NEXTCYCLE WASHINGTON

Circular Infrastructure Gap Analysis

Modeling a Path Towards a Circular Economy in Washington

JUNE 30, 2023

NextCycle Washington is a circular economy innovation platform and accelerator designed to support the growth of businesses and organizations working within Washington’s waste prevention, reuse, repair, recycling and/or organics recovery industry.

Executive Summary

NextCycle Washington helps to reduce waste, keep materials in use longer, and regenerate natural systems while developing equitable local economies. Through technical support, engagement, networking and funding assistance, the program prepares businesses and projects for future investment and improves their impact potential and economic opportunities. The program is funded by King County Solid Waste Division, City of Seattle, and the Washington Recycling Market Development Center, a collaboration of the State Departments of Ecology and Commerce.

The NextCycle Washington Circular Infrastructure Gap Analysis report has been prepared to support the efforts of NextCycle Washington. The goal is to aggregate and analyze existing data to identify and prioritize system needs and forecast possible outcomes of targeted interventions and investments in the state's circular economy. Improved understanding of these gaps and opportunities allows for a more targeted approach to the development of businesses and projects and can help drive smarter investment in the system. Information found below can help program funders, staff, partners, and investors as they work to develop strategic approaches and can also help prospective businesses and organizations as they seek to identify market opportunities and activities that may have the greatest impact potential.

The work presented in this report:

- Utilizes baseline data on disposal, recycling, reuse, and prevention,
- Analyzes gaps in access and infrastructure associated with these activities, and
- Models diversion potential and associated costs for possible investments in the system.

It should be noted that this approach looks at past activity to project future opportunity. This approach has limitations. Aspects of the system that do not have a lot of existing data, such as reuse and other upstream solutions, are not projected to have as large of a future impact as those that have a lot of detailed data available through regular reporting, such as recycling and composting and other downstream solutions. Likewise, when projecting infrastructure needs and costs, the data skew towards downstream solutions. While this report has been successful at aggregating and integrating known upstream data sets, it could be improved with more systemic tracking of upstream investments and related outcomes, such as the quantity of materials diverted, number of jobs created and costs of upstream interventions.

A key finding of the research indicates that 84% of materials going to landfill have known recovery pathways. A detailed circularity gap model was created to estimate potential capture rate – amount of diversion - of materials from the municipal solid waste (MSW)[1] disposal stream. The model estimates that 2 million tons of the nearly 5.8 million tons of disposed MSW can be source reduced, prevented, reused, or recycled through interventions that exist today. Previous NextCycle Washington internal research estimated that this additional diversion could lead to 75,000 direct, indirect, and induced jobs if all the material is reused, processed and/or remanufactured into new products within

1 Municipal solid waste is defined as waste generated from the residential, commercial, and institutional sectors and excludes industrial, construction and demolition and agricultural waste.

the state. It would also reduce greenhouse gas (GHG) emissions by 5.1 million tons of CO_2 equivalent (NextCycle Washington Circular Economy Impact Analysis, 2022).

Collection programs are the foundation of diverting material through methods such as recycling or organic waste recovery. A key finding in this study identified that high income census tracts (median income $137,882) are 13 times more likely to have recycling services and 18 times more likely to have organic recovery options than low-income tracts (median income $49,677; Figure 1). Meanwhile low-income tracts are three times more likely to host a landfill and 2.5 times more likely to host a material recovery facility (MRF) or organic processing facility. Providing more upstream and downstream services in low-income tracts, while taking environmental justice concerns into consideration, is a clear opportunity to divert more material, while creating economic opportunities in those communities.

While the focus of this report relates primarily to service access and infrastructure, there is a huge role for policy, public education, and community engagement in the effort to develop a more equitable circular economy. These could be a great subject for future study.

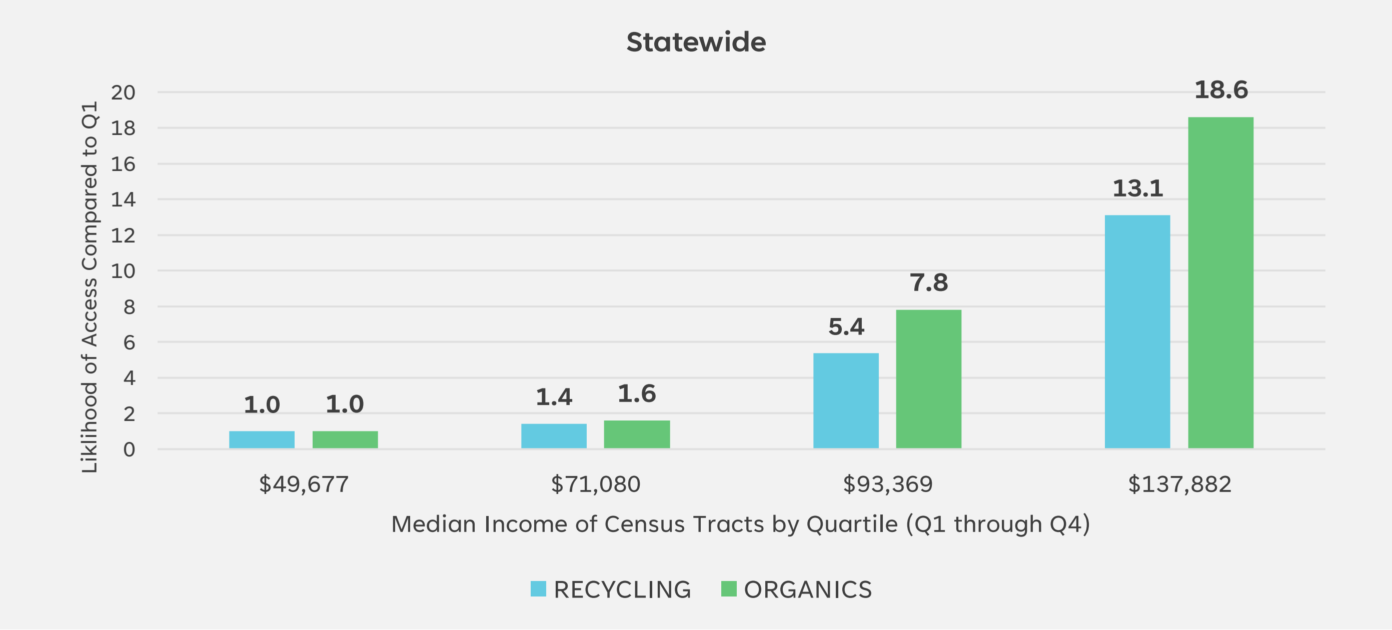


Figure 1. Access to recovery services by tract median income

Introduction

The circular economy is based on three principles: eliminate waste and pollution, circulate products and materials at their highest value through waste reduction, material reuse and end of life recycling, and support practices that regenerate, rather than exploit, nature. Conceptually, this approach moves economic activity from a linear model of resource extraction, use, and disposal towards a more sustainable system that keeps materials in circulation at the highest value for as long as possible (Figure 2). The shift towards circularity has tangible benefits for the environment, the economy, and society:

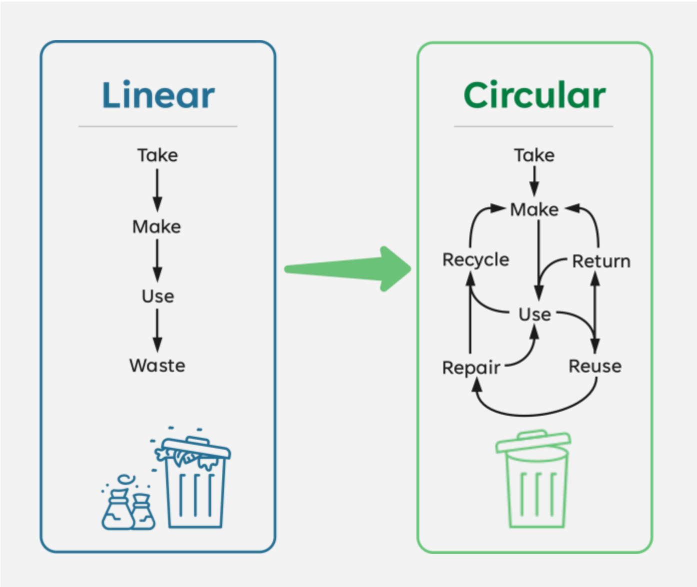


Figure 2. Shift from linear to circular economy

- It realizes environmental benefits, as recirculated materials are a substitute for virgin inputs and reduce the significant impacts associated with resource extraction, such as GHG emissions and water usage.
- It represents economic benefits, as recovering materials as inputs for new products creates more jobs than moving that same unit of material through a one-way trip to the landfill.
- If done right, it can provide social benefits by harnessing those jobs and market activities to create economic opportunities and increased access to services for overburdened and underserved communities in both urban and rural areas.

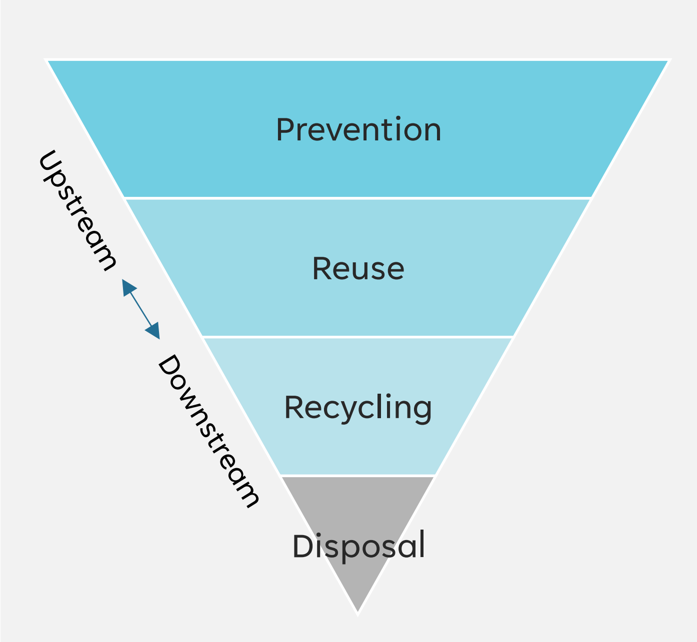


Figure 3. Waste hierarchy

Moving towards a circular economy requires a paradigm shift in the structure of supply chains, processes and business models and requires intentionality, collaboration, and resources. That is where NextCycle Washington fits in, as we support the growth of business and organizations that represent a circular approach and can help to make this transition a reality.

The waste hierarchy (Figure 3) is an important concept for understanding the relationship of materials management, circularity, and the environment. It was adopted by the U.S. Environmental Protection Agency (EPA) and uses a four-tiered approach to define priorities in sustainable materials management activities. The most preferred methods are upstream solutions, including waste prevention (source reduction) and reuse, followed by downstream solutions, such as recycling and composting[2]. Disposal, including landfilling and incineration, are considered the least preferable management options (U.S. Environmental Protection Agency 2021).

In practice most Municipal Solid Waste (MSW) in the U.S. is managed through disposal, the least preferable option. According to the EPA over 62% of U.S. MSW is handled by landfilling or incineration. Another 32% is currently diverted to recycling and composting[3]. For decades, the diversion rate was gradually increasing, from just 6% of MSW diverted 60 years ago, to 16% 30 years ago, to a peak of 35% in 2017 (U.S. Environmental Protection Agency 2021). Since then, however, the diversion rate has been essentially flat as current systems struggle to adapt to the increasing amount and diversity of waste generated and shifting global policy landscapes[4]. More solutions must be added to the current toolbox to put the diversion rate back on an upward trajectory. This report will look at current gaps in the access and infrastructure of downstream diversion systems in Washington and evaluate some early success in emerging upstream pathways such as waste prevention and reuse initiatives. This will help identify which tools hold the most potential for the future to fill gaps in the State's circular economy.

Washington's recovery rate from the MSW stream is above the national average at 37% recovered[5]. In 2021, Washington disposed of more than 5.7 million tons of MSW, most of which could be reduced at the source, diverted, reused, or recycled. Washington has set goals to move towards a more circular economy, driven by sustainable upstream and downstream solutions and away from disposal and incineration. For example, King County, the largest county in the State that includes the City of Seattle, has established a goal of zero waste of resources[6] by 2030 in its Re+ Strategic Plan: Reimagining a Waste Free King County (2022). Additionally, adopted statewide legislation sets a goal to reduce organic waste disposal by 75% by 2030 compared to 2015 figures ("Final Bill Report E2SHB 1799" 2022).

2 Throughout the document recycling will refer generically to recycling of technical materials (paper, metals, plastics, glass, textiles, scrap metal, etc.) and recovering organic materials (food and yard waste) through composting or anaerobic digestion.

3 The remaining 6 percent of MSW is food waste management through other pathways such as animal feed, codigestion/anaerobic digestion, bio-based/biochemical processing, donation, land application, and sewer/wastewater treatment facilities.

4 Per capita waste generation has been relatively flat over the past 30 years.

5 Washington disposal and recycling rate estimated from solid waste disposal data by county 2021 and recovered material, collection, and sector data 2021 downloaded from Ecology: https://ecology.wa.gov/Research-Data/Data-resources/Solid-waste-recycling-data. The estimate includes MSW disposal and recovery and excludes industrial recycling and disposal, and material burned for fuel or land applied.

6 This means that discarded materials that have value will not be managed as waste, but rather as resources that can be reused or recycled.

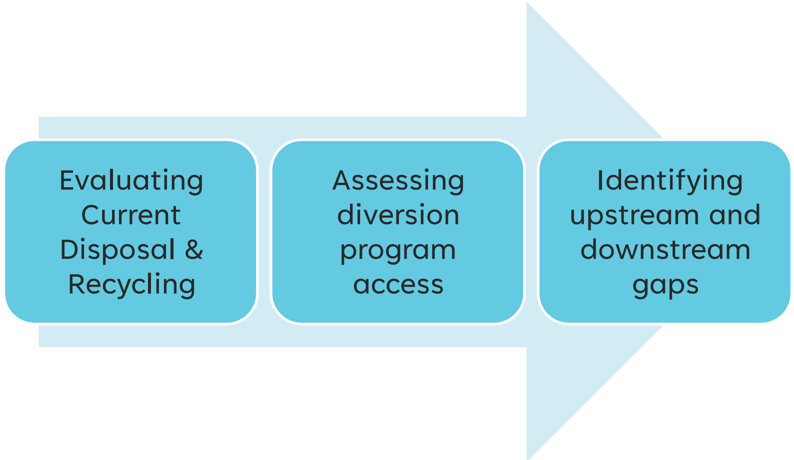


Figure 4. Circularity modeling approach

The circularity gap model developed for this work concludes that an additional 2 million tons of currently disposed MSW can be achievably diverted by scaling solutions that are available today. The report also highlights data related to access disparities by income, which frame significant gaps and opportunities. For example, data show that residents in the highest income brackets of Washington (median income $137,882) are 13.1 times more likely to have access to curbside recycling and 18.6 times more likely to have curbside or drop-off organics recovery programs than residents within the lowest income brackets (median income $49,677). The pattern of access disparity by income holds true in rural, suburban, and urban settings. The disparity in access translates to differing levels of pounds per capita disposal and recovery. On average residents lacking access to curbside recycling dispose of 333 more pounds per capita per year than residents that can access curbside recycling services. The disparity in access is even more meaningful when combined with the finding that the lowest income communities are 3.3 times more likely to host landfills and 2.6 times more likely to host a material recovery facility (MRF) or organics processing facility.

