



The Recycling Development Center advisory board spent three board meetings discussing glass recycling issues in Washington State. Notes and slides from the meetings in June, August, and October of 2021 are available at the advisory board website¹.

This report focuses on glass containers, bottles, and jars which can be recycled in furnaces. Other glass uses, which have different properties and melting points compared to containers, are not included: plate glass, windshields, Pyrex™ and other cookware, and ceramics.

The report includes:

- Next steps and policy ideas
- Glass data
- Glass overview
- Research needs

Report Overview

The report on glass recycling summarizes data, challenges, and barriers in the current glass market, and suggests next steps and research to improve markets for glass containers, bottles, and jars

Next steps to consider:

- Evaluate options to remove glass from the comingled recycling stream, like implementing multi-stream collection systems, increasing glass drop-off options, or implementing other policies.
- Identify operational improvements for material recovery facilities (MRFs) that result in cleaner glass.
- Identify approaches that would reduce the costs of transporting glass long distances from the source to the processing and remanufacturing.
- Identify options for increasing glass collection from commercial sources like restaurants, wineries, distilleries, or breweries.
- Research opportunities and evaluate options to increase the use of refillable glass containers and refill systems.
- Conduct additional research into the market for alternative uses of container glass and identify barriers and opportunities for bringing new end markets users to Washington.

Policy ideas for further investigation:

Several policy options are discussed in this report that could improve glass reuse and recycling in Washington.

- Beverage bottle deposit return program would increase collection and quality of glass bottles for refill or recycling.
- Mandates for minimum post-consumer recycled content requirements in glass containers or for use as pozzolan in cement would increase demand.
- Extended producer responsibility programs for packaging would result in increased collection of glass containers for refill or recycling.

¹ https://www.ezview.wa.gov/site/alias_1962/37596/recycling_development_center_advisory_board.aspx

- Restrictions on landfilling glass (once the infrastructure is in place resulting in state-wide glass collection for recycling) would result in increased diversion from disposal.

Glass data

Estimated annual global production of glass is 143 million tons². That volume of glass is made up of 48% container glass, 42% flat glass (construction, windows, auto windshields), 5% tableware, and 6% other glass products. Globally, glass recycling captures 21% of the glass produced with the highest rates in container glass recovery at 32% and only 11% of flat glass is being recycled. A Glass Packaging Institute analysis reported 308,145 tons of glass beverage containers sold Washington in 2018³. Total glass container sales in Washington for 2018 would be 385,000 tons (beverage glass was 80 percent of overall glass container market manufactured in 2018).

Washington's glass data

Our understanding of the materials in Washington's municipal solid waste (MSW) stream come from two sources.

- **Disposal data:** Disposed materials are determined using the results of waste characterization studies. Every five years, Ecology conducts a waste characterization study of MSW from residential, commercial, and self-hauled sources. The most recent waste characterization study was completed in 2021. The proportion of each material from the study is applied to the total MSW for the years when a study is not conducted.
- **Recycling data:** Every year, solid waste handling facilities report to Ecology on the materials they manage. That data comes from a variety of facilities and sources that encompass the solid waste and recycling systems in Washington⁴. Data reported to Ecology through 2018 are publicly available. Over 150 reports were submitted to Ecology for the collection of glass in 2018.

Table 1 summarizes the 2018 data for glass in Washington based on the two sources described above. Based on Washington's solid waste data about 47% of glass containers were recycled in 2018. The data collected does not capture the use of refillable glass bottles or glass disposed in construction and demolition debris. Additionally, an estimate of the total sales or consumption of glass containers in Washington is not available.

Table 1 Disposition of glass in Washington in 2018

Material	Tons Collected for Recycling	Tons Disposed	Total Tons Generated	Recycling Rate
Glass Containers	78,533	90,264	168,796	47%
Other Glass	9,338	41,232	50,570	18%
Total Glass	87,871	131,495	219,366	40%

Source: 2020-2021 WA Statewide Waste Characterization Study and Dept. of Ecology data.

² [Glass recycling – Current market trends - recovery \(recovery-worldwide.com\)](https://www.recovery-worldwide.com/glass-recycling-current-market-trends-recovery/)

³ Personal communication with Scott DeFife, Glass Packaging Institute, November 16, 2021.

