King County LinkUp

Organic Materials Management in King County

King County
Department of
Natural Resources and Parks
Solid Waste Division

Waste Prevention | Resource Recovery | Waste Disposal

www.kingcounty.gov/solidwaste

August 2019

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Executive Summary

Document Structure

In 2019, the King County Solid Waste Division contracted with Cascadia Consulting Group on a body of work on the organics management system for King County. This document is organized into the following sections:

- **Section 1. Regional Organic Material Data Assessment.** This section presents trends in disposal and recovery of organic materials, including food scraps and yard trimmings, based on available data from King County, City of Seattle, and Snohomish County.
- **Section 2. King County Organics Market Assessment.** This section provides an update of local organics market conditions, which were previously documented in 2015 and 2017. It summarizes relevant trends related to King County's organics supply, processing, and end market demand.

Organics management challenges for the region include mitigating contamination across all stages of the supply chain, as well as ensuring adequate processing capacity for the quantity of organics generated by residents and businesses. The document closes with potential actions King County can consider to address challenges and strengthen markets for products from recovered organics (e.g., compost).

The document also includes the following appendices:

- **Appendix A. King County Organics Disposal and Recovery Data by Sector**. This appendix includes additional analyses from (Section 1), presenting King County (excluding Seattle) organics data by sector.
- **Appendix B. Organics Disposal and Recovery Analysis Methodology**. This appendix includes definitions on which the organics disposal and recovery analyses are based, as well as an overview of the analysis methodology and data sources.
- **Appendix C. Compost Use Best Practices Literature Review.** This appendix elaborates on the potential end markets identified in the Market Assessment (Section 3), providing information on end markets for compost in North America, as well as supportive policy and incentives. Compost uses included in the review are those relevant to agriculture, erosion control, transportation/roadside uses, stormwater management, and other emerging options.
- **Appendix D. References.**

Introduction to the Organic Material Management System

The illustration on the next page highlights the flow of organic material management in King County. Compost is created through a process that begins as residents in homes and businesses produce organic material. The finished compost is often used as a soil amendment and landscaping material to improve soil and plant health. It can also be used for many other applications, from stormwater treatment to turf field maintenance. Composting organic material also reduces landfill waste and prevents the carbon emissions that would have been generated as the organic material decomposes in the landfill.

2018 Organic Materials Management in King County

King County
Department of
Natural Resources and Parks
Solid Waste Division

Food, yard and wood waste, and compostable paper

King County's vision is to create a self-sustaining regional organics system that minimizes waste, promotes healthier soils, and protects the environment.

563,800 tons of organic materials is generated from King County business and residential yards and kitchens. Most is recycled or disposed.

An estimated **10,000** tons of organic waste is prevented through food donation and recovery.

Organics Recycling

220,000 tons recycled

- Recycling cart **91%**
- Self-haul **9%**

39% collected and sent for processing

Garbage

343,900 tons disposed

- Self-haul **17%**
- Garbage cart **83%**

61% sent to landfill for disposal

85%

Regional organics recycling, servicing Seattle, King and Snohomish counties, is estimated at 85% of permitted capacity

In 2018

- **553,000** tons annual permitted compost capacity
- **469,800** tons estimated material recovered for processing

Processing

- Compost
- Alternative technologies i.e. Anaerobic digestion

Cedar Hills Landfill

Burial, decomposition, methane generation, collection and capture

Local Organics Markets

- Mulch
- Compost
- Fertilizer
- Energy – fuel, heat

Opportunities

- Local agriculture and horticulture
- Local government and cities pilots and projects
- Climate mitigation action by business and government
- Local landscaping and building/construction services