Finally, the report outlines investments in upstream and downstream solutions that would assist Washington in making a just transition toward a circular economy. Just transition is a process for changing toward a more sustainable and healthy economy that does not cost workers or community residents their health, environment, jobs, or economic assets (Adapted from the Just Transition Alliance, jtalliance.org). Upstream investments are needed in areas of risk to build resiliency in those communities. Early examples of NextCycle Washington investments are doing just that with the goal of scaling upstream networks statewide. Diverting more material from disposal will also require additional recycling and organics processing investments, including new facilities as well as growth in end markets that can utilize these materials. As many as eight new MRFs to process additional commingled recyclables[7] and 24 additional organics facilities with the capacity to accept food waste may be needed across Washington. Moving Washington towards a circular economy following the modeled outcomes in this study will capture 35% of MSW disposed of today. This provides environmental benefits, reduces the State's greenhouse gas emissions, and creates significant economic growth within the state.

7 Commingled Recyclables include materials traditionally processed by MRFs such as cardboard, newsprint, mixed paper, plastic bottles, lids, and tubs resin types #1, 2, 5, aluminum and steel cans, and glass containers.

Municipal Solid Waste Disposal and Economic Opportunity

In 2021, Washington's residents, commercial businesses, and institutions disposed of 5.8 million tons of MSW. Figure 5 and Table 1 show total MSW disposed by material type. Organic materials, including yard and food waste and compostable paper, are the largest fraction disposed, representing nearly 30% or 1.69 million tons of MSW. Plastics and paper are the second and third largest MSW disposal streams estimated at over 789,000 tons (14% of the total) and 661,000 tons (11% of the total), respectively. These data suggest that the majority of the disposed MSW is readily recoverable with technology and processes available today. For example, wasted food and food scraps are the largest component of organic waste. A portion of this disposal stream can be rescued upstream to feed food insecure populations. The remaining portion can be recovered downstream. It could be composted into a product that can improve soil health, digested to produce renewable natural gas and nutrient rich digestate or processed into new materials, such as PLA or PHA[8]. Plastic and paper represent a variety of commodities such as PET, HDPE, EPS, LDPE[9] film, cardboard, boxboard, and mixed paper which have market value and can be readily recycled from a technical perspective[10].

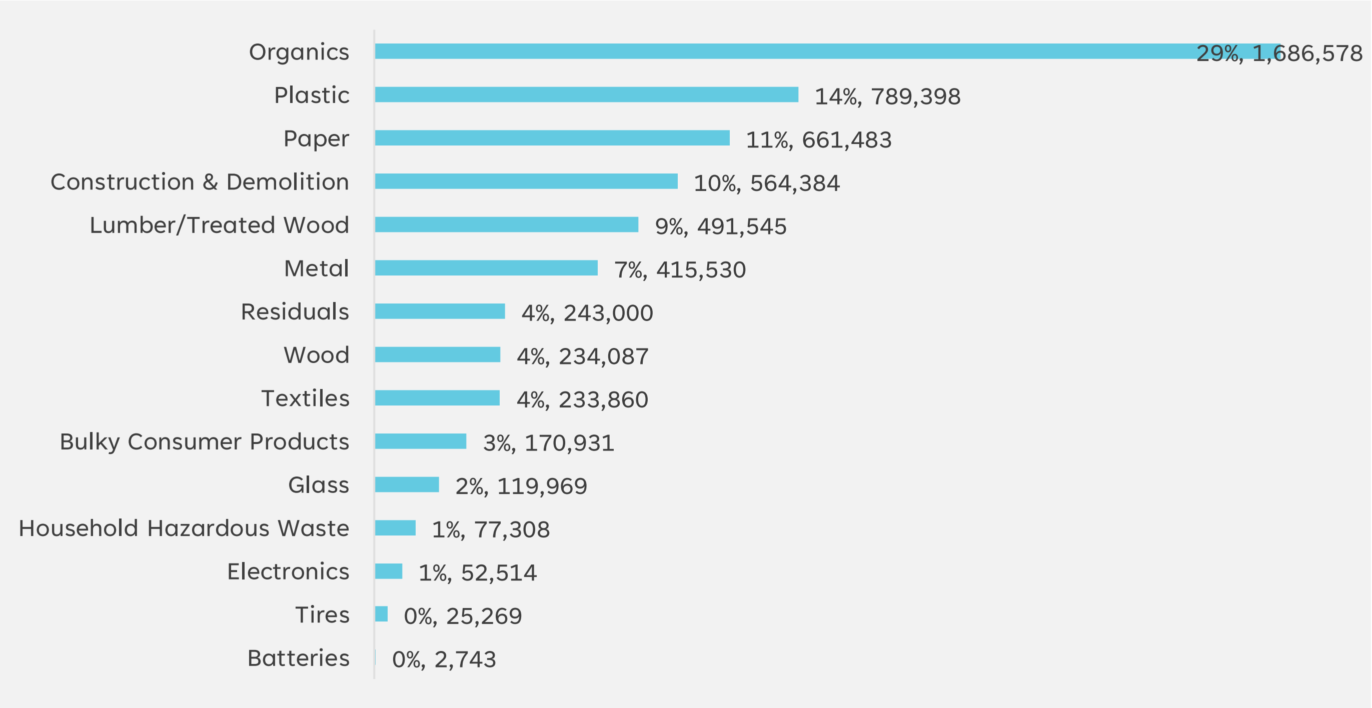


Figure 5. Total 2021 MSW disposal by material type (tons)

8 Bioplastics that can substitute for virgin plastics, PLA stands for polylactic acid and PHA stands for polyhydroxyalkanoate. Both are emerging bioresins with a broad range of applications, from single use packaging to durable products.

9 Polyethylene terephthalate (PET); high density polyethylene (HDPE); expanded polystyrene (EPS), low density polyethylene (LDPE)

10 Many barriers to current recovery are related to the economics of recovery. Programs such as NextCycle Washington, Re+, Industrial Symbiosis, and the Recycling Development Center are designed to help overcome these barriers.

Table 1. 2021 Estimated MSW disposal by commodity and generator type (tons)

	Residential	Commercial	Self-Haul	Total
Organics[11]	1,053,007	447,361	186,211	1,686,578
Plastic	364,973	286,716	137,709	789,398
Paper	259,895	270,271	131,317	661,483
Construction and Demolition	119,352	152,515	292,517	564,384
Lumber/Treated Wood	94,580	127,723	269,243	491,545
Metal	166,416	102,680	146,434	415,530
Residuals	199,600	33,631	9,769	243,000
Wood[12]	28,419	90,417	115,251	234,087
Textiles	116,449	59,256	58,155	233,860
Bulky Consumer Products	45,127	27,241	98,563	170,931
Glass	76,220	24,889	18,860	119,969
Household Hazardous Waste	24,631	38,641	14,036	77,308
Electronics	31,930	4,874	15,710	52,514
Tires	12,958	6,550	5,761	25,269
Batteries	2,312	130	301	2,743
Total	**2,595,869**	**1,672,894**	**1,499,836**	**5,768,599**

Figure 6 presents potential recovery broken down by stream type for the different material streams listed above, including materials that could be reused (textiles and other durable products) processed at MRFs (commingled recyclables), organics facilities (rescuable, compostable, digestible), or items that have available recovery markets and could be collected via drop-off recycling programs. This chart also shows the proportion of the stream that is wood waste, lumber and treated wood, and construction and demolition (C&D) in which reuse, and recycling opportunities could be implemented. Theoretically more than 84% of the disposal stream is material that could be reused or recycled with existing technologies and processes. Using the methodology described in Table 2, this report estimates that 35% of this material could be diverted or recovered. This is based on modeling scenarios on known diversion solutions that can be expanded, to divert an additional 1.88 million tons from disposal.

11 Organics includes food waste, yard debris, compostable paper and plastic, and manure.

12 Wood includes pallets and crates, untreated wood, wood by-products such as sawdust, and composite wood materials.

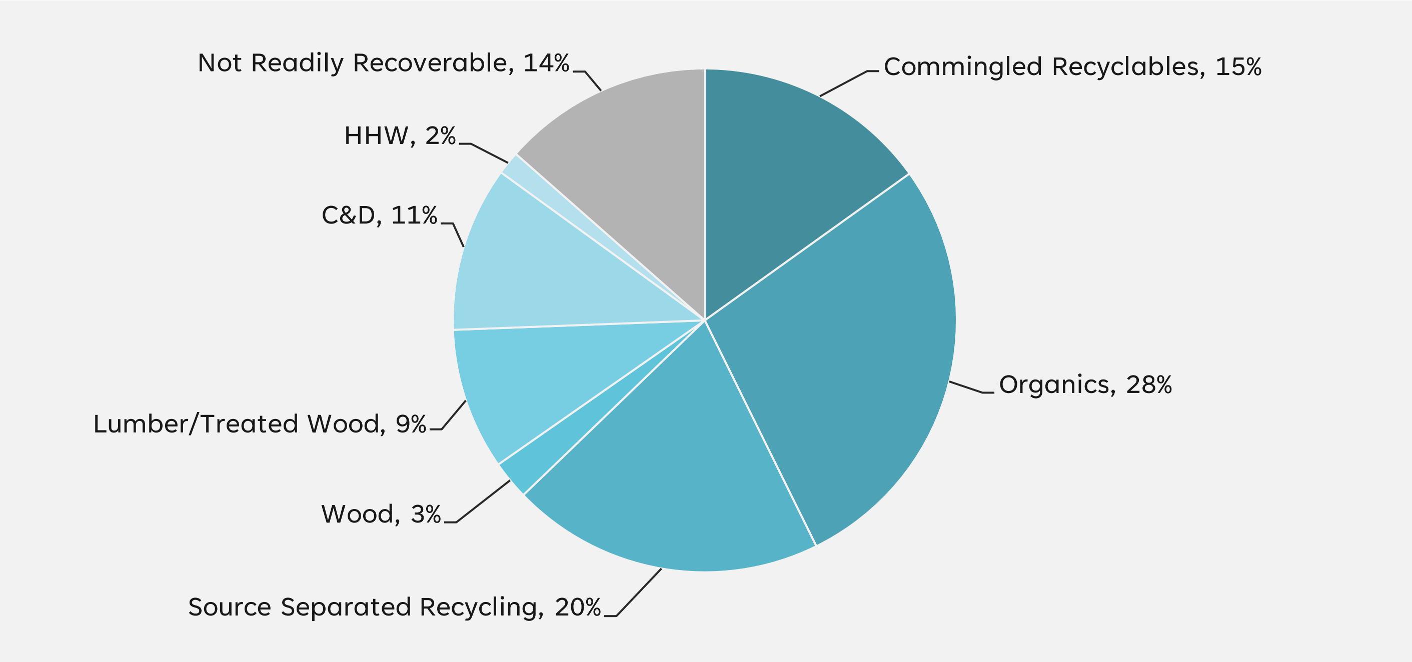


Figure 6. Potential recovery broken down by stream type for current MSW disposal[13]

Disposal of potentially reusable and recyclable materials results in missed economic opportunities. The recycling, reuse, and remanufacturing sectors are estimated to create four to 20 jobs per 1,000 tons of material collected, depending on the specific commodity. This is compared with roughly one job created per 1,000 tons of material landfilled (Tellus Institute 2011). These missed economic opportunities have different impacts in different areas. Jobs added to areas lacking economic opportunity will have a greater influence on reducing disparities (Ames et al. 2001). The final section of this report, titled Environmental Justice, demonstrates that lower-income communities are disproportionately impacted by the siting of recycling and composting facilities. It is critical that these facilities are distributed equitably across the state, that they provide ladders of economic opportunity (not just permanent low-wage work), and that they employ the highest standards for protecting the health and wellness of their workers and the surrounding community.

Diverting these additional materials from disposal and keeping the materials in circulation within the state, could create up to an additional 75,000 direct, indirect, and induced jobs and contribute $32.3 billion to Washington's economy (Figure 7). This material diversion could reduce the state's greenhouse gas emissions by 5.1 million tons CO_2 equivalent (NextCycle Washington Circular Economy Impact Analysis, 2022).

13 Commingled Recyclables include materials traditionally processed by MRFs such as cardboard, newsprint, mixed paper, plastic bottles, lids, and tubs resin types #1, 2, 5, aluminum and steel cans, and glass. Source separated materials includes any recyclables that have markets but cannot be processed at a MRF and require separate collection from typical comingled curbside programs such as plastic film, bulk plastics, appliances, or electronics. Although this work did not look at C&D disposal, on average 1% of the MSW stream is composed of C&D waste in Washington, and the recovery of C&D in the MSW disposal stream was part of the modeling work performed in this study.

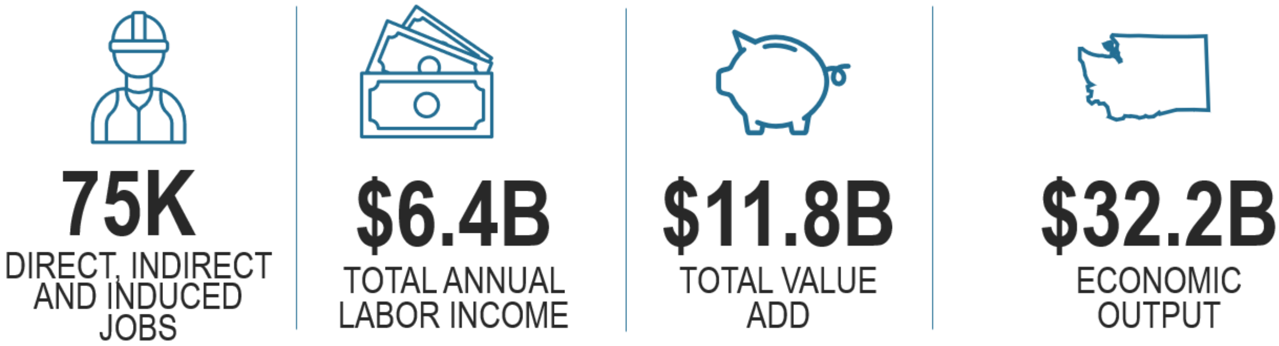


Figure 7. Economic impact of diverting additional 1.9 million tons of material from the municipal solid waste stream

Circularity Gap Modeling

Upstream-Downstream Circularity Model Methodology

An upstream-downstream circularity model was developed to explore the potential of increasing circular activity using data from the 2020-2021 Washington Statewide Waste Characterization Study and quantifying opportunities for prevention, reuse, and recovery at the commodity level within the MSW stream. Table 2 provides a description of the model inputs, key assumptions, and shows the low, medium, and high scenario inputs used within the model. For each material type the model considers the degree of achievable diversion potential associated with possible future activity and assigns a potential diversion percentage factor. The following examples provide illustrative logic to the modeling approach:

- The introduction of a reusable cup program is a business model used by NextCycle participant, OKAPI Reusables. This represents an *emergent market* with very early traction. This model considers that the growth of such activity could result in future waste **prevention** of 1% single use paper coffee cups in a low scenario, 2% in a medium scenario and 4% in a high scenario. The activity is not credited with additional recycling. Other reuse programs supported by Reuse Seattle, such as reusable cups at music venues, for example, are evaluated in the same way, through their prevention of wasted single use items.
- Food Rescue is a form of **prevention** that represents a *growing market*. It is already done at a meaningful scale through food banks and organizations such as Food Lifeline, a project partner of NextCycle participant Duwamish Valley Sustainability Association (DVSA). This type of activity is expected to grow as a result of targets set by the Washington State Department of Ecology (Ecology) in its Use Food Well Washington Plan. The model assumes that 5%/10%/15% (low/medium/high scenarios) of food waste currently bound for disposal can be diverted through rescue to feed people that are food insecure. The model goes on to assume that 30%/50%/75% of remaining food waste can be diverted through *Well Established / Policy Driven Markets* for **recycling** (composting) due to the goals associated with House Bill 1799 (Washington State Department of Ecology 2022).
- Textile **reuse** is an *established market*, as there are numerous resellers, such as Goodwill, and many new business models are developing around repair and reuse of textiles. The model assumes this activity can increase and divert additional textile waste by (10%/20%/30%) based

on the growing number of activities in this space and upcycling efforts by organizations such as NextCycle participant Refugee Artisans Initiative and the Redesign Collective.