⁴ [Solid waste & recycling data - Washington State Department of Ecology](https://www.ecology.wa.gov/programs/solid-waste/recycling-data/)

Figure 1 provides a visual comparison of disposal and recovery for several material categories. The specific materials within these general categories often differ when disposed or recovered. For example, disposed glass includes glass containers, flat glass, and ceramics, but only glass containers are recovered in significant amounts. In Figure 1, disposed glass totals 131,495 tons and the recovered glass total 87,871.

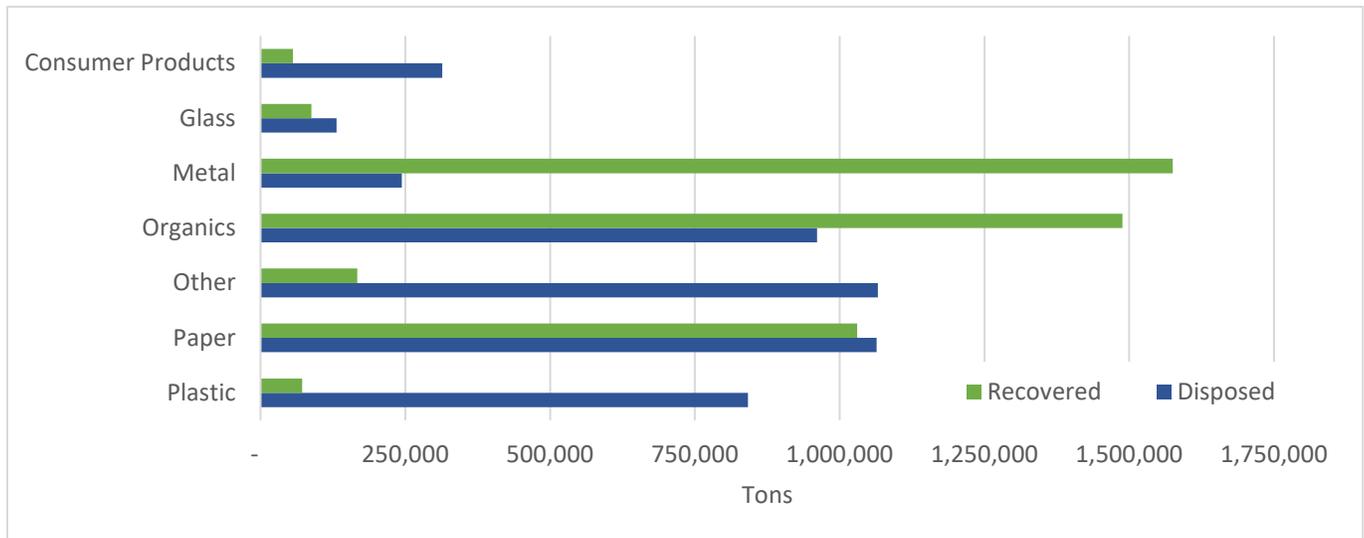


Figure 1 Materials disposed and recovered in 2018.

For comparison, Figure 1 shows other disposed and recovered materials. The disposed plastic category includes plastic products while recycling focuses mostly on plastic packaging. As a result, there are 10 times more plastics in the disposal stream. Recovery of consumer products for reuse is not tracked or reported. The largest category of materials, construction and demolition debris, was not included in Figure 1.

Environmental Impact

Glass is an amazing material that stands the test of time; its uses are diverse and varied. The glass bottle and jar industry started in the 1600’s and was industrialized in 1903 in North America with the first automatic glass bottle blowing machine. Modern day glass production remains high and so too does the importance and necessity of recycling glass.

Glass is a high quality recyclable material. When properly collected and processed glass can be repeatedly recycled with no loss in quality or purity. Recycled glass can substitute for up to 95% of raw materials and extends the life of manufacturing equipment⁵.

Use of glass containers to manufacture new glass containers saves⁶:

- 1,300 pounds of sand per ton of recycled glass used
- 410 pounds of soda ash per ton of recycled glass used
- 310 pounds of limestone per ton of recycled glass used
- 160 pounds of feldspar per ton of recycled glass used
- Two to three percent in energy cost for every 10% of recycled container glass used in the manufacturing process.