FARMERS MARKET

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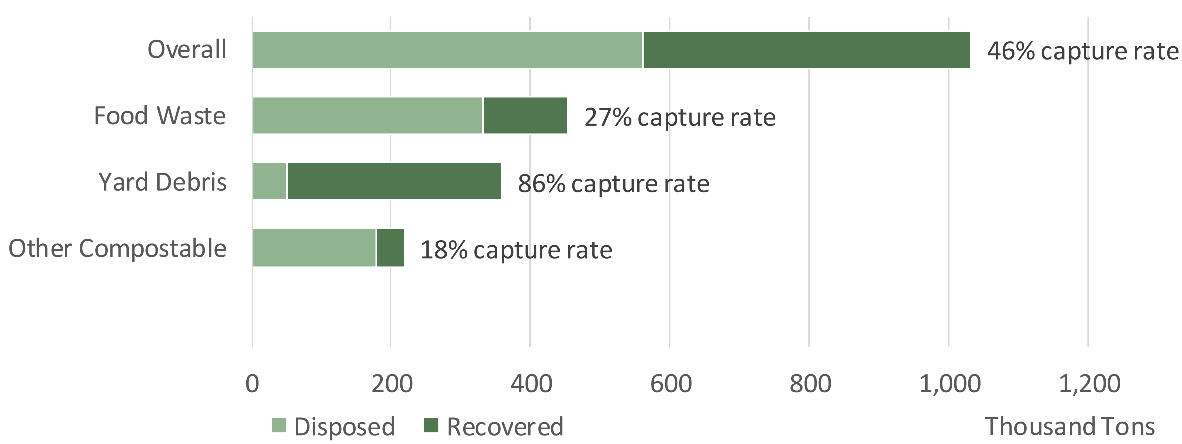
Organics Disposal and Processing

While the infographic above primarily illustrates local flow of materials, the organic material management system is a regional one. King County, Seattle, and Snohomish County together generated approximately 1.03 million tons of organics in 2018. King County organics contributed more than half (55%) of the total generation by weight. Three composting facilities—Cedar Grove Composting in Maple Valley, Cedar Grove Composting in Everett, and Lenz Enterprises—accept and process organic material from residences and businesses in the region.

Overall, nearly half (46%) of generated regional organics were captured for composting through curbside organics collection or at local transfer stations. While most yard debris is captured for composting, a much higher percentage of food waste and other compostable material is still going to the landfill. There remains opportunity for King County to increase organics recycling rates and divert more material—during the most recent residential curbside study (2018), less than half (47%) of the single-family households who subscribe to organics service in King County set out their food and yard waste container for collection, and less than 40 percent of King County single-family households overall set out an organics cart for collection.

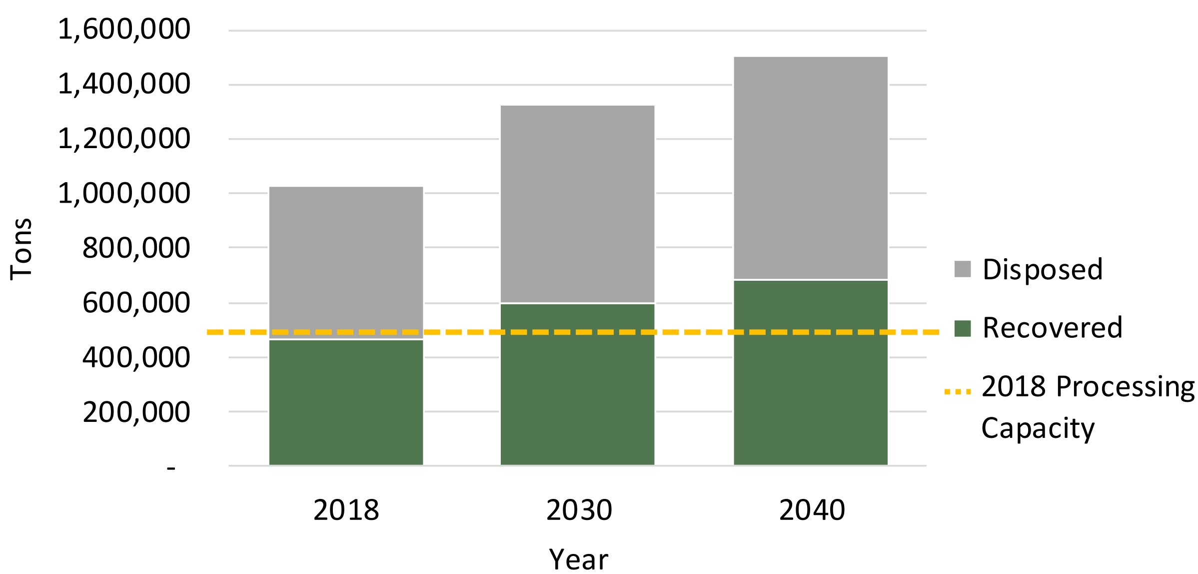
Figure 1. Organics disposal, recovery, and capture rates by material type, regional