- **Recycling** of non-reusable textiles is a *growing market*, as it is less established, but commercial activity is expected to grow, especially as companies like NextCycle participant Ravel and Seattle-based company EVRNU scale their promising recycling technologies.

Table 2. Description of upstream-downstream circularity model inputs

Description	Low	Med	High	Upstream Recovery: Prevention and Reuse	Downstream Recovery: Recycling and Composting
Emergent Market	1%	2%	4%	Cardboard, Single Use Food Service Ware, Compostable Paper, Single Use Beverage Containers, Reusable PP Containers, Reusable Stainless-Steel Cups, Reusable Bulky Plastics, Wood Waste	Chemical Plastics Recycling, Wood Waste
Growing Markets	5%	10%	15%	Edible Food Waste, Appliances, Electronics	Non-Reusable Textiles
Established Markets; Limited Collection	20%	30%	40%	Reusable Textiles	Source-Separated Recyclables, not suitable for single stream
Well Established or Policy Driven	30%	50%	75%	Single Use Plastic Bags, Expanded Polystyrene	Commingled Recyclables, Yard, and Food Waste

The circularity gap model works by establishing an achievable potential diversion rate for every commodity as it relates to upstream and downstream recovery solutions. Table 3 provides an excerpt from the model of select materials. For example, cardboard is estimated to comprise 307,301 tons of MSW disposal based on data from the 2020-2021 Washington Statewide Waste Characterization Study. If 4% of the disposed cardboard were prevented through conversion to alternative reusable packaging, for example, 12,292 tons of cardboard would be diverted from the MSW disposal stream. If the remaining cardboard in the MSW disposal stream were reused at a rate of 4%, another 11,800 tons of cardboard would be diverted. Finally, if the cardboard remaining in the MSW disposal stream after prevention and reuse were recovered for recycling at a rate of 75%, 212,406 tons of cardboard could be recovered. In total the prevention, reuse, and recycling initiatives would result in a 69% diversion rate for cardboard that currently remains in the MSW disposal stream[14]. A total of 50 material categories were evaluated following the same logic as described in the cardboard example to arrive at an overall average diversion rate from the MSW stream which is presented in the next section.

Table 3. Upstream-downstream circularity model results snapshot

14 Note, this rate does not relate to cardboard that is already diverted through recycling.

Commodity	Amount in Disposal (Tons)	Prevention Rate	Prevented (Tons)	Reuse Rate	Reuse (Tons)	Recycle Rate	Recycle Tons	Overall Diversion Rate of Material
Cardboard	307,301	4%	12,292	4%	11,800	75%	212,406	69%
Expanded polystyrene (EPS)	35,232	60%	21,139	0%	0	40%	5,637	16%
Food Waste	863,291	15%	129,494	4%	29,352	60%	422,667	49%
Textiles	233,860	0%	233,860	15%	35,079	15%	29,817	13%

Circularity Gap Model Results and Next Steps

The circularity gap model estimates that up to 2 million tons, or 35%, of total current MSW disposal (5.8 million tons) could be prevented or captured for reuse and recycling based on existing technologies and processes such as reuse and donation channels and MRFs and compost facilities (Figure 8). Figure 9 and Table 4 show a breakdown of the upstream and downstream impacts from the model. The model draws on the past to predict the future and historical investments have focused on downstream actions, weighting the model in that direction. As such, the largest impact on reducing MSW disposal according to the model comes from downstream activities such as commingled, drop-off and C&D recycling and organics recovery. The model attributes a much smaller diversion impact from upstream activities such as prevention and reuse. Model inputs are limited regarding upstream activity, as there is less available data. As described in Table 2, much of the prevention and reuse impacts in the model are coming from emergent markets which are estimated to divert 4% from the MSW disposal stream in the high model (ex: cardboard reuse and prevention results in 4% of cardboard diverted from MSW disposal). It is possible that the future results in a much larger impact than this. The goal is to periodically update the model to account for the dynamic landscape.

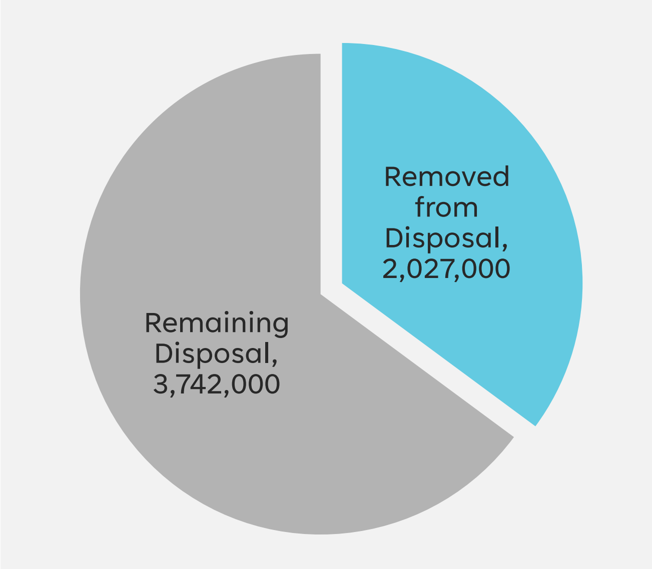
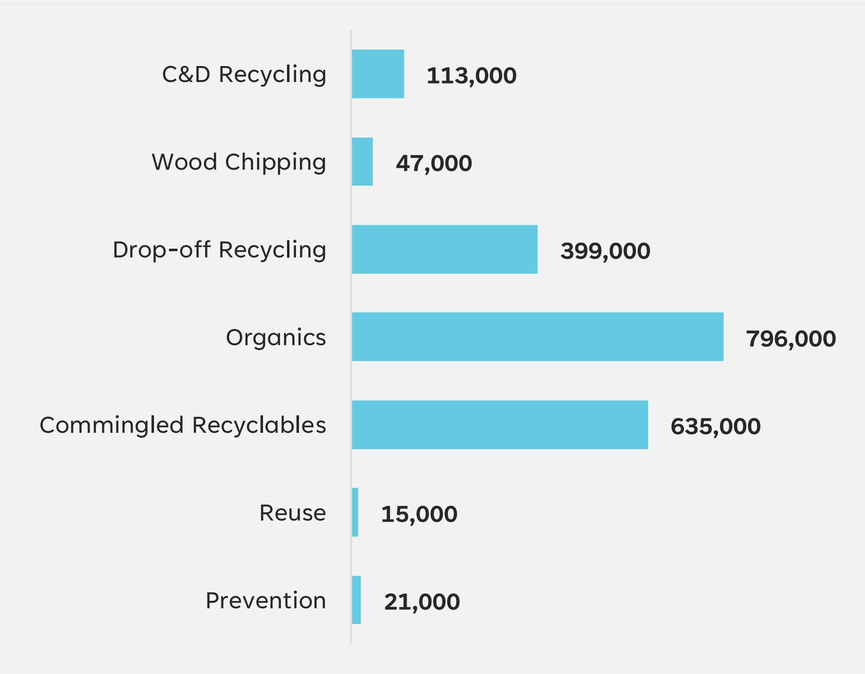


Figure 8. Breakdown of potential diversion from disposal (tons)



Diversion Category	Potential MSW Diversion
Prevention	21,000
Reuse	15,000
Commingled Recyclables	635,000
Organics	796,000
Drop-Off Recycling	399,000
Wood Chipping	47,000
C&D Recycling	113,000
Total Removed from Disposal	2,027,000
Remaining Disposal	3,742,000

Figure 9 and Table 4. Results of upstream-downstream circularity model potential diversion (tons)

Although the diversion data related to prevention and reuse are lacking, there are available data to show growing traction for upstream solutions through policy and market forces. For example:

- A 2022 survey from Trivium Packaging found that 74% of consumers expressed interest in buying products in refillable packaging (Trivium Packaging 2022).
- A 2020 survey from the Reusable Packaging Association found that 66% of respondents saw demand for reusable transport products (pallets, gaylords, dunnage, etc.) increase in the past 12 months, and that 95% of respondents felt that public concern for the environment would increase the demand for reusable transport products (Reusable Packaging Association 2020).
- According to the Upstream Policy Playbook several cities have adopted ordinances for restaurants to switch to reusable food ware and/or are requiring government events to include reusable options ("Roadmap to Reuse — Upstream | Sparking Innovative Solutions to Plastic Pollution" 2022).
- Reuse Seattle is supporting reuse businesses by launching pilots to support a shift to reusable cups and foodware in schools and venues. Over 20 sites have switched to reusables within the last 18 months ("The Reuse Seattle Partnerships" 2023).

The growing demand for reusable products is backed by the fact that 58% of the businesses and organizations participating in the NextCycle Washington program are focused on waste prevention and reuse. NextCycle Washington participants and partners such as Okapi Reusables, Encora, and Bold Reuse are demonstrating business models aimed at reusable food serviceware. Reuse models for durable goods are represented in NextCycle Washington as well, including South King Tool Library, GeerGarage and Community Gearbox. A full list of NextCycle Washington participants can be found here.

Diversion Access Gaps

The foundation of successful diversion is access to a variety of publicly and privately operated programs. These programs must be available to all residents, convenient to use, and communicated effectively to bring awareness to the effort. This section examines the availability of recovery programs for residents throughout the state and identifies gaps in access that limit diversion opportunities for residents, businesses, and institutions.

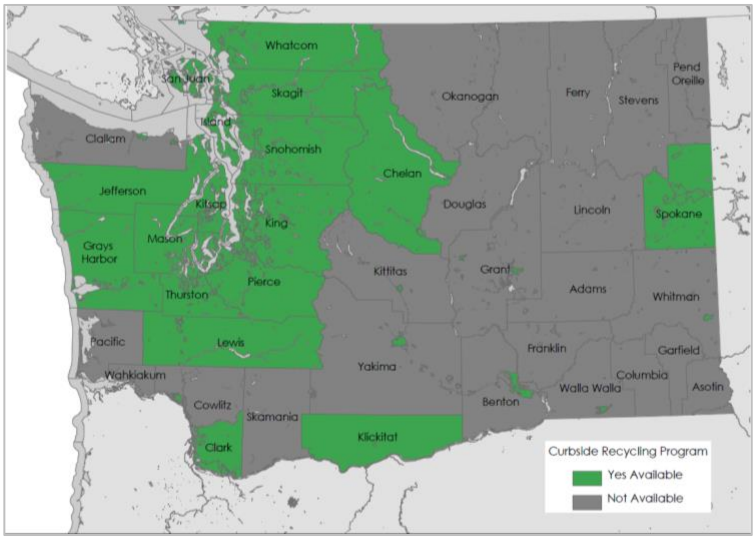


Figure 10. Curbside recycling access across Washington15

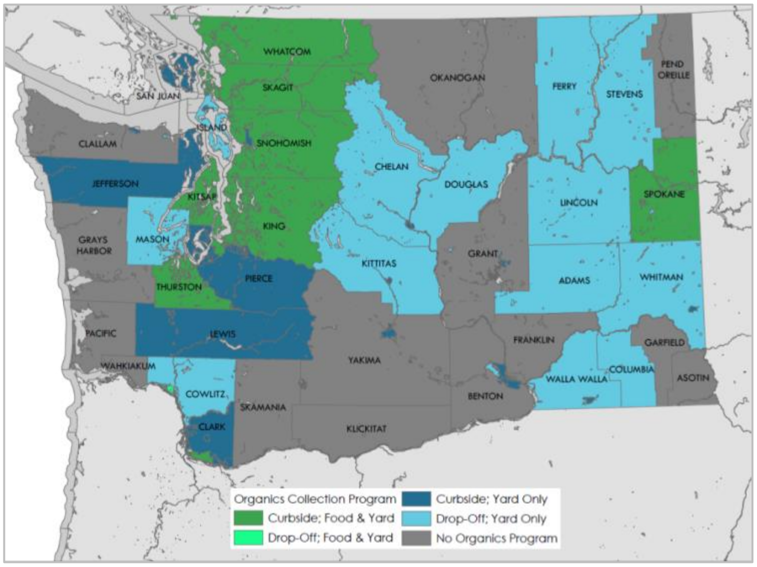


Figure 11. Curbside and drop-off organics recovery programs across Washington

Why Diversion Access For a Community Matters

Historically, capitalistic models posited a trade-off between environment, prosperity, and equity: pick two. Yet research has increasingly proven how small reorientations of our system can create beneficial ripple effects across all three capacities. One such example is material management.

Kinder Institute for Urban Research ascertains, "Where you live determines to a great extent how much access you have to quality education, health care, housing, public services, and more. More access correlates to better outcomes in life." Lack of quality public services, such as waste and material management (reduction, reuse/repair, and recycling), expose communities to heightened amounts of illegal dumping, litter, and sense of disorder. These activities increase feelings of stress and depressive symptoms, decrease sense of belonging, public health and affinity, and perpetuate other social and economic inequities (Razzaq et al. 2021; Gonyea et al. 2018; Begur et al. 2018).

Diversion Collection Access

Figure 10 and Figure 11[15] show the distribution of curbside recycling and organics recovery program access throughout Washington. Table 5 provides insight into that distribution with respect to population density. In general, access is concentrated near population centers such as Seattle,

15 Data on curbside recycling and curbside and drop-off organics programs is from Washington Department of Ecology, "State of Residential Recycling/Organics Collection in Washington Survey (2020)."

Spokane, and Vancouver. Urban areas, characterized by population densities greater than 3,000 people per square mile, have the highest level of access in the state. In these areas 98% of the urban population has access to curbside recycling and curbside or drop-off organics collection programs. Approximately 98% and 92% of residents in suburban areas (501 to 3,000 people per square mile) have access to curbside recycling and curbside or drop-off organics recovery programs, respectively. The level of access declines significantly in rural areas (fewer than 500 people per square mile) where only 66% of rural residents have access to curbside recycling, and 75% of rural residents have access to curbside or drop-off organics recovery programs.