⁵ [Glass Containers – NCD Corporation](#)

⁶ [2019 Recycling Industry Yearbook \(scrap2.org\)](#)

- One ton of carbon dioxide emitted for every six tons of recycled container glass used in the manufacturing process.

The life cycle of glass from the consumer to its end of life is shown in Figure 2. This graphic presents percentages of glass container use in the US⁷. The end of life options for glass containers include remanufacturing into glass products (glass containers, fiberglass), use as replacement materials (beads, aggregate), or disposal in a landfill (as waste or landfill cover). Data is currently lacking for end market uses of glass in Washington.

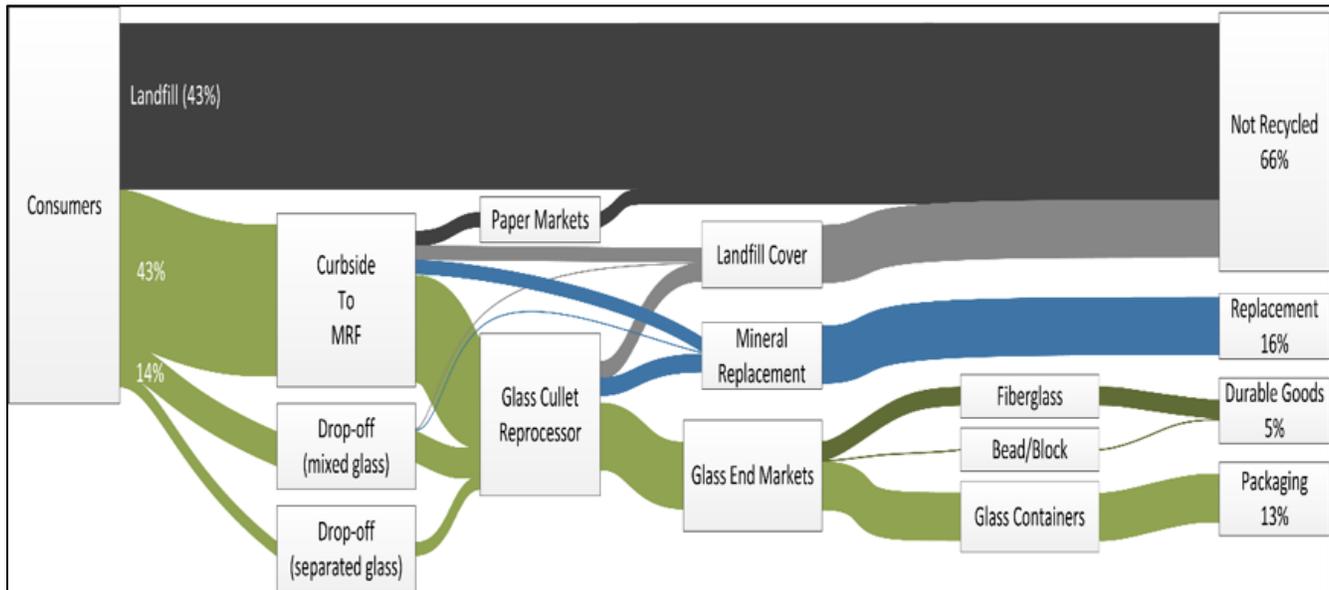


Figure 2. Glass flow from consumer to end markets.

Economic Impact

Glass recycling benefits Washington’s economy providing both direct and indirect inputs to the economy. On average, recycling 1,000 tons of glass creates roughly eight jobs. Beverage container deposit systems (or ‘bottle bills’) provide 11 to 38 times more direct jobs than curbside recycling systems⁸. A 2021 AMERIPEN analysis reported 437 glass manufacturing jobs in Washington with an economic impact of over \$180 million⁹.

Glass has variable market value based on how well it has been collected and processed:

- Mixed glass with levels of contamination can have a negative value of \$25 a ton.
- Separated glass with low contamination can have a positive value ranging from \$10 to \$30 a ton¹⁰.