While there is a lot of potential to capture more organic material for composting, especially food waste, local composting facilities are already operating near permitted capacity. Organics generation for the region is projected to increase over current levels by 29 percent by 2030 and 36 percent by 2040. The figure below estimates organics disposal and recovery for King County, Seattle, and Snohomish County combined, as well as current annual permitted capacity for composting for the three composters that accept material from King County and the surrounding region. The estimates for future organics recovery and disposal are based on current per-person and per-employee generation of organics and available projections for population growth. The organics disposal and recovery projections do not include future changes in organics diversion behavior (e.g., increased diversion of organics from disposal to recovery streams or reduction in organics generation due to food waste prevention from new programs and policies).

By 2030, composting capacity will have been exceeded and there will need to be additional processing capacity for the region to keep up with the additional organic material being generated at current recovery rates. If recovery of organics increases relative to generation, the need for additional processing capacity will be even more acute.

Figure 2. Regional organics disposal and recovery projections through 2040 (King County, Seattle, and Snohomish County). Projections are based on current generation and disposal trends.



While composting represents an opportunity to turn waste into a marketable, beneficial product, physical contaminants in compost—mainly in the form of plastic film—remain a challenge. Of the material collected for organics processing in 2018 in the region, 3.9 percent by weight of recovered organic material was contamination. Non-compostable contaminants such as plastic film and rigid non-compostable plastics pose challenges to processing and the quality of end product. While plastic represents a relatively small fraction of incoming organics by weight, it can be noticeable in visual assessments. Small pieces of plastic in the finished product (as a result of plastic present in the material collected for recovery) can affect some customers' perceptions of and may reduce their willingness to use compost products derived from recovered organics.

Confusion about what is and isn't compostable is an ongoing challenge and contributes to contamination of materials sent to compost processing facilities. The specific materials accepted for composting varies across jurisdictions, and unclear claims on packaging like "biodegradable" and rapidly changing packaging types also contribute to the confusion. To produce a commercially desirable product and maintain adequate market demand for their compost, producers must spend more on removing contamination—through more labor, new technology, or both—which increases overall processing costs and may reduce the market competitiveness of compost products produced from regionally recovered organics.

Markets for Compost

Most processed organics currently sold are used as soil amendments and landscaping material purchased by residential and commercial customers. Applications for compost include:

- Residential and commercial soil amendments and other landscaping applications, including use by nurseries.
- Construction, land clearing and grading, and other site development projects for use in erosion control and for topsoil blending or as a soil amendment for reestablishing vegetation and/or landscaping.
- Transportation projects for erosion control, stormwater management, and for reestablishing vegetation.
- Public and private sector green stormwater infrastructure projects such as rain gardens, bioswales, and green roofs.

Compost is also used in applications such as habitat restoration; site remediation and reclamation; urban forestry; public landscape and park land management; and turf maintenance. Local processors continue to seek to expand and diversify their markets for finished product, and there is local interest in growing both municipal purchasing as well as agricultural markets for local compost.

