycling Route per Annum |
|---|---|---|---|
| Analyst/Administration | 0.046 | $51,263 | 2,358 |

*Source: Data from the Cities of Olympia, Tacoma and Spokane*

### Sorting Facilities

Jobs associated with sorting PPP collected in Washington were taken from published Waste Management on their JMK Fibers,[82] Cascade Recycler Center,[83] and SMaRT[84] facilities, as well as data from Recology's King County MRF. This information was used to calculate the number of jobs by type per 1,000 tons of PPP processed. Table 96 provides the job figures based this data. These figures were used to assess the potential additional jobs that could be created in accordance with an increase in the amount of PPP collected and sorted under future systems.

**Table 96: Jobs Associated with Sorting PPP in Washington**

| | Jobs per 1,000 tons sorted | Average Salary* | Cost per 1,000 tons sorted |
|---|---|---|---|
| Administration and supervision | 0.069 | $116,100 | $7,994 |
| Equipment operators | 0.162 | $67,895 | $11,010 |
| Sorters and quality control | 0.491 | $48,006 | $23,590 |
| Maintenance | 0.058 | $104,790 | $6,123 |

*Source: Eunomia, Correspondence with Washington MRF Operators*

*includes 35% costs to cover, pension, healthcare, social security and taxes

### Drop-Off Facilities

The number of drop-off facility reception jobs was calculated using prior Eunomia research on the number of jobs per 1,000 tons managed at a drop-off location as shown in Table 97.

**Table 97: Jobs Associated with the Reception of Materials at Drop-Off Locations**

| | Jobs per 1,000 tons Managed | Average Salary* | Cost per 1,000 tons received |
|---|---|---|---|
| Drop-off Reception | 0.47 | $60,500 | $28,700 |

*Source: Eunomia Economic Benefits Report for Recycling Council of Alberta (2019)*[85]

The cost for hauling material from drop-off facilities was taken directly from City of Olympia's per lift hauling costs and so no calculations for this activity were necessary.

### Secondary Reprocessing

The number of jobs associated with secondary processing of mixed plastics bales has been estimated based on information provided by EFS Plastics[86], a plastic reprocessor currently operating in Canada and Pennsylvania. The information was broken down into a cost per 1,000 ton metric and applied to future system scenarios. These numbers are small, but included for completeness.

**Table 98: Jobs Associated with Secondary Reprocessing**

| | Jobs per 1,000 tons sorted | Average Salary* | Cost per 1,000 tons sorted |
|---|---|---|---|
| Manager | 0.024 | $115,000 | 2,800 |
| Supervisor | 0.091 | $103,000 | 9,400 |
| Admin | 0.045 | $61,700 | 2,800 |
| Staff | 0.523 | $42,800 | 22,400 |

*Source: Eunomia Modelling and Correspondence with EFS Plastics*

### PRO

PRO jobs were estimated using annual reports from the Canadian Stewardship Service Alliance (CSSA) and extrapolating from the number of program management jobs. CSSA employs approximately 70 people for program management, based on primary research. Because CSSA oversees not only Recycle BC (the EPR program for PPP), but other stewardship programs as well, the total number of jobs was apportioned to the Recycle BC program, based on its share of CSSA's costs, which was reported as 38%.[87] Multiplying 38% by 70 yields just under 30 total jobs.

PROs also include education jobs as well. Education jobs under EPR scenarios were estimated by applying the weighted average FTEs of 0.3 per household for education, derived from jobs in the City of Seattle, and scaled up to the household total for the state under EPR.[88] This yields 6 education jobs under EPR scenarios.

### State Government Agency

The amount of resources needed in the state government agency will be dependent upon its final role in providing oversight. The number of direct jobs assumed in the model is 4: manager, supervisor and two analyst positions.

## Amenity Benefit Calculations

A number of studies have sought to quantify, in monetary terms, the 'welfare loss' - i.e. the extent to which citizens are negatively impacted – from the existence of littered items in their local neighborhood. This welfare loss is often referred to as the 'amenity impact ' arising from litter – much of which is considered attributable to the 'visual amenity impact ', which is understandable given that litter can transform the look and feel of a place.[xxix] The studies have typically sought to place a monetary value on this amenity impact through determining the amount that respondents would be willing to pay for a marginal improvement from the current situation, in terms of a proportional reduction in the levels of litter.

While it is possible to measure litter by weight, number of items, and volume, it is likely that visual amenity impact is most closely related to the overall volume of litter, which depends both on the number and volume of littered items, rather than the weight, or only the number. While litter is composed of a number of different materials and items, of which single use plastics will comprise a proportion, there is no research available, to the best of our knowledge, on how the impact varies by material and item type.