Glass overview

Glass manufacturing

Two companies in Washington manufacture glass bottles; Ardagh Group in Seattle and Owens-Illinois in Kalama. Both operations use recycled glass bottles in their manufacturing. Strategic Materials, Inc., in Seattle, processes glass containers into the cullet used in the manufacture of new glass containers. A search of registered businesses in Washington identified four glass bottle distributors operating in Washington; Bottles R Us in Mill

⁷ [GPI | Glass Packaging Institute Home](#)

⁸ [Glass Recycling Facts - Glass Packaging Institute \(gpi.org\)](#)

⁹ [American Institute for Packaging and the Environment \(ameripen.org\)](#)

¹⁰ [Recycling Markets](#)

Creek, Graham Packaging Co in Selah, Richards Packaging, Inc., in Auburn and Tacoma, and Specialty Bottle in Seattle.

Glass collection

Since glass is one of the heaviest recyclable commodities, value chain economics depends heavily on facility proximity and transportation costs. Unlike smaller states on the East Coast or many European countries, Washington has the challenge of long distances between the processing facilities in Western Washington and rural areas of the state. As a result, many jurisdictions beyond the Puget Sound region offer limited or no glass collection for recycling. Improving glass recycling in less populated areas would support Ecology’s goals for equity in underserved communities. Figure 3 shows the locations of glass processors around Washington, with circles showing the transportation distance for glass to these facilities.

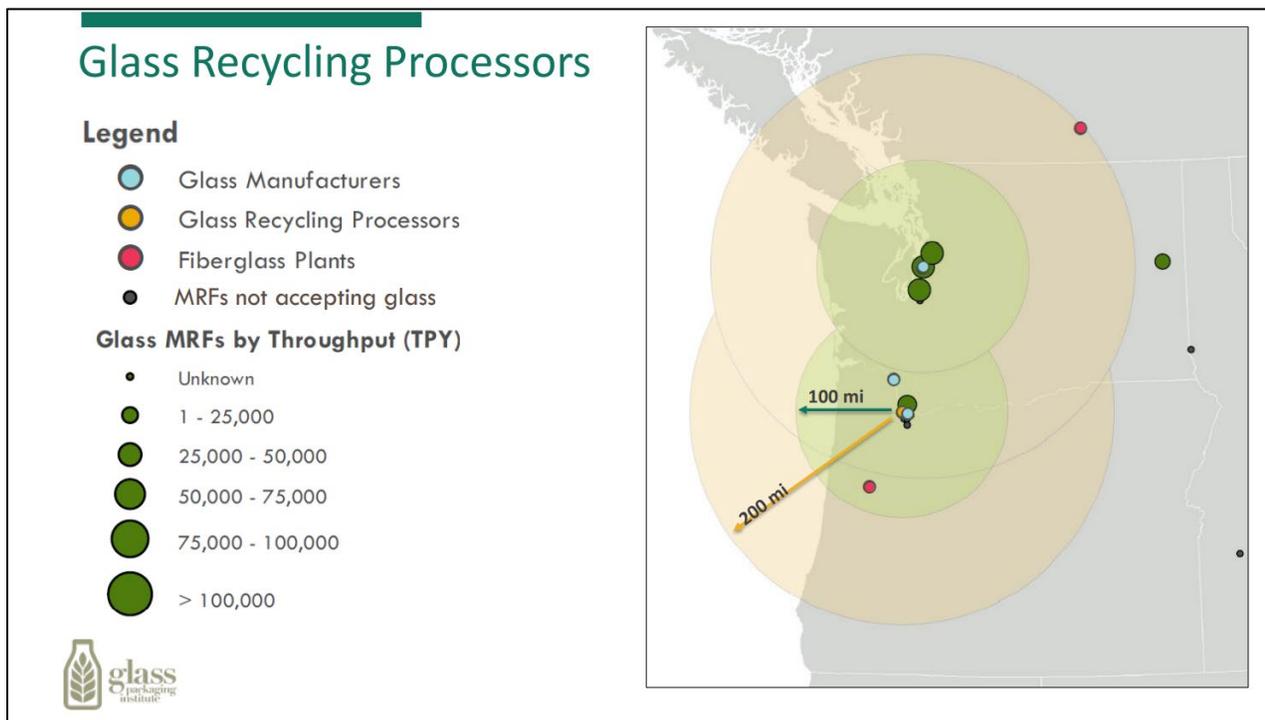


Figure 3. Map of glass recycling processors in the Pacific Northwest.