Next Steps

Realizing the environmental benefits of both organics diversion from landfill and use of compost depends on the ability of local processors to produce high quality products that have robust local markets. At the same time, King County is continuing to work with partners across the supply chain to improve organics collection and processing and develop markets for locally produced compost.

On the supply side, King County and the Cities are working to educate customers on what can and cannot be placed in their curbside organics collection carts to reduce contamination. King County is also examining barriers and opportunities to expanding processing capacity by considering rural area zones, mineral use zones, and other areas with property-specific conditions appropriate for organic composting facilities.

To promote robust markets for locally produced compost, King County is developing the King County Compost Commitment designed to expand and enhance the regional market for compost from the county's organics stream through the following next steps:

- **Consider the broader benefits of compost use.** Quantify the broader environmental impacts of compost use beyond solid waste management, such as its role in building healthy soil, promoting water conservation, and its potential to sequester carbon. Communicate these benefits with potential new compost users and the public.
- **Identify current government approaches and uses** to inform the development and piloting of a technical assistance program for King County government agencies that includes compost specifications, simplified contract arrangements, and internal marketing. This technical assistance program will determine how to optimize compost purchase by County project managers and County use.
- **Develop new opportunities** by leveraging the technical assistance program for increased compost use in appropriate public projects and continue to monitor and draw on best management practices, tools, and market development strategies elsewhere.

Section 1. Regional Organic Materials Data Assessment

The below sections document data and trends in disposal and recovery of organic material from King County, Seattle, and Snohomish County. As local composters manage recovery of increasing quantities of food scraps, yard trimmings, and other recoverable organic materials, King County and other local jurisdictions will need to work regionally to ensure adequate capacity for processing organic materials diverted from the waste stream.

Overall, the analysis shows that King County, Seattle, and Snohomish County together generated over 1 million tons of organic material in 2018, of which 46 percent was collected and recovered for processing through composting. The quantity of recovered organics in 2018—estimated at 469,800 tons—is approximately 85 percent of the current permitted processing capacity for the three major composting facilities that serve the region. On the supply side, significant opportunity remains to divert organics disposed to landfill, especially food waste.

The analysis accounts for only organic materials handled through the solid waste management system (e.g., landfill or commercial composting). Additional organics that are processed and diverted through backyard composting, in-sink disposal, or other on-site management are not included the presented data. The methodology and data sources for the analysis are provided in Appendix B. Organics Disposal and Recovery Analysis Methodology.

Overall Regional Organics Data

REGIONAL ORGANICS GENERATION

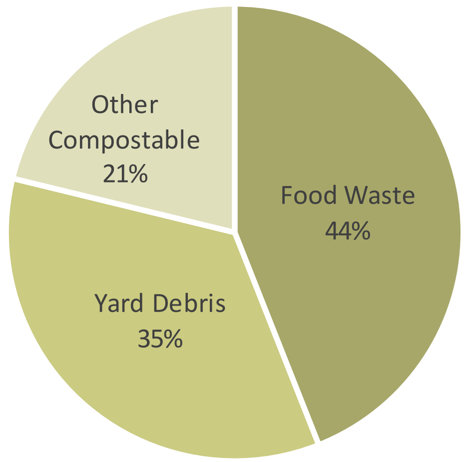
Cascadia estimates that King County, Seattle, and Snohomish County together generated approximately 1.03 million tons of organics in 2018. King County organics contributed more than half (55%) of the total generation by weight, as shown in Table 1.

Table 1. Regional organics generation by jurisdiction

	Generated Organics (tons)	% of Total
King County (excluding Seattle)	563,800	55%
Seattle	291,800	28%
Snohomish County	177,600	17%
Total	**1,033,200**	**100%**

Figure 3 shows the composition of regional (King County, Seattle, and Snohomish County) generated organics. The generated organics stream sent to the solid waste system in the region is mostly food waste by weight (44% of generated organics), followed by yard debris (35%). The remaining one-fifth of the stream is other compostable material (21%), which includes compostable paper and wood.