Table 4. Overall access to curbside recycling and organics collection programs by population density

	Total Population	Average Population Per Square Mile	Total Population with Curbside Access	Proportion with Curbside Access	Population with Some Organics Access[16]	Proportion of Population with Organics Access
Rural	1,617,107	155	1,063,172	66%	1,208,500	75%
Suburban	2,106,059	1,635	1,877,934	89%	1,947,960	92%
Urban	3,963,174	7,656	3,889,439	98%	3,895,328	98%

While at first the data appear to display a divide in access to programs between urban and rural populations, a deeper dive into access compared to Census tract median incomes reveals another factor at play influencing diversion program access. Table 5 shows the average median income by quartile for the state. In the lowest quartile, the average household earns $48,677 whereas in the highest quartile, the average household earns $137,813 annually[17]. For reference, the median household income is $87,946.

Statewide, people living in tracts with a median income in the top quartile are 13 times more likely to have curbside recycling and 18.6 times more likely to have an organics collection program compared to those living in tracts with the median income in the bottom quartile.

Census Tract Quartile	Average Household Income by Quartile
Q1	$49,677
Q2	$71,058
Q3	$93,309
Q4	$137,813

Table 5. Average income in Washington

While clearly showing the degree to which higher income households are more likely to have access to diversion programs, the statewide analysis does not illuminate how much of this access divide is driven by population density. As shown above, urban areas have greater access to programs than rural areas and have a higher cost of living. When breaking the data down further into median income quartiles with rural, suburban, and urban divisions, however, a similar access disparity pattern by income emerges. For those living in rural tracts, income significantly predicts likelihood of program access: households with income levels above $100,000 annually (Q4) are 12.6 times more likely to have access to a curbside recycling program and 14.6 times more likely to have access to an organics collection program than households in the bottom quarter of median

16 Organics access includes curbside and drop-off programs and at minimum the inclusion of yard waste in the program.

17 US Census Bureau 2021 ACS 5-Year Estimate Household Median Income by Census Tract

income Q1. In suburban tracts, households in the top half of the income range, Q3 and Q4, are 15.6 times and 11.6 times more likely, respectively, to have access to curbside recycling and 9.6 times and 8.2 times more likely, respectively, to have access to an organics collection program than households in the lowest income quartile Q1. Even at the urban level, disparities in income correlate with access. Only three urban tracts in the top half of household incomes lack access to curbside recycling while 13 urban tracts in the bottom quarter lack access to curbside recycling. Similarly, only two urban tracts in the top half of household income lack access in an organics program while 12 urban tracts lack access in the bottom quarter. Figure 12 shows the likelihood of access compared to Q1 statewide, and for rural, urban, and suburban Census tracts. Figures 13 and 14 show the distribution of access for rural, suburban, and urban regions relative to the state's median income.

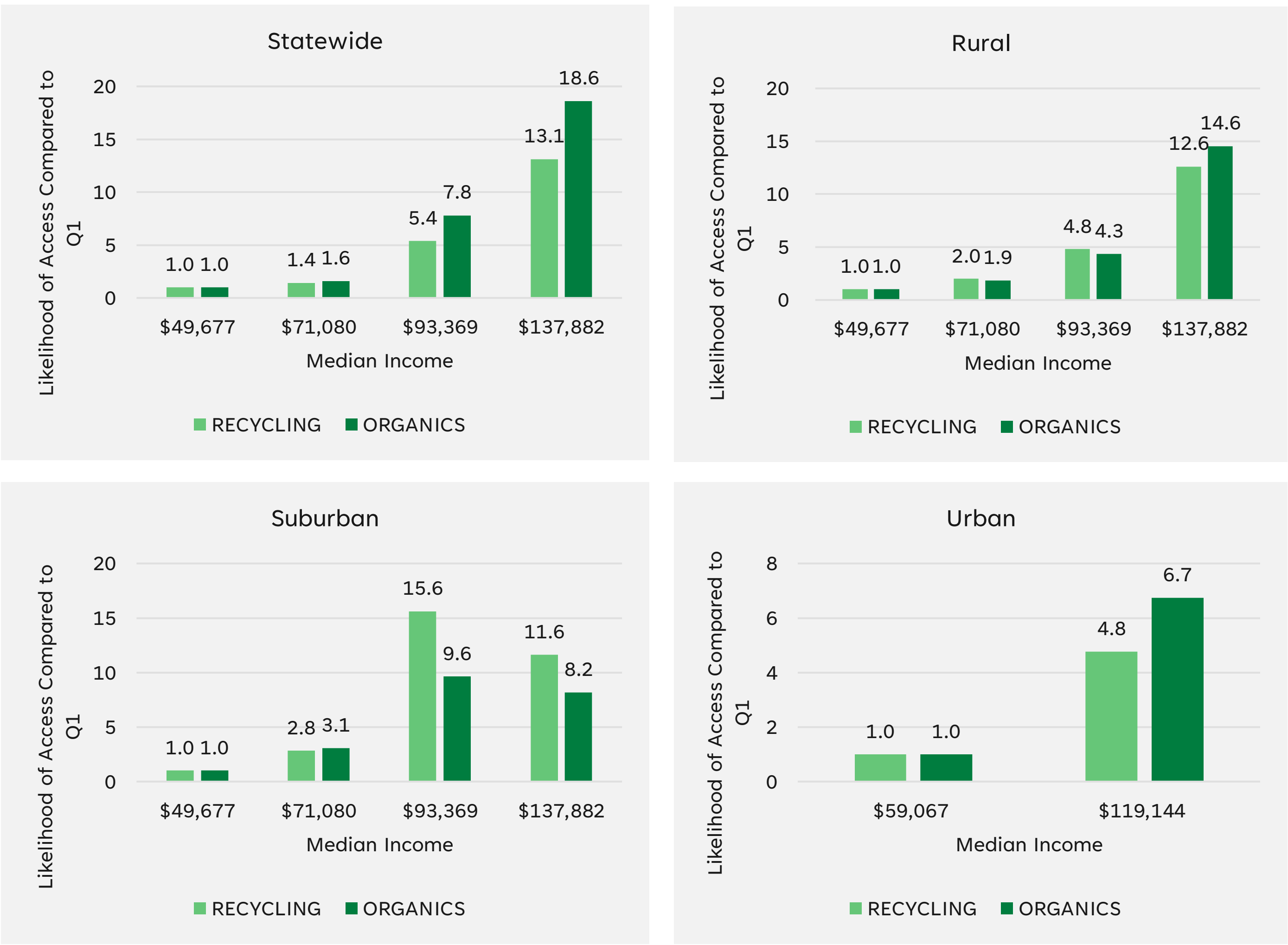


Figure 12. Statewide likelihood of access to programs compared to Quartile 1 (Q1)[18]

18 Note: The Urban analysis shows only the top and bottom half quartiles because there are so few Census tracts in the top two quartiles without program access.

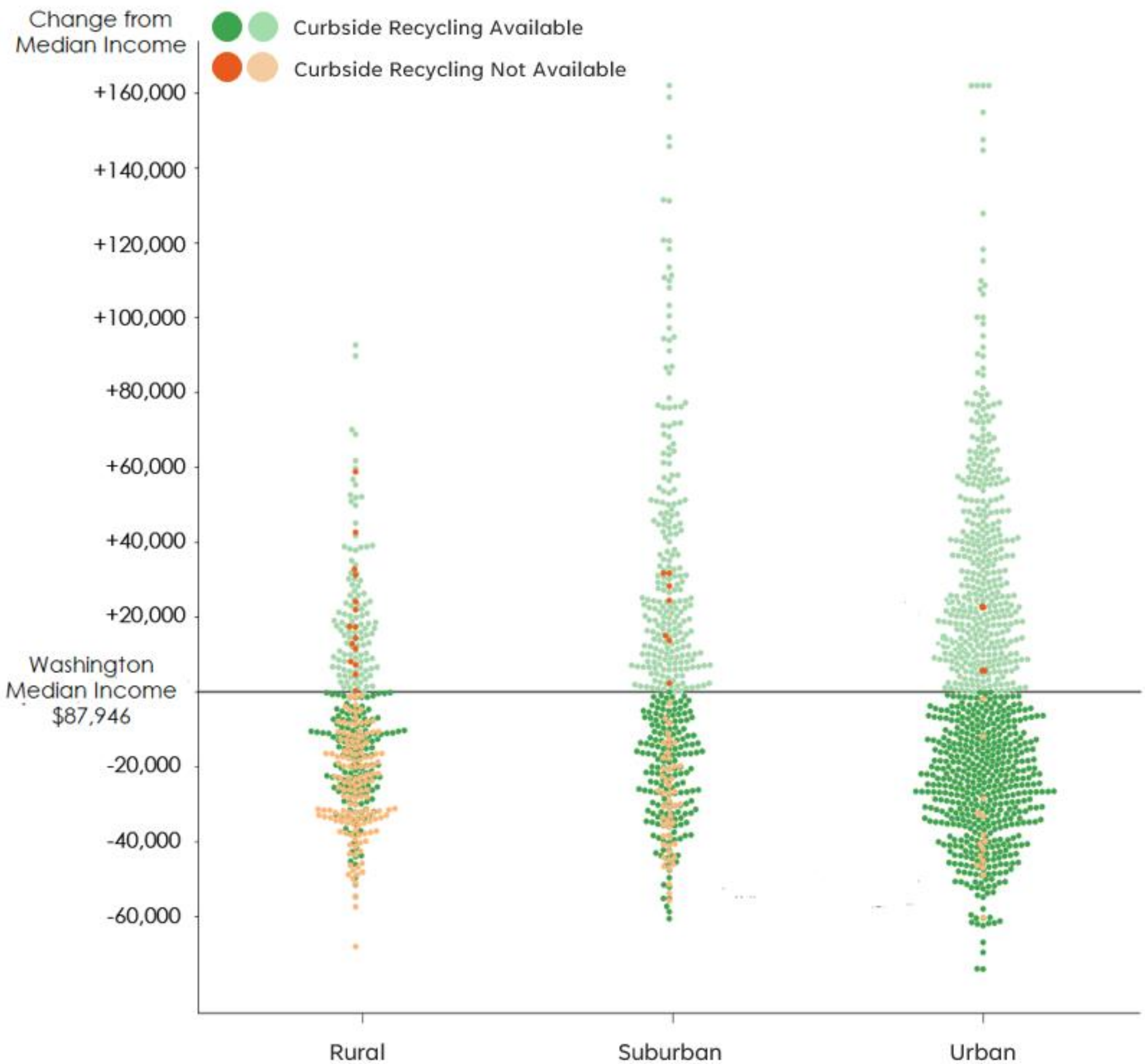


Figure 13. Total tract curbside recycling access compared to median income

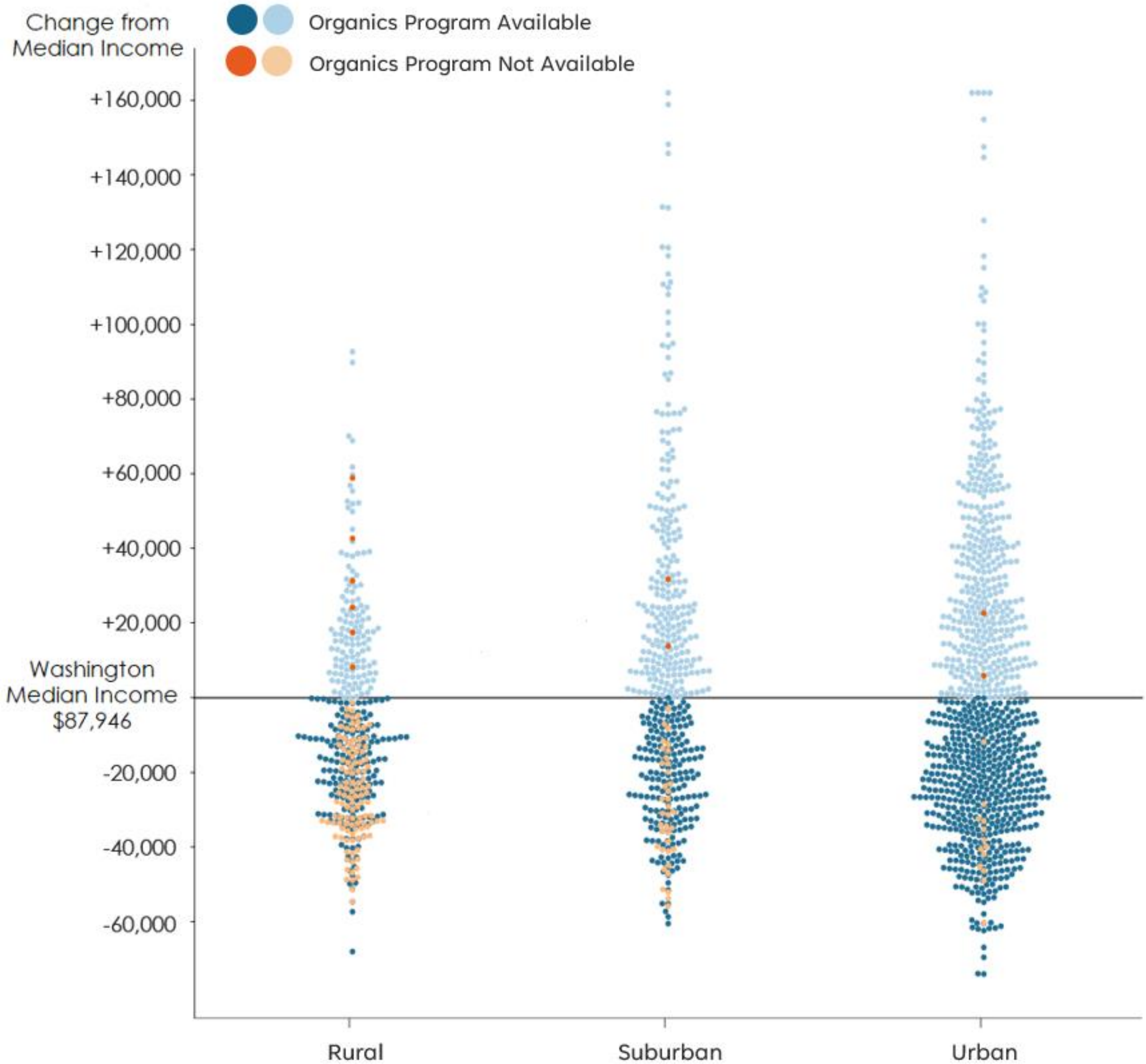


Figure 14. Total tract organics access compared to median income

Impact of Diversion Access Gap on MSW Disposal

When considering program access gaps in the circular economy and opportunities to create value from materials that are currently moving through the linear economy towards disposal it is important to consider geography as well as population. In most instances the places where materials are generated and disposed of influence the available opportunities. Materials generated in rural areas far from recovery infrastructure such as MRFs, organics processing facilities and end markets, present different gaps and opportunities than materials generated in densely populated areas that are closer to service providers and end markets. As shown in the above analysis, the economics of curbside service may be much more challenging in a rural, low-population density scenario, but convenient drop off networks linked to hub and spoke systems could present a viable solution. This is the approach developed by the NextCycle Washington participants the Glass Packaging Institute (GPI) and Beverage Industry Glass (B.I.G.) Recyclers to advance glass recycling in Central and Eastern Washington.