Residential glass collection

Most residents in Washington are able to deposit their glass bottles and containers in their curbside bin or at local drop-box sites. Sixty-eight percent of Washington’s residents have access to curbside collection of glass containers. Some curbside service includes glass in a single-stream recycling bin, where glass is mixed with recyclable paper, plastic, and metal. Other residential collection service requires glass to be set at the curb in a separate bin¹¹. About 23 percent of Washington residents can drop off glass at drop-box locations. The remaining 9 percent has no access to glass recycling options.

Due to confusion about what is and what is not recyclable, residents often mix inappropriate materials with the recyclable material by placing non-recyclable items in the single-stream recycling bin. In some cases, acceptable materials can even cross-contaminate other recyclables in the bin.

¹¹ [Publications - Zero Waste Washington](#)

Mixing materials in one container is a major problem in single-stream bins. Unlike other recyclable materials, glass can break, which can contaminate recyclable paper with glass bits and liquids. Glass can break during collection in the bin, during transport, or when being sorted at the MRF.

Glass processing

Delivery of glass for remanufacturing requires the collection and processing of glass containers from consumers to the end users. Through single-stream collection systems, hauler trucks collect and compact the commingled material, drop it on the concrete floor at the MRF where forklifts and loaders roll over it. To remove glass as early as possible in the stream, disk screens break it and screen it out of the container line. Because of this process, single-stream glass gets mixed with organics, ceramics, shredded paper and other small objects (less than 50 mm). The resulting glass will be about 20-30 percent contaminated and in many cases, instead of having a revenue from glass, many MRFs have to pay to get rid of it. Some MRFs deliver glass to Strategic Materials, Inc. for processing using optical sorters to separate different colors of glass. This glass is delivered to end users for remanufacturing into glass or other alternative uses.

Management of glass at high performing MRFs includes a glass breaker, trammel, and vacuum early in the process to separate glass from other materials. MRFs unable to manage incoming glass can find broken glass to be problematic for processing machinery and result in expensive repairs at the MRF and other end users of recyclable materials, like a pulp and paper mill. Improving the processing technology at these MRFs would result in better management of collected glass. An estimated 40% of glass in single-stream recycling systems ends up remanufactured into new products compared to 90% of glass collected separate from other recyclable material¹².

Glass opportunities

Moving container glass from the consumer back to the manufacturer can take many forms. Additional discussion of a few of these options are offered below.

- Separate residential glass from other recyclables, using a drop-box or multi-stream collection system, that results in a cleaner stream of glass.
- Partner with processors to offer on-site solutions at high-generating facilities, like wineries or breweries.
- Design a hub-and-spoke model within a region to move glass from smaller communities to a central location for efficient transport to the MRF or processor. Utilizing rail when possible.
- Pilot mobile collection and processing concepts for event sites and locations incapable of hosting permanent solutions.
- Promote the use of refillable bottles, especially for those businesses that use large volumes of bottles, like distilleries, wineries or breweries.
- Find local solutions to handle glass containers, like community glass crushing efforts.
- Develop state-wide legislation to:
 - Establish a beverage container deposit return system, or bottle bill, that includes options for refill. Oregon, California, and British Columbia all operate beverage container deposit return systems.
 - Establish a producer responsibility program for packaging, including glass containers. This would require companies that make packaging to be responsible—financially and/or operationally—for the management, reuse, and disposal of the packaging.
 - Restrict the presence of glass containers in the disposal stream, also called a landfill ban.

¹² [Why glass recycling in the US is broken \(acs.org\)](https://www.acs.org/pressroom/2017/04/why-glass-recycling-in-the-us-is-broken)

Bottle bills

Bottle bills can increase recycling rates. Currently ten states in the US have bottle bills including our neighbors in Oregon, California, and British Columbia. The US glass recycling rate has plateaued around 25%. The glass recycling industry set a national 50% recycling rate goal by 2030¹³. The highest glass recycling rates in the US occur in bottle bill states with those in the Pacific Northwest ranging from 61%-78% in 2018¹⁴. Oregon has been the leader in glass recycling, passing the first bottle bill in 1971. In addition to recycling glass, the Oregon's refillables program reported 407,840 tons of glass bottles have returned to the bottler avoiding the costs of recycling¹⁵. In 2021 California, passed Assembly Bill 1311 allowing wineries to sell wine in reusable containers.