Our approach to estimating the litter amenity impact for Washington is based on a study recently conducted by Eunomia for DG Environment of the European Commission. A review of the literature found no studies relating to litter amenity impact in the US. We have therefore referred to European data which, while sparse, provides a basis for estimating the amenity impact associated with litter. Eunomia's approach to calculating the overall willingness to pay for reduced litter on land is described in the following paragraphs.

Drawing on what we consider to be the best available study[xxx] to establish the overall amenity impact associated with local land-based litter across the EU, we first take the unweighted average of a 'to best' improvement across the area types (inner-city, suburban, rural).[xxxi] A 'to best' improvement is an improvement that brings the level of cleanliness to be litter free. This equates to $62.02 per adult per month in 2011. Inflated to 2018 values, this is equivalent to $71.75 per month, or $861 per adult per year.[xxxii] We then scale this figure to Washington, on per capita GDP basis, adjusted by purchasing power parity. Ideally, we would have detailed analysis of litter composition and prevalence to use in scaling the amenity values. However, there are very few composition analyses and those available are not readily comparable. Accordingly, it is appropriate to simply scale by purchasing power parity-adjusted GDP, noting that the figure may lead to a slight overestimate in some less-littered locations, and an under-estimate in other more-heavily littered locations.

It is important to note that the calculated amenity impacts relate only to neighborhood amenity, and do not cover the impact of litter that might be found on journeys to areas beyond one's neighborhood, such as on walking excursions. Therefore, these estimates do not provide a complete picture of the total land-based amenity impact associated with littered items. Indeed, in terms of neighborhood litter, citizens may start to see this as somewhat 'normal' (while still having a strong preference for it not to be there). However, for litter encountered on a walking trip in a beautiful area, for example, the sense of upset and potentially anger might be proportionally higher than when it is seen in a day-to-day context.

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[xxix] The association between a littered environment and perception of public safety / fear of crime is an example.
[xxx] Mark Wardman, Abigail Bristow, Jeremy Shires, Phani Chintakayala and John Nellthorp (2013) Estimating the Value of a Range of Local Environmental Impacts, Report for Dept. for Environment, Food and Rural Affairs, 1 April 2011, <http://randd.defra.gov.uk/Document.aspx?Document=9854_LEQFinal.pdf.
[xxxi] *Ibid.*
[xxxii] UK GDP deflators at market prices, and money GDP December 2017 <https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-december-2017-quarterly-national-accounts>

Proportional reductions in amenity impact are be calculated linearly based on anticipated reductions in volume. In respect to land-based litter, to assume a linear reduction (given the argument of diminishing returns) could well be to underestimate the benefit of such reductions – especially given that they will be of beverage containers. However, we take this approach in order to derive a conservative estimate.

An 80% reduction in litter is also assumed following implementation of the DRS. This is a conservative estimate based on a comparative review of the effect of DRSs on littering behavior.[XXXIII]

## DRS Modeling - Technical Assumptions and Calculations

### DRS Material Flows and Quantities

The tonnage of beverage material generated in Washington in 2017 was calculated based on an assessment of the percentage of bottles and containers assumed to be beverages. These assumptions are detailed along with the per container weights from the Container Recycling Institute and the number of containers assumed to be POM in Table 99.

**Table 99: Quantity and Number of Containers Estimated to be Placed on Market in 2017 and Calculation of Beverage Containers POM**

| Beverage Material | Tonnage all Bottles/ Containers Generated | % of Bottles/Containers Beverage | Tonnage Beverage Containers POM | Average Weights Per Container (Oz) | Number of Containers POM (Million) |
|---|---|---|---|---|---|
| PET | 55,900 | 80% | 44,700 | 0.7 | 2,040 |
| HDPE Natural | 22,900 | 80% | 18,300 | 2.3 | 254 |
| HDPE Colored | 19,900 | 10% | 2,000 | 2.3 | 2.78 |
| Aluminum | 30,000 | 90% | 27,000 | 0.5 | 1,728 |
| Glass | 235,800 | 80% | 188,600 | 11.0 | 548 |
| Cartons | 4,700 | 75% | 3,600 | 0.9 | 128 |

*Source: Washington Department of Ecology Waste Generation and Recovery Data (2017), Eunomia Modelling and CRI 2017 BMDA Data*

The material flows for beverage containers by type are contained in Table 100, these are based on Eunomia's experience of modeling other systems. The litter rates are based on the following assumptions taken from a study recently conducted by Eunomia for DG Environment of the European Commission.