Scale is a factor in the recovery equation as well. The scale of opportunities is different in geographies that generate less materials or have less available space to handle and process. Furthermore, even places that have access have room to improve. NextCycle Washington participant Restaurant 2 Garden, for example, is developing a composting business in a very small but densely populated geography in the Seattle Chinatown-International-District. Their site is small and is nested within the community that it serves. The city has curbside organics service access, but, according to the organization’s founders, 30% of food scraps continue to move towards disposal. This can be explained in part by a behavioral gap, where the city carts are not being fully, or properly, utilized. The Restaurant 2 Garden model relies on close community and cultural ties to educate and improve diversion behavior from restaurants to feed their community-scale compost operation. To move the circular economy forward solutions are needed at all scales in all geographies and designed to meet culturally appropriate needs in the communities where they are sited and to whom they serve.

Table 7 breaks MSW disposal data down by six “waste generation regions.” It shows the percentage of the population within the region with curbside recycling access, and the per capita disposal rate by region (regions are shown in Figure 15). In general, total disposal can be somewhat explained by population. The two most populated regions, Puget Sound and East Washington, correspondingly have the highest total MSW disposal. Likewise, the smallest region by population, West Washington, has the smallest total MSW disposal. However, there are nuances related to reuse, recycling, and compost service access that also have a significant impact on the gaps and opportunities within a given geography and impact the disposal rates. For example, the Central Washington region has the third highest total MSW disposed but has a smaller population than the third most populous Southwest Washington region. Part of this can be explained by the fact that Central Washington has the lowest percent access to curbside recycling at 41% and the highest per capita disposal of all regions.

Table 6. Population, total MSW disposal (2021), curbside access, and per capita disposal by waste generation regions

Region	Population	Total Disposal (Tons)	Total Recycled (Tons)[19]	Percent of Population with Curbside Recycling Access	Per Capita Disposal (Lbs./ Person/ Year)	Per Capita Recycling (Lbs./ Person/ Year)
Northwest	461,015	373,033	261,857	100%	1,618	1,136
Puget Sound	4,589,166	2,955,277	2,241,407	100%	1,288	977
Southwest	712,648	561,549	303,988	88%	1,576	853
East	1,080,554	939,768	390,136	67%	1,739	722
West	274,859	196,470	83,059	72%	1,430	604
Central	587,039	742,502	161,675	41%	2,530	551
Total / Average	**7,705,281**	**5,768,599**	**3,442,122**	**78%**	**1,697**	**807**

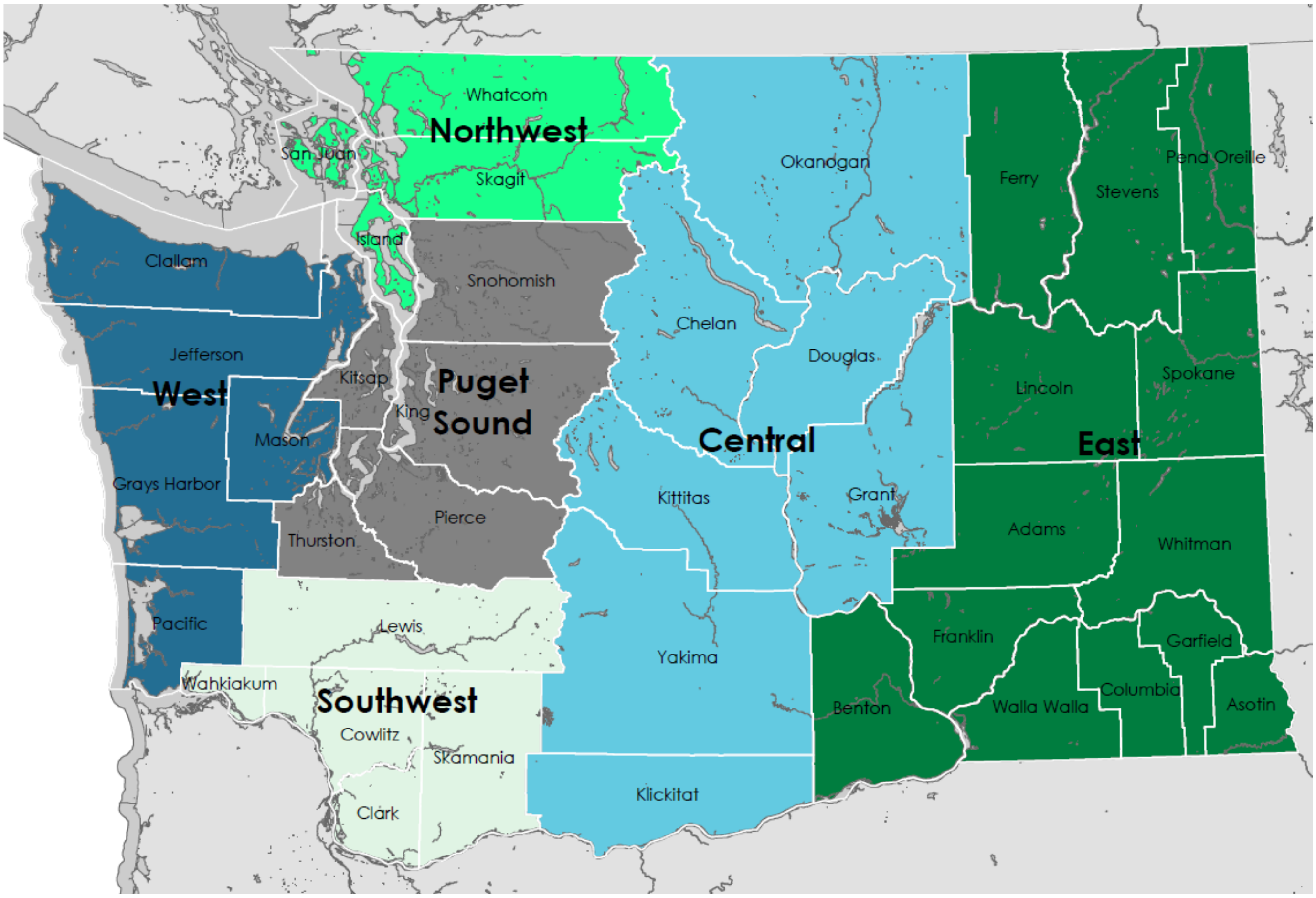


Figure 15. Map of Washington waste generation regions

19 Total recycled includes commingled recycling, source separated, and organics and excludes C&D, industrial, and agricultural diversion.

While curbside recycling access cannot completely explain differences in per capita disposal by region there is a connection. For example, on average, residents with access to curbside recycling in Washington generate 319 more pounds of waste annually than residents without curbside access, and yet they dispose of 333 fewer pounds. When considering comingled, source separated and organic materials, the diversion rate on average per capita is 40% for areas with curbside recycling access and 20% per capita for areas without. Residents living in areas with diversion program access recycle 290 pounds per capita of commingled recyclables, 488 pounds per capita of source separated recyclables, and recover 376 pounds per capita of organics annually. Comparing this to residents living in areas without curbside recycling access only 50 pounds per capita of commingled recyclables, 333 pounds per capita of source separated recyclables, and 119 pounds per capita of organics are recovered (Table 8 and Figure 16).

	Curbside Recycling Available	Curbside Recycling Not Available
Disposal	1,739	2,072
Comingled Recycling	290	50
Source Separated Recycling	488	333
Organics Recycling	376	119
Generation	2,893	2,574
Percent Diversion	40%	20$

Table 7. Per Capita Generation and Recovery by Availability of Curbside Recycling Programs (Lbs./Person/Year)

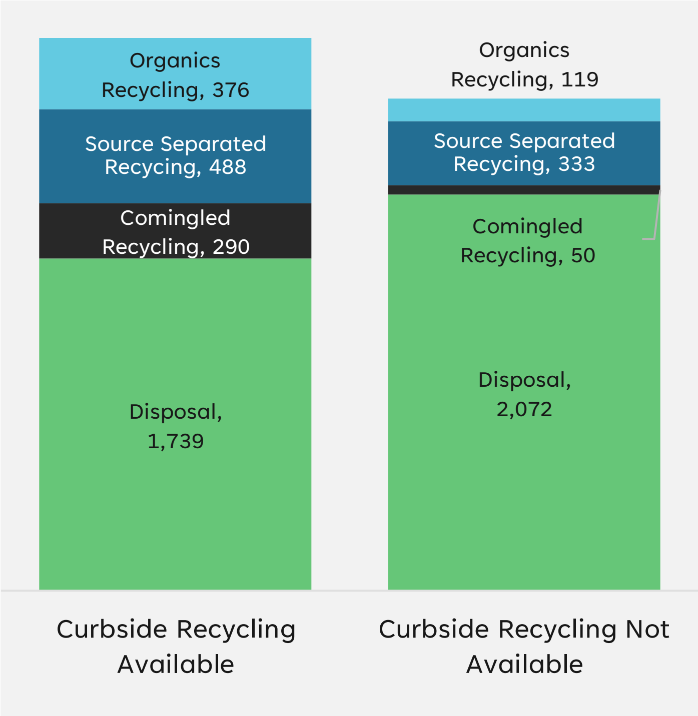


Figure 16. Average waste generation per capita for communities with and without curbside recycling access (lbs./person/year)

An analysis of the percentage of the population with curbside access compared to per capita disposal finds a reasonably strong positive correlation between the two variables (R-value 0.7). This indicates that as a region's access to curbside recycling increases, generally per capita disposal rates decline (Figure 17). For example, as shown in Table 7, both the Puget Sound and the Northwest regions of the state have 100% access to curbside recycling. On average those regions have a per capita disposal rate significantly lower than the Central region, where only 40% of the population has curbside recycling access. Puget Sound and the Northwest regions also recycle the most per capita at 977 and 1,136 pounds per person per year respectively compared to the Central region's per capita recycling rate of 551 pounds per person per year.

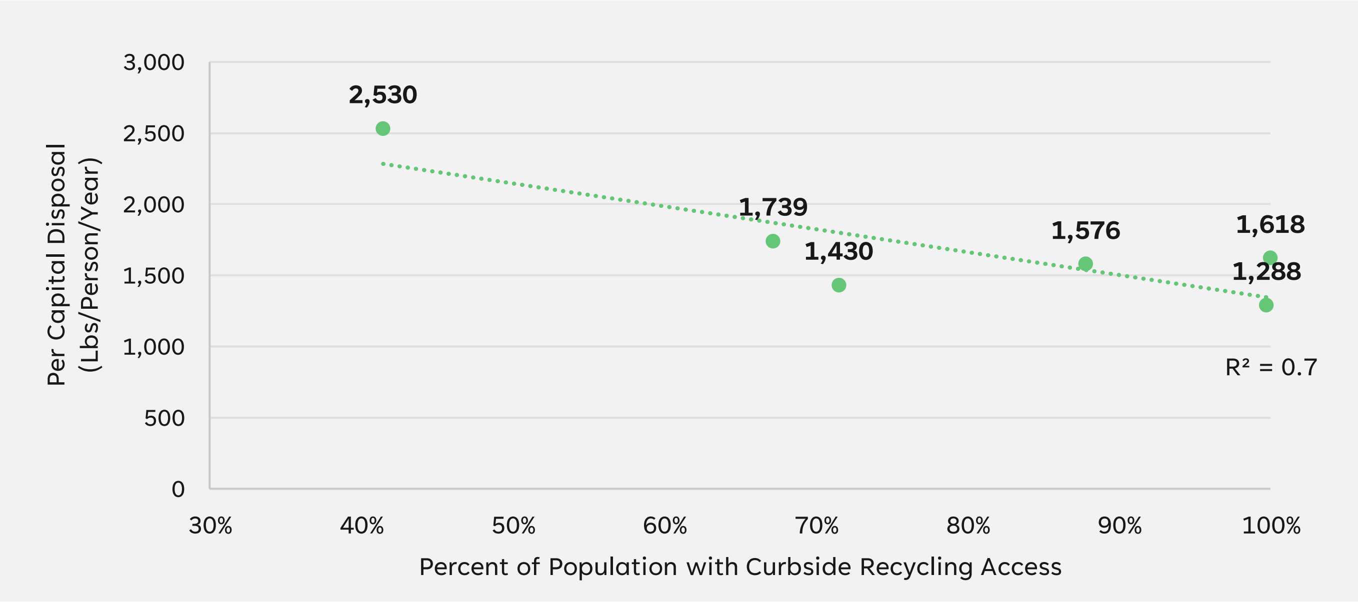


Figure 17. Correlation between per capita disposal and proportion of population with curbside recycling access

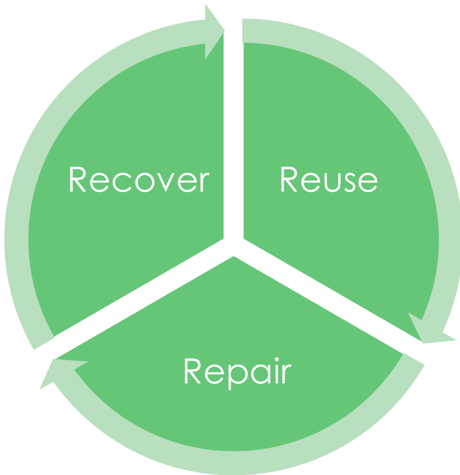
While the analysis presented above relies on relating disposal per capita to curbside recycling access, access to other diversion programs are also important such as drop-off, organics recovery and the presence of reuse options. As mentioned earlier in this section, drop-off recycling programs can be vital for rural regions where curbside recycling programs are not available. However, data on drop-off program availability were not available for this study. Areas with curbside recycling access collect more pounds per person annually of source separated materials, which are traditionally collected via drop-off, than areas without curbside recycling services (Figure 16). This suggests that there may be true areas of haves and have nots within Washington for diversion program access – populations lacking curbside access are lacking other convenient diversion opportunities as well.

Lack of access has been identified as a main driver behind why rural residents do not recycle. A 2022 survey of residents in a rural county of Michigan, for example, found that nearly two-thirds of residents did not recycle simply because the services were not available to them. Another 16% indicated they did not know how to recycle or if those programs were available, and less than 10% indicated they did not believe in the impacts of recycling. The survey also found that three-quarters of residents were willing to pay a fee for recycling services in their area[20]. After surveying their residents, the county began pursuing recycling program options for their residents. For reference, the median household income of the rural Michigan county is about $44,000[21]. This type of research could be helpful in Washington.

20 The survey was conducted as part of a Michigan Materials Management County Engagement Grant: https://www.michigan.gov/egle/about/organization/materials-management/solid-waste/planning/materials-management-engagement-grants.

21 US Census Bureau 2021 ACS 5-Year Estimate Household Median Income

Infrastructure Gaps



In a circular economy there are upstream and downstream approaches to diverting waste from disposal, capturing value, and keeping material in use longer. Most of these solutions require infrastructure. Upstream infrastructure includes repair and reuse centers, tool libraries, thrift stores, product remanufacturers, wash plants, and food banks. Downstream infrastructure includes drop off centers, sorting and processing facilities such as MRFs and compost sites, secondary processing sites such as plastic reclaimers and glass beneficiators, and end markets such as paper mills, plastic packaging manufacturers, metal foundries, and glass bottle manufacturers. In an optimized system, upstream and downstream infrastructure work in conjunction so that each material can achieve its highest and best use. That which can be repaired, rescued, or reused is directed to upstream facilities to enable recirculation, while material that is truly at the end of its useful life is sent to downstream facilities for processing into an input for new products.