An example of how effective bottle bills are at increasing recycling is in Ontario Canada. Their original bottle bill from 2007 resulted in a recycling rate of 97% for alcoholic beverage bottles, well above the 40% rate result from the "Blue Box" program for all other containers¹⁶.

Community glass crushing

Rural communities often do not have access to glass recycling. Some community initiatives are crushing glass locally for alternatives uses.

- In Kittitas County, the Ellensburg Glass Recycling Cooperative (EGRC)¹⁷ operates a glass crusher. The EGRC is responding to the October 2019 decision by the county's waste and recycling contractor to stop accepting glass as part of its curbside program. EGRC purchased a small glass-crushing machine and have a network of volunteer glass ambassadors that work to collect the glass, crush it, and offer it back to the community to use in landscaping. EGRC also collaborates with Central Washington University to explore the use of glass ground to sand in concrete mix.
- Chelan County recently purchased a glass crushing system¹⁸. The Lake Chelan Rotary operates the system that has the capacity to crush up to two tons of glass per hour, turning it into a fine sand and aggregate. Chelan area farms and wineries support this effort.
- In San Juan County, on Orcas Island, the non-profit Exchange reuse and recycling center installed a glass crusher to collect and grind glass into sand for use in landscape and construction. Crushing and re-using the glass on island reduces what has to be sent back to the mainland—so less transportation, carbon, and cost.

Refillable glass bottles

There are more than 1,000 wineries in Washington that annually produce over 17.7 million cases of wine or 212 million bottles of wine. Use of refillable bottles would have an impact on glass use.

- A Kittitas County study of secondary recycling markets determined that using refillable wine bottles and bottle washing had about the same overall cost as using new wine bottles¹⁹. That same report noted that the Bunker Hill Vineyard and Winery reused 54,000 wine bottles over a five-year period, reducing their carbon footprint by 60%.

¹³ [GPI Roadmap to U.S. Glass Recycling - Glass Packaging Institute](#)

¹⁴ [Bottle bill states and how they work \(tomra.com\)](#)

¹⁵ [Oregon - Bottle Bill Resource Guide](#)

¹⁶ [Ontario - Bottle Bill Resource Guide](#)

¹⁷ [Home | Ellensburg Glass Recycling Cooperative](#)

¹⁸ [Home - 911 Glass Rescue](#)

¹⁹ [Kittitas County Secondary Market Feasibility Study Final 06212021.pdf](#)

- Two New York area circular container startup companies Good Goods and Gotham Project have started testing refill models. Both use digital technology that tracks purchases, return rates, and helps predict the flow of cleaning, refilling and recorking. They also share this with the retailer and wine producers, which does not typically happen. Customer get credit when they return their bottles²⁰.
- Coopers Hall Winery and Taproom in Portland has been filling refillable bottles from wine kegs since 2014. In 2019, they started offering a refillable beer bottle program under Oregon’s Beverage Recycling Cooperative program²¹.

Research needs

This report identified several areas where more data research or continued discussions could enhance glass recovery and recycling in Washington State.

- Identifying where glass containers are manufactured into other products. Examples would be fiberglass or alternative construction materials. These opportunities for glass could provide an end market in local areas around the state.
- How much glass, containers and other glass products, is sold and consumed in Washington each year? Without this information, we only have an estimate of the recycling and disposal rate. This data would also identify how much potential material is available for end markets.
- Identifying large users of glass bottles and containers. For example, which large wineries or breweries in the state provide reusable containers. How can this be expanded to other markets?
- Reaching out to the restaurant and hospitality industry about their use of glass containers. What kind of approaches could help increase their recycling rates.
- More investigation into how glass in rural communities can be collected and delivered to end markets.

²⁰ [These entrepreneurs want consumers to reuse wine bottles | Greenbiz](#)

²¹ [Coopers Hall unveils Oregon's first redeemable, refillable wine bottles - Portland Business Journal \(bizjournals.com\)](#)