- Aluminum: 4.3%

[XXXIII] Eunomia (2017) Impacts of a Deposit Refund System for One-way Beverage Packaging on Local Authority Waste Services, 11th October 2017

- PET: 3.3%
- HDPE: 3.3%
- Glass: 0.8%
- Cartons and aseptic: 3.3%

**Table 100: Beverage Container Material Flow Under DRS**

| Activity | Aluminum | PET | HDPE Bottles | Glass | Cartons |
|---|---|---|---|---|---|
| Placed on Market | 27,000 | 44,700 | 20,300 | 188,600 | 3,600 |
| Recycled DRS (1) | 25,100 | 41,600 | 18,300 | 169,700 | 2,100 |
| Recycled Curbside (2) | 670 | 690 | 460 | 7,400 | 40 |
| Disposed (3) | 920 | 2,000 | 1,400 | 12,700 | 1,300 |
| Littered (4) | 150 | 200 | 90 | 200 | 20 |
| Recycling Rate (5) | 95% | 94% | 92% | 94% | 59% |

*Source: Eunomia Modeling, Department of Ecology Waste Generation and Recovery Data (2017), Cascadia Statewide Waste Characterization (2015-2016), CRI 2017 BMDA Data*

(1) Includes 1% allowance for cross border fraud and a 1% loss rate through the system

(2) Proportion of units not collected through DRS are split according to current split in waste stream, includes processing loss rates for each material, the quantity of which is included in the disposed/trash stream

(3) Includes containers that flow into the trash, plus the loss rates associated with both the DRS and curbside collected items plus an amount collected as litter

(4) This is the amount assumed to remain in the environment[89]

## DRS Costs

### *PRO*

The upfront capital and operating costs for the PRO are detailed in Table 101.

**Table 101: PRO Annual Cost Breakdown**

| Cost Item | Cost ($) |
|---|---|
| **Capital Costs** | |
| IT - capital investment | 473,400 |
| Office - furniture and equipment | 23,670 |
| Project (setup) management | 118,350 |

| Cost Item | Cost ($) |
|---|---|
| Communication | 355,050 |
| Annualized Capital cost | 167,716 |
| **Staff Costs** | |
| 11 Staff | 803,33 |
| **Office Space** | 1,382 |
| **Administration – IT, Legal, Utilities etc.** | 414,225 |
| **Marketing (0.10% of turnover)** | 515,539 |
| **Total per Annum Costs** | 1,902,193 |

*Source:* Eunomia Modeling, OBRC, TOMRA Data, CLYNK Data

### DRS Benefits

#### *Jobs*

The number of direct jobs generated as a result of the DRS system is provided Table 102.

**Table 102: Jobs Associated with the Deliver of the DRS**

| Activity | Number of Jobs |
|---|---|
| DRS Collection | 188 |
| Addition transfer and hauling | 55 |
| Retail | 186 |
| Redemption center | 37 |
| Bag-drop | 255 |
| Counting center | 11 |
| PRO | 127 |
| **Total** | **860** |

*Source: Eunomia Modeling*

## EPR Modeling - Technical Assumptions and Calculations

### EPR Material Flows and Quantities

Under each FS, the increase in the amount of material recycled is a function of:

- Increase coverage – all households having access

- Increase capture – resulting from all households achieving best practice capture rates
- Wider and uniform range of materials accepted in curbside programs
- Increased capture from secondary sorting facilities (#3-#7 processing and residue capture) with an assumed capture rate of 100% for incoming materials, to illustrate the maximum potential of secondary sorting

Table 103 below shows the tons estimated to be captured through secondary sorting facilities.

**Table 103: Tons Recycled through Secondary Sorting Facilities**

| | FS2 | FS3 | FS5 | FS6 |
|---|---|---|---|---|
| #1 PET Bottles | 690 | 690 | 180 | 180 |
| #1 PET Other Packaging | 340 | 340 | 340 | 340 |
| #2 HDPE Natural Bottles | 140 | 140 | 30 | 30 |
| #2 HDPE Colored Bottles | 200 | 200 | 190 | 190 |
| # 2 Other HDPE Packaging | 40 | 40 | 40 | 40 |
| #3 PVC Packaging | 70 | 70 | 70 | 70 |
| #4 LDPE Packaging | 50 | 50 | 50 | 50 |
| #5 PP Packaging | 8,200 | 8,200 | 8,200 | 8,200 |
| #6 PS Packaging | 1,100 | 1,100 | 1,100 | 1,100 |
| Aluminum Cans | 290 | 290 | 50 | 50 |
| Total | 11,100 | 11,100 | 10,300 | 10,300 |

*Source: Eunomia Modeling, EFS Plastics Data, Cascadia MRF Research*[90]

## EPR Costs

### *Material Revenues*

The gross cost of sorting is assumed the same under each scenario using sorting costs obtained via correspondence with Washington MRF operators. To reach net costs, material revenues were subtracted from the gross sorting costs.