To move Washington towards a circular economy, investment in both upstream and downstream infrastructure is needed at varied scales and geographies. Large, centralized operations are important for driving macro impacts and diverting large amounts of material using economies of scale. Community scale infrastructure is needed to provide equitable access and improve engagement from communities often marginalized by centralized operations.

Upstream Infrastructure

The NextCycle Washington program and stakeholder engagement process has highlighted the value of waste prevention, reuse, and repair activities to community building and resiliency. The theme is explored in depth in the NextCycle Washington risk-resiliency report which is a complement to this report. Figure 18 shows an excerpt from the risk-resiliency report which maps community-focused circular economy initiatives around reuse and repair overtop areas of high risk. This demonstrates that NextCycle Washington investments are generally focused on areas of greatest risk with the potential to add resiliency to these areas. To build upon the connection with upstream investments and community resiliency, additional research should be conducted to methodically measure prevention and reuse activities and outcomes, establish pathways to scale upstream projects statewide, and improve the tracking of associated environmental, social, and economic benefits.

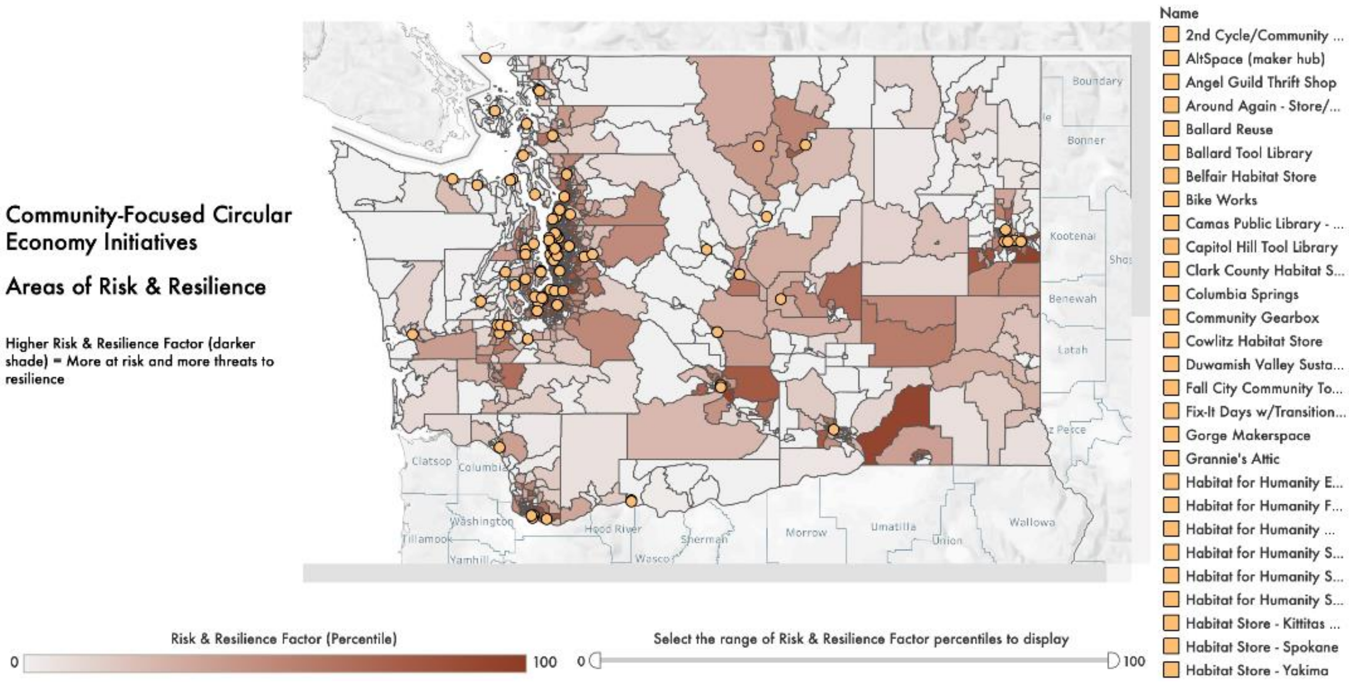


Figure 18. Community-Focused Circular Economy Initiatives and Areas of Risk & Resilience by census tract

Available data for reuse facilities include sites focusing on specific products, such as bicycles, building materials, electronics, home goods, tool libraries, food service packaging, and clothing resale. Reuse infrastructure is generally established around the major population centers in Washington, with a broader distribution of construction material reuse statewide (Figure 19)[22]. Figure 20 shows the total count distribution of reuse activities occurring in Washington.

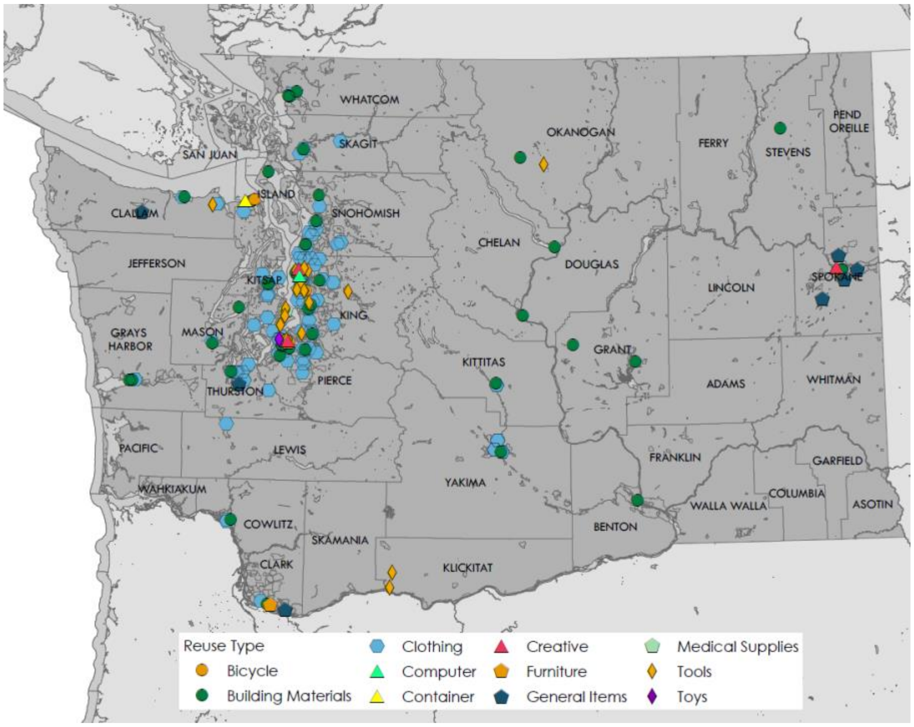


Figure 19. Map of reuse facilities in Washington

22 There are many instances where reuse is taking place informally. This data set is inherently incomplete and will require continued primary research to capture a more accurate and exhaustive picture.

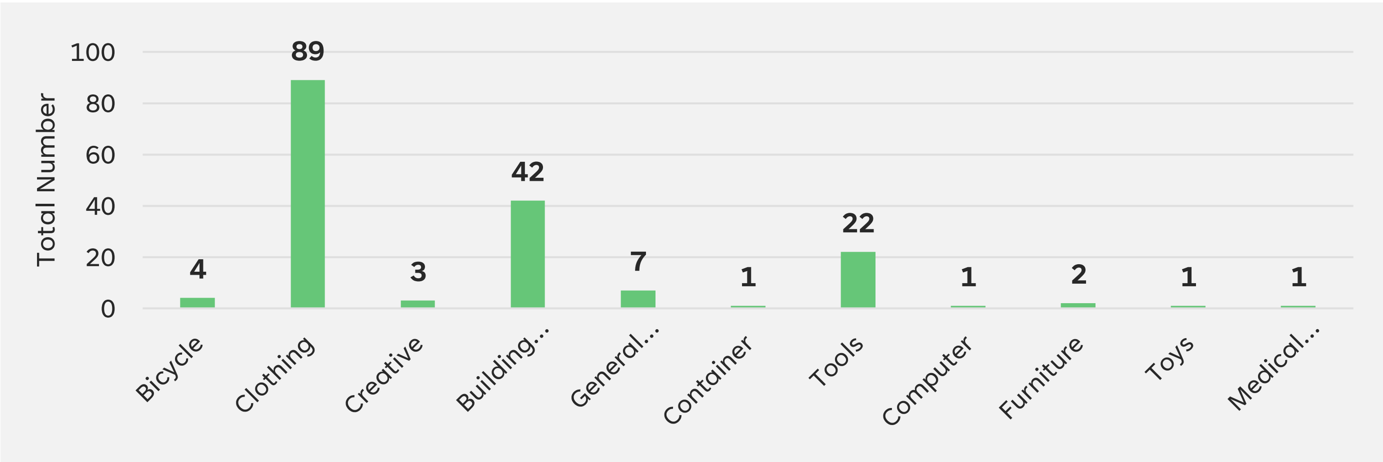


Figure 20. Chart of reuse facilities by type in Washington

An emerging reuse activity involves replacing single use food service cups and containers with reusable options. NextCycle partner Reuse Seattle has targeted this intervention for venues and schools in Seattle and has helped over 25 sites transition to reusables in its first 18 months (Figure 21; Reuse Seattle Interactive Map). Available data is limited statewide, however this trend is further supported by the growth of NextCycle participants OKAPI Reusables and Encora, who are expanding their efforts into the State as well.

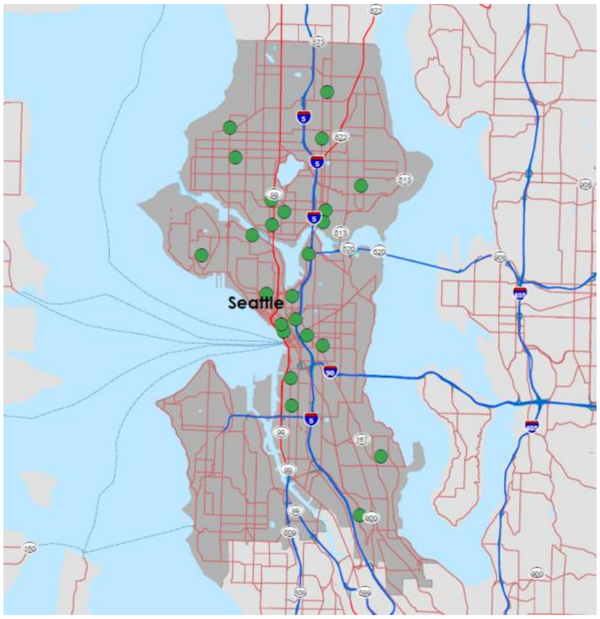
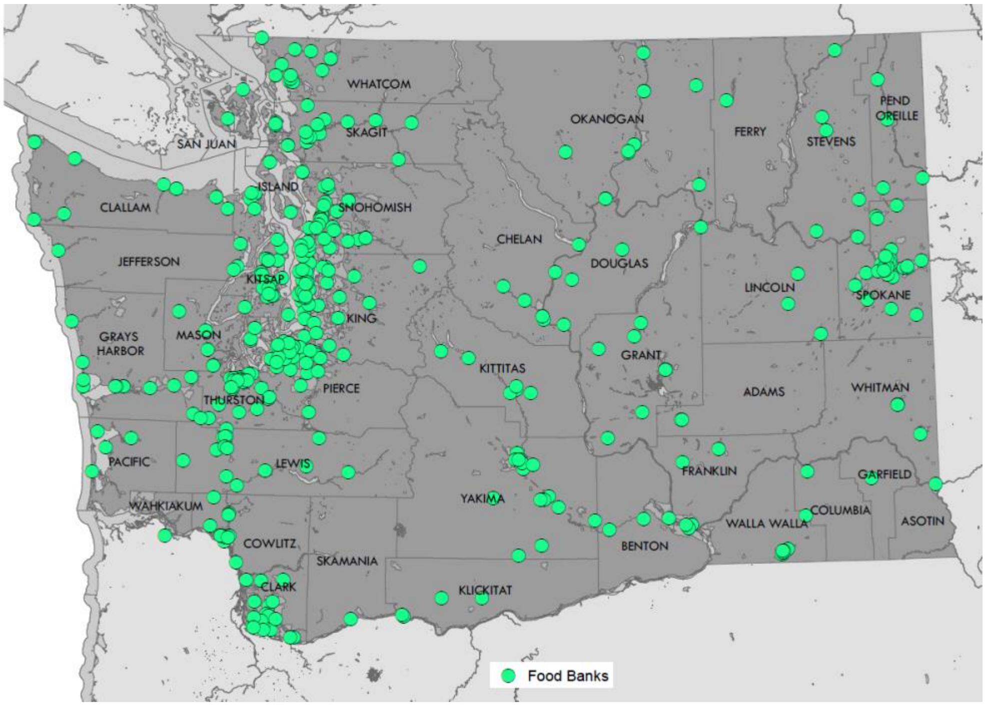


Figure 21. Reuse Seattle map

Food rescue facilities such as food banks represent incredible promise for addressing multiple significant problems simultaneously. Washington Department of Ecology data suggests that 45%[23] of food waste is edible, while, according to Feeding Washington, one in ten people in the state are food insecure (Feeding Washington 2023). Food rescue operations are the key to connecting those facing hunger with edible food that would otherwise be wasted. Figure 22 presents a Map of Food banks in Washington. These facilities are distributed broadly across the state, however there is an opportunity to greatly improve this system to help the state meet its goal of reducing food waste generation by 50% by 2030, through the Use Food Well Washington Plan (Washington State Department of Ecology 2022)
According to ReFED "A stronger food rescue system requires expanded storage, transportation, and staffing capacity within food rescue organizations – as well as a consistent flow of goods from food business donations, which can be achieved from implementing solutions like business education or coordination and matching technologies that make food donation easier" ("Strengthen Food Rescue - ReFED, Inc. - Food Waste Organization" 2022)

23 480,000 lbs. in 2018, which is the most recent study.

Figure 22. Food banks in Washington[24]



As Washington works towards a more inclusive circular economy, it is critical to collect quantitative and qualitative data measuring progress in prevention, reuse, and recovery programs. Data collection should include basic information such as tons of disposal prevented or diverted, along with data on community health such as jobs created and greenhouse gas reduction. Areas of data gaps include quantitative data around the impact of prevention and reuse programs, bulky materials that are difficult to measure through traditional waste sorts, and direct business to business diversion activities that are not reported to Ecology.

Downstream Processing Infrastructure Gaps

Historically, investment in downstream infrastructure occurs at a large, centralized scale with significant public and/or private investment in capital expense for construction, engineering, design, and equipment procurement. In Washington, most municipal solid waste landfills and transfer stations are owned and operated by public sector entities[25], while most downstream recovery infrastructure like MRFs and compost facilities are owned and operated by private sector companies[26].

Figure 23 shows downstream infrastructure across Washington. MRFs and compost sites that accept post-consumer waste are predominantly concentrated near major population centers such as Seattle, Tacoma, Olympia, Spokane, and Vancouver and more likely to be in low-income census tracts. Landfills and compost facilities that do not accept post-consumer food scraps are more dispersed across the state.

---

24 Data from Washington State Department of Agriculture https://agr.wa.gov/services/food-access/access-food-near-you.

25 79% of the operating municipal solid waste landfills in Washington are publicly owned, and 62% of the operating transfer stations are publicly owned according to data from Washington Department of Ecology.

26 All single stream MRFs in Washington are privately owned, and 70% of operating compost facilities are privately owned according to data from Washington Department of Ecology.