The value of the material recycled, not collected, is provided for each option. For all FSs except 4 and 7 (dual stream), average monthly mid-point material revenues for 2019, as published for the Pacific Northwest on *Recyclingmarkets.net* were applied. For FSs 4 and 7, the upper point averages were applied, due to higher levels of bale purity

#### *PRO*

The PRO program management cost has been calculated based on prorating the Canadian Stewardship Services Alliance (CSSA) costs charged to Recycle BC in 2019 to Washington's population, as detailed in Table 104. The CSSA reports a program management expenditure of $6.89M CAD, or $5.24M USD annually for 2019. On a per capita basis, this works out to $1.03 USD per capita. This cost is for general program management and administration of the PRO.

**Table 104: PRO Cost Calculation**

| PRO Activity | CSSA Cost to Recycle BC CAD $ | CSSA Cost to Recycle BC US $ | Cost per Capita US $ | Cost for Washington US $ |
|---|---|---|---|---|
| Program Management | 6,890,000 | 5,236,400 | 1.03 | 7,843,450 |

*Source: Eunomia and CSSA Reports*[91]

#### *Educational Costs*

The education costs assumed to be necessary to bring all households up to the same capture rates as the City of Seattle have been calculated based on data provided by the City of Seattle for 2019[92] and prorated across the whole state, as shown in Table 105.

**Table 105: Calculation of PRO Costs Associated with Education and Engagement Pro-rated from City of Seattle**

| Item | Cost |
|---|---|
| Education spending per household single family | $2.30 |
| Education spending per household multifamily | $0.80 |
| Weighted average per households spending | $1.75 |
| Total households | 3,170,600 |
| Total spend across state on education | $5,559,000 |

*Source: Eunomia and Data from Seattle Public Utilities Source: City of Seattle, 2019*

#### *State Government Agency*

No costs except staff costs have been assumed for the government agency.

### EPR Benefits

#### *Jobs*

Hermes calculates the number of collections drivers and helpers required for each vehicle, the management and MRF sorting costs use the per route and per 1,000 tons, the PRO and government agency jobs and DRS PRO jobs are detailed above.

**Table 106: Job Breakdown by Future System**

| Job Type | FS 1 | FS 2 | FS 3 | FS 4 | FS 5 | FS 6 | FS7 |
|---|---|---|---|---|---|---|---|
| Collection | | | | | | | |
| Drivers | 473 | 656 | 660 | 820 | 648 | 468 | 820 |
| Loaders | 292 | 410 | 347 | 508 | 405 | 284 | 508 |
| Management | | | | | | | |
| Director | 49 | 67 | 68 | 84 | 67 | 67 | 48 |
| Supervisor | 68 | 94 | 94 | 117 | 93 | 93 | 67 |
| Radio Operator | 74 | 103 | 103 | 128 | 102 | 102 | 73 |
| Analyst/Clerk | 94 | 130 | 131 | 163 | 129 | 129 | 93 |
| MRF Sorting | | | | | | | |
| Admin and Supervisory | 32 | 56 | 59 | 56 | 50 | 49 | 51 |
| Equipment Operators | 76 | 132 | 138 | 131 | 117 | 115 | 119 |
| Sorting and QC | 230 | 399 | 420 | 398 | 355 | 348 | 362 |
| Maintenance | 27 | 47 | 50 | 47 | 42 | 41 | 43 |
| PRO | 0 | 35 | 35 | 35 | 35 | 35 | 35 |
| State Government Agency | | 4 | 4 | 4 | 4 | 4 | |
| DRS Jobs | | | | | | | |
| Collection | 721 | | | | 721 | 721 | 721 |
| Administration and Counting | 138 | | | | 138 | 138 | 138 |
| Depot Reception | 14 | 13 | 3 | 3 | 6 | 12 | 3 |
| Secondary Sorting | 0 | 8 | 8 | 0 | 7 | 7 | 0 |

*Source: Eunomia Calculations and Correspondence with Washington MRF Operators*

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