A critical connection for rural areas are transfer stations, shown as squares in the map below. Transfer stations can be established to transfer trash, recycling, organics, or multiple materials to their destinations. Recovery of materials, such as cardboard, can take place in transfer stations as well.

The extent of success in developing downstream recovery infrastructure to date has relied on ensuring that the economic structure of these models are self-sustaining, if not profitable. This system, therefore, favors conditions that allow for economies of scale and optimal efficiency. As a result, infrastructure generally emerges in areas within or adjacent to dense population, leaving more sparsely populated areas without proximate post-consumer recovery infrastructure. This adds system costs to servicing these communities and contributes to access gaps. In this sense one can consider that infrastructure gaps exacerbate access gaps and efforts to close such gaps in infrastructure should always include a combined approach at a range of scales. For example, where possible, a well-established hub and spoke network has the potential to bring material from rural areas to processing hubs that otherwise would not generate materials at a scale to support the cost of handling and transport.

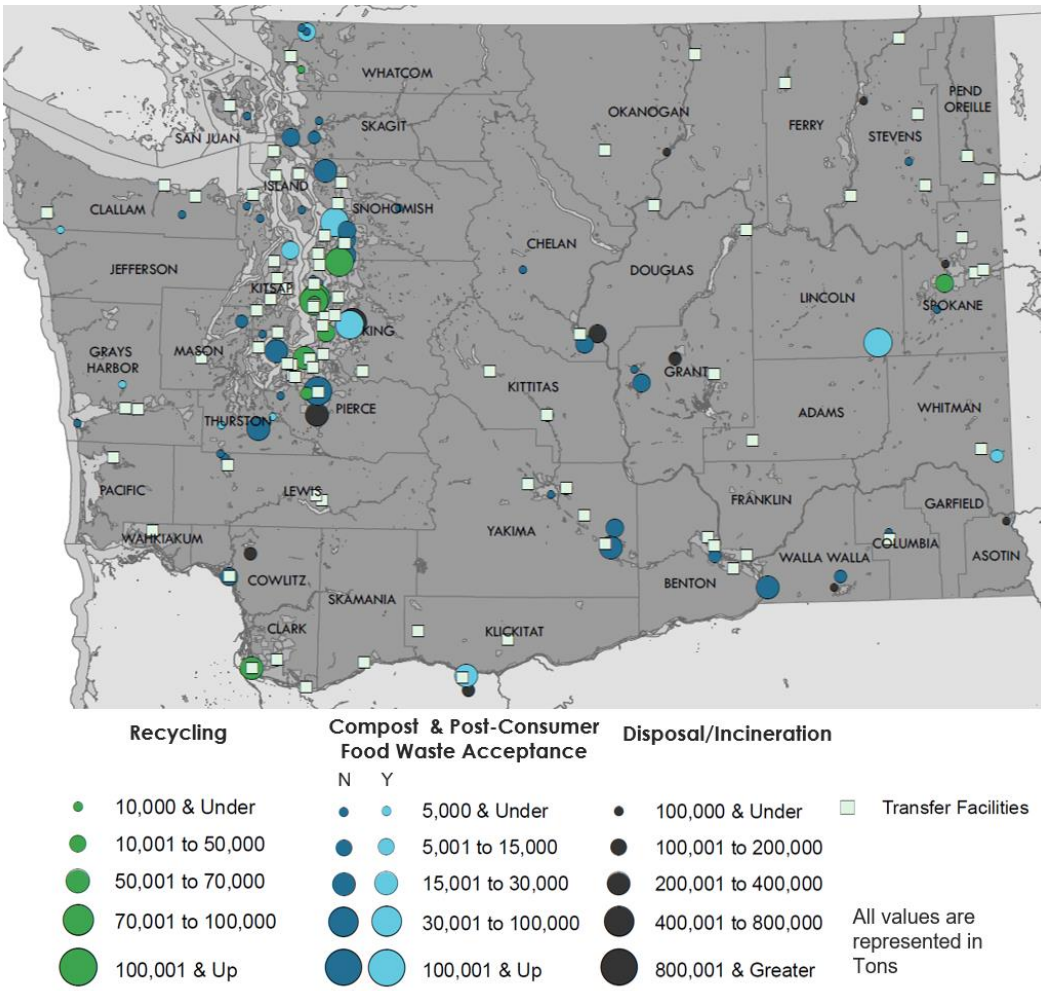


Figure 23. Map of downstream processing infrastructure in Washington[27]

27 An MSW incinerator not shown on the map is present in Spokane and processes between 15,000 to 30,000 tons of MSW annually.

MATERIAL RECOVERY FACILITIES

The circularity gap model estimates that an additional 635,400 tons of commingled recyclables could be collected across Washington. The material category with the biggest diversion potential from MSW is paper at 409,200 additional tons, followed by plastics at 118,200 tons. Table 9 and Figure 24 show the potential additional tons by sector and commodity, along with detailed examples of the specific targeted commodities.

Table 8. Potential Additional Commingled Recyclables for MRF Processing (Tons)[28]

MRF Material Categories	Material Examples	Residential	Commercial	Self-Haul	Total	Percent Total
Plastic	PET, HDPE, PP, and Rigid PS Bottles and Jugs	72,000	35,100	11,000	118,200	19%
Paper	Newspaper, Cardboard, Mixed Paper, Cartons	168,700	155,500	84,900	409,200	64%
Metal	Aluminum and Steel Cans	32,200	12,900	3,100	48,300	8%
Glass	Glass Containers	44,900	10,100	4,800	59,800	9%
Total		**317,900**	**213,600**	**103,900**	**635,400**	100%

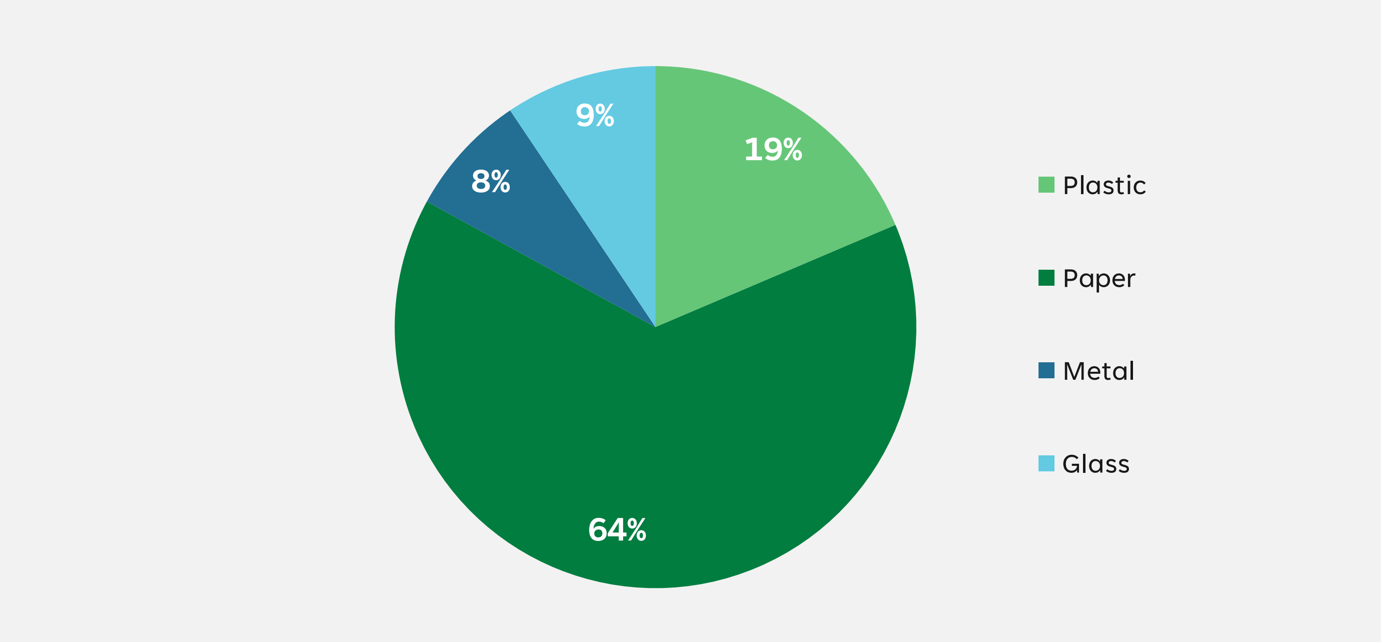


Figure 24. Additional commingled recyclables for MRF processing (tons)

28 The potential additional recycling data is tons diverted from estimate composition of the 2021 MSW disposal data.

Table 10 presents a potential scenario for handling the additional commingled recyclables using a traditional approach of centralized MRFs. It suggests up to eight MRFs would be needed to process the potential additional diverted material, assuming none of the MRFs currently operating in Washington could absorb additional tons. The Circularity Gap Model proposes a strategy to distribute additional MRFs across the state's regions except for the West Washington region where a transfer station for recyclables may be more appropriate given the volumes available for capture. Each of these eight MRFs would require approximately 82,000 tons per year processing capacity per facility utilizing modern sorting technology. The estimated total capital expense for eight additional MRFs is $216 million, and the annual operating costs are estimated at $53.69 million, including an offset from recyclable revenue at $40 per ton on average[29]. It may be possible that existing MRF infrastructure could add capacity through facility upgrades or adding shifts. If present day MRFs could absorb additional tons, the total investment needed may be reduced. The state of Washington should work with local MRF operators to understand what processing levels are possible with today's infrastructure. It is also unclear the extent to which small scale sorting operations such as the system that NextCycle team WasteExperts has developed can contribute to this processing need. A combination of large-scale and small-scale solutions will be needed to meet the potential demand and access related to increased diversion of comingled recyclables.

Table 9. Estimated additional MRF processing capacity needed

Region	Number of MRFs	Capital Expenses	Annual Operating Expense
East	1	$27,000,000	$6,710,000
Central	1	$27,000,000	$6,710,000
West	0	NA	NA
Puget Sound	4	$108,000,000	$26,850,000
Northwest	1	$27,000,000	$6,710,000
Southwest	1	$27,000,000	$6,710,000
Total	8	$216,000,000	$53,690,000

ORGANICS FACILITIES

Organic waste including food and yard waste, compostable paper and plastic, manure, and wood waste encompasses the largest diversion potential for Washington, with a particular opportunity to capture food waste. The state of Washington has fewer than 60 composting facilities of which 12 accept post-consumer food waste. Less than 5% (48,304 tons) of total organics processed at Washington compost facilities was post-consumer food waste[30]. To reach the state's zero waste goals, another 392,600 tons of food waste would need to be captured and processed (Table 11 and Figure 25).

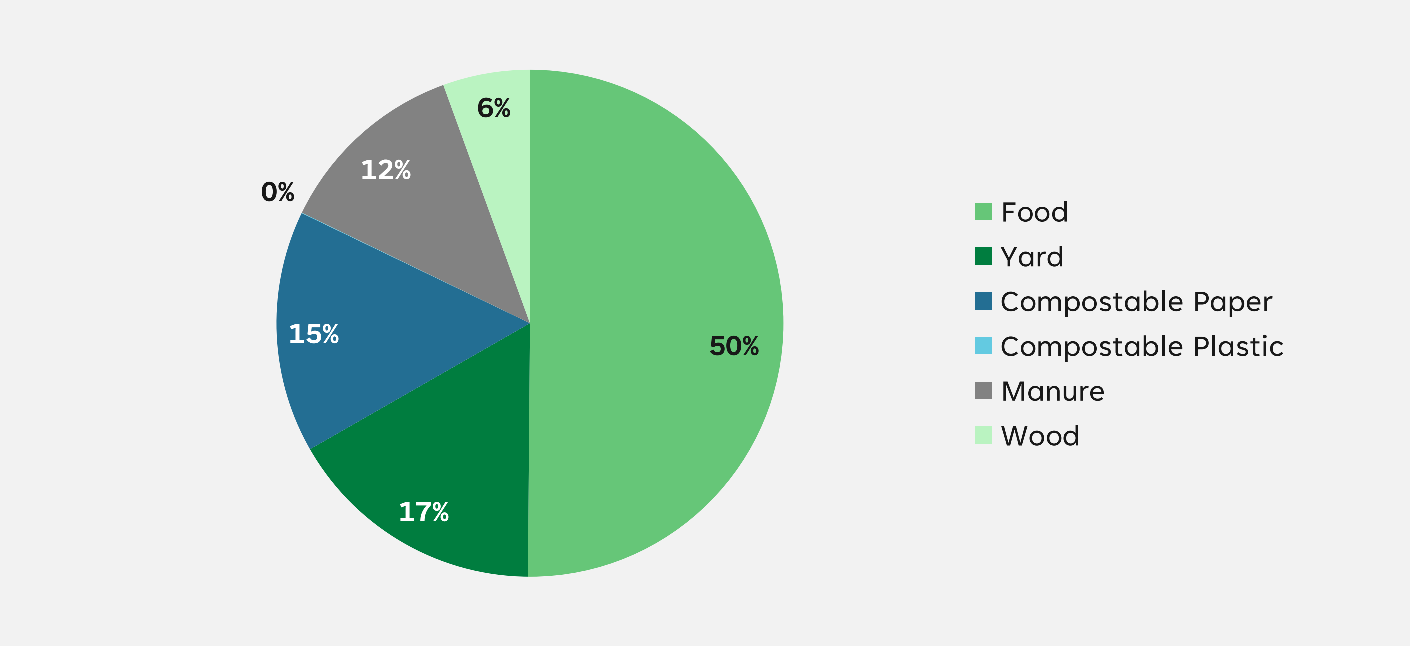
29 Median 5-year value of a ton of sorted and marketed comingled recyclables based on typical composition.

30 Estimation based on Ecology's Washington State Composted Materials for 2021 report: https://ecology.wa.gov/Waste-Toxics/Reducing-recycling-waste/Waste-reduction-programs/Organic-materials/Managing-organics-compost

Table 10. Additional organics collection (tons)

Organics Material Categories	Material Examples	Residential	Commercial	Self-Haul	Total	Percent Total
Food	Edible and Inedible	231,400	127,600	33,600	392,600	50%
Yard	Yard and Green Waste	61,400	16,800	53,800	132,000	17%
Compostable Paper	Tissues, napkins, uncoated paper products	71,300	43,800	6,200	121,300	15%
Compostable Plastic	PLA Compostable Packaging	200	0	0	300	0%
Manure	Animal manures and soiled bedding	86,500	5,000	6,200	97,700	12%
Wood	Natural wood, pallets, untreated wood, sawdust	5,400	16,700	21,400	43,500	6%
Total		**456,100**	**210,000**	**121,200**	**787,300**	**100%**

Figure 25. Breakdown of additional organics collection



Using a traditional scenario of large, centralized composting, approximately 24 additional processing facilities at 30,000 tons per year spread across each region of the state would be needed (Table 12). The estimated total capital expense is $182 million, and the annual operating expenses are estimated at $26 million. As with MRF infrastructure, it is unknown if current infrastructure can process additional material including food waste which may require new permitting and system and technology upgrades. Similarly, the Washington Department of Ecology should work with local organics facility operators to understand what processing levels are possible with today's infrastructure. It is also unclear the full extent to which small scale compost operations can contribute, like NextCycle Washington teams Restaurant 2 Garden, Leaping Sheep Farms, or Point Roberts Organics. As with comingled recyclable sorting, a combination of large-scale and community scale infrastructure is needed. Composting large amounts of food waste typically requires a bulking agent that can come from chipped wood waste. Table 13 estimates potential capture of wood waste and the processing cost of chipping the wood waste for incorporation into organics processing.

Table 11. Additional organics facilities capital and operating expenses

Region	Medium Sites	Capital Expense	Annual Operating Expense
East	4	$28,000,000	$4,000,000
Central	3	$21,000,000	$3,000,000
West	1	$7,000,000	$1,000,000
Puget Sound	15	$105,000,000	$15,000,000
Northwest	1	$7,000,000	$1,000,000
Southwest	2	$14,000,000	$2,000,000
Total	24	$182,000,000	$26,000,000

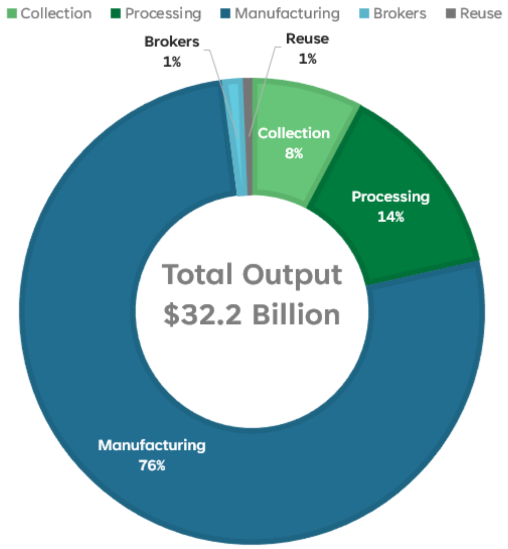
Table 12. Additional wood estimated chipping costs for incorporation into organics processing

Region	Wood Tons	Total Estimated Cost
East	5,600	$1,180,000
Central	4,900	$1,040,000
West	1,500	$310,000
Puget Sound	22,600	$4,790,000
Northwest	4,000	$860,000
Southwest	43,500	$9,220,000
Total	82,100	$17,400,000

Secondary Processors and End Market Gaps

End markets are essential to a functioning recovery system and play an important economic role in Washington. Recovering 35% of the material in the waste stream is anticipated to add 75,000 jobs across the state, with three-quarters of the job growth occurring in manufacturing sectors such as glass beneficiators and manufacturers, paper mills, foundries and product manufacturers using recycled content (Figure 26[31]). Figure 27[32] shows known recycling end markets in Washington. This is likely incomplete due to the challenging nature of tracking all potential end markets across a state. Washington is particularly strong in paper mills and nonferrous and steel foundries, but lacks glass end markets in the state's central and eastern regions and does not have any post-consumer plastic reclaimers within its borders.

Figure 26. Breakdown of source for total additional economic output with 1.9M tons of additional



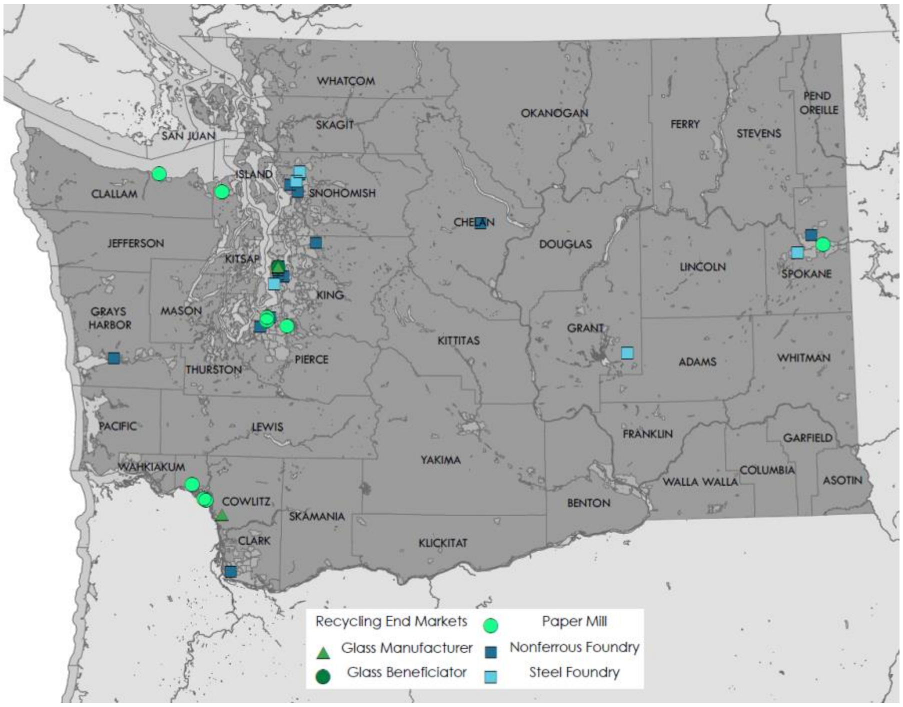


Figure 27. Recycling end markets in Washington

Environmental Justice Considerations and Infrastructure

While additional diversion processing infrastructure is needed in Washington to reduce disposal and capture value through recirculating materials, careful consideration needs to be taken when determining new infrastructure development. Waste infrastructure such as landfills, MRFs, and organics processing sites are predominantly located within lower income census tracts (Table 14 and Figure 28).

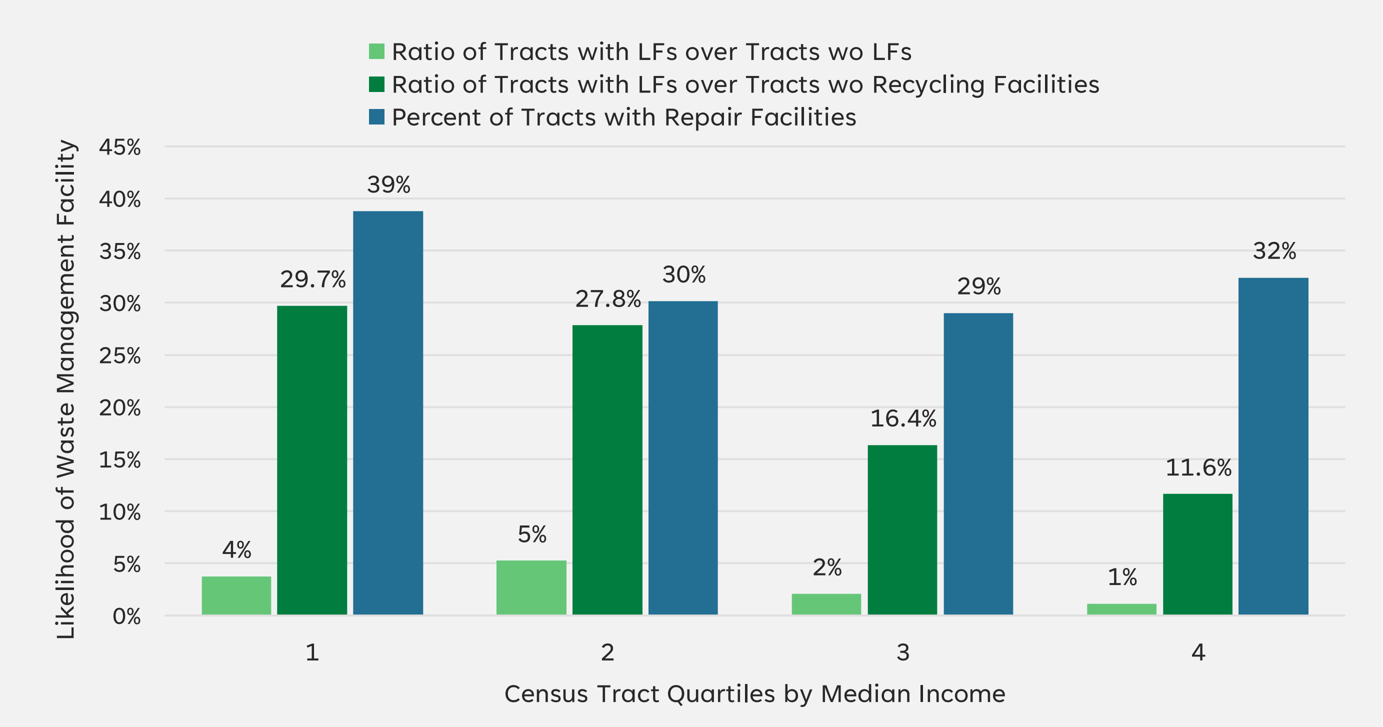
31 Data describing Figure 23 in more detail are available in the NextCycle Washington Circular Economy Impact Analysis, 2022 report.

32 Post-industrial plastic recyclers are not included in this map.

Table 13. Comparison of Tracts by Median Income and Waste Management Facilities

Census Tracts Quartiles	Median Income	Population	Percent with Landfills	Percent with Recycling Facilities	Percent with Repair Facilities
Q1	$49,677	1,704,350	3.6%	22.9%	39%
Q2	$71,058	1,868,305	5.0%	21.8%	30%
Q3	$93,309	2,080,227	2.0%	14.1%	29%
Q4	$137,813	2,033,458	1.1%	10.4%	32%

Figure 28. Likelihood of a waste management facility being located in a census tract by median income as compared to Quartile 4



For example, Census tracts within the lower 2 quartiles of (Q1 and Q2) of median income in Washington are 3.3 and 4.6 times more likely to have a landfill located within their tract respectively than the top median income quartile (Q4). These same low-income quartiles, Q1 and Q2, are also 2.6 and 2.4 times more likely to have a recycling and/or composting facility within their tract than the wealthiest tract Q4. However, the likelihood of a repair or reuse facility falling within any given tract was roughly equal.

It is not possible to determine from the correlation what came first – waste infrastructure or lower income residents. However, moving towards a circular economy and in particular upstream investments, have the potential to level the playing field while reducing reliance on disposal since there does not seem to be a strong link between repair and reuse facilities and tract income. Additional MRF and organics facilities have the potential to bring economic opportunity, but they also have the potential to negatively impact their surrounding community through truck traffic, odors, and other nuisances. They should be sited with particular attention to the benefits and risks for the surrounding communities. Alternatives to large processing infrastructure should be considered in communities that are particularly vulnerable to environmental risks according to the Washington Environmental Health Disparities Map. These community scale alternatives such as community composting can positively impact community wellbeing through direct diversion activities as well as serving as a hub for community engagement and education around sustainability.

Conclusion

The work presented in this report defines gaps between Washington's current programs and infrastructure and its circular economy goals. Further expounded on are the economic, environmental, and community wellbeing benefits achievable to Washington should the state transition more towards an equitable circular economy. Ensuring Washington communities are resilient moving through the 21st century will require implementation of upstream and downstream approaches to waste management focused on community engagement, equal program access, and economic opportunities within low income and at-risk areas of the state. More work is needed to collect quantitative and qualitative data tracking progress and documenting success stories, particularly around upstream activities. Yet, it is already clear that the potential benefits to the state are enormous for environmental, social, and economic opportunities. Additional research could include the following areas:

- Continue efforts to identify reuse organizations/businesses throughout Washington.
- Continue efforts to track and report waste diversion quantities and associated environmental and economic impacts from reuse activities.
- Research efforts to track impact of other waste prevention efforts on the disposal stream such as the of expanded polystyrene and plastic bag bans on prevalence in the MSW stream through successive waste sorts.
- Conduct a circular policy gap analysis to understand opportunities associated with new legislation and ordinances.
- Research methods to minimize impacts of MRFs and organics facilities on neighboring areas.
- Assess best practice programs to provide recycling and organics recovery access to regions of the state that are lacking access currently. For example, conducting a survey of residents in all regions to understand waste diversion behaviors and barriers to reducing disposal.
- Continue discussions with end markets to understand their needs and pain points in the state as it relates to supporting growth in use of recycled feedstock.
- Understand the capacity of existing manufacturers to shift supply chains and practices to support more circularity.

Citations

Ames, Brian, Ward Brown, Shanta Devarajan, and Alejandro Izquierdo. 2001. "Macroeconomic Policy and Poverty Reduction." https://www.imf.org/external/pubs/ft/exrp/macropol/eng/.

Begur, Hema, Mithila Dhawade, Navit Gaur, Pulkit Dureja, Jerry Gao, Medhat Mahmoud, Jesse Huang, Sean Chen, and Xiaoming Ding. 2018. "An Edge-Based Smart Mobile Service System for Illegal Dumping Detection and Monitoring in San Jose." *2017 IEEE SmartWorld Ubiquitous Intelligence and Computing, Advanced and Trusted Computed, Scalable Computing and Communications, Cloud and Big Data Computing, Internet of People and Smart City Innovation, SmartWorld/SCALCOM/UIC/ATC/CBDCom/IOP/SCI 2017* -, 1–6. https://doi.org/10.1109/UIC-ATC.2017.8397575.

Feeding Washington. 2023. "Facts About Hunger." 2023. https://feedingwashington.org/learn-about-hunger/facts-about-hunger/.

"Final Bill Report E2SHB 1799." 2022. https://lawfilesext.leg.wa.gov/biennium/2021-22/Pdf/Bill Reports/House/1799-S2.E HBR FBR 22.pdf?q=20230603121642.

Gonyea, Judith G., Alexandra Curley, Kelly Melekis, and Yeonjung Lee. 2018. "Perceptions of Neighborhood Safety and Depressive Symptoms among Older Minority Urban Subsidized Housing Residents: The Mediating Effect of Sense of Community Belonging." *Aging and Mental Health* 22 (12): 1564–69. https://doi.org/10.1080/13607863.2017.1383970.

Razzaq, Asif, Arshian Sharif, Arsalan Najmi, Ming Lang Tseng, and Ming K. Lim. 2021. "Dynamic and Causality Interrelationships from Municipal Solid Waste Recycling to Economic Growth, Carbon Emissions and Energy Efficiency Using a Novel Bootstrapping Autoregressive Distributed Lag." *Resources, Conservation and Recycling* 166 (September 2020): 105372. https://doi.org/10.1016/j.resconrec.2020.105372.

Reusable Packaging Assocation. 2020. "Reusable Transport Packaging: State of the Industry Report."

"Roadmap to Reuse — Upstream | Sparking Innovative Solutions to Plastic Pollution." 2022. 2022. https://upstreamsolutions.org/roadmap-to-reuse.

"Strengthen Food Rescue - ReFED, Inc. - Food Waste Organization." 2022. 2022. https://refed.org/action-areas/strengthen-food-rescue/.

Tellus Institute. 2011. "More Jobs, Less Pollution: Growing the Recycling Economy in the U.S." https://doi.org/10.1111/j.1468-0041.1995.tb00074.x.

"The Reuse Seattle Partnerships." 2023. 2023. https://reuseseattle.org/.

Trivium Packaging. 2022. "Global Buying Green Report." https://www.triviumpackaging.com/media/kwkpgrfb/2022buyinggreenreport.pdf.

US Environmental Protection Agency. 2021. "National Overview: Facts and Figures on Materials, Wastes and Recycling." 2021. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials#composting.

Washington State Department of Ecology. 2022. *Use Food Well Washington Plan: A Roadmap to a More Resilient Food System through Food Waste Reduction*. www.ecology.wa.gov/contact.