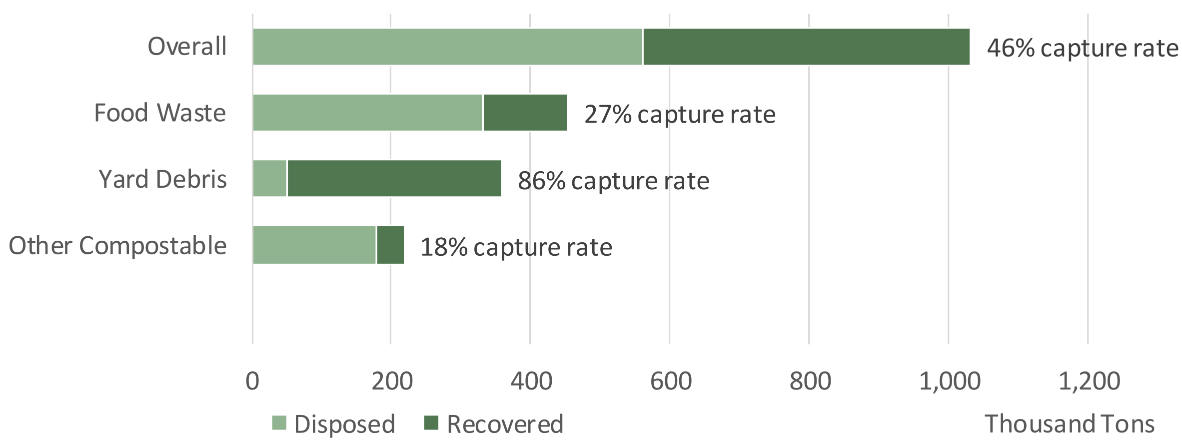
Figure 3. Organics generation by material type, regional (King County, Seattle, and Snohomish County)



REGIONAL ORGANICS RECOVERY

Overall, nearly half (46%) of generated regional organics were captured for composting through curbside organics collection programs or through source-separated drop-off at local transfer stations. Figure 4 shows the quantities of organic material disposed and recovered by material type for the overall region.

Figure 4. Organics disposal, recovery, and capture rates by material type, regional



ORGANICS STREAM CONTAMINATION

Of the material collected for organics processing in King County, Seattle, and Snohomish County in 2018, Cascadia estimates that 18,900 tons was contamination. This contamination represents 3.9 percent by weight of the organic material collected for recovery. Examples of contamination of organic material collected for processing includes non-compostable plastic, glass, and non-compostable papers, such as aseptic and polycoated papers. However, available data on what the specific types and quantities of contaminant material in organics is limited in existing composition studies.

PROJECTIONS FOR FUTURE ORGANICS GENERATION

This section shows projections for future regional organics generation through 2040, based on current per-person and per-employee generation of organics and available projections for population growth. The organics disposal and recovery projections do not include future changes in organics diversion behavior (e.g., increased diversion of organics from disposal to recovery streams or reduction in organics generation due to food waste prevention from new programs and policies).

Current permitted processing capacity for the three regional composters that together serve King County, Seattle, and Snohomish County is 553,000 tons. The estimate of recovered organics in 2018 (469,800 tons) is 85 percent of the current processing capacity. The organics that are currently disposed (an additional 562,400 tons), if diverted to the appropriate streams, significantly exceed current processing capacity.

Organics generation for the region is projected to increase over current levels (2018) by 29 percent by 2030 and 36 percent by 2040 due to population growth. The corresponding tons of organics recovered projected for these time periods (assuming no increase in recovery relative to generation) will exceed the processing capacity currently available to the region.

The source data and detailed methodology for developing projections for the region is included in Appendix B. Organics Disposal and Recovery Analysis Methodology.

Figure 5. Regional organics disposal and recovery projections through 2040 (King County, Seattle, and Snohomish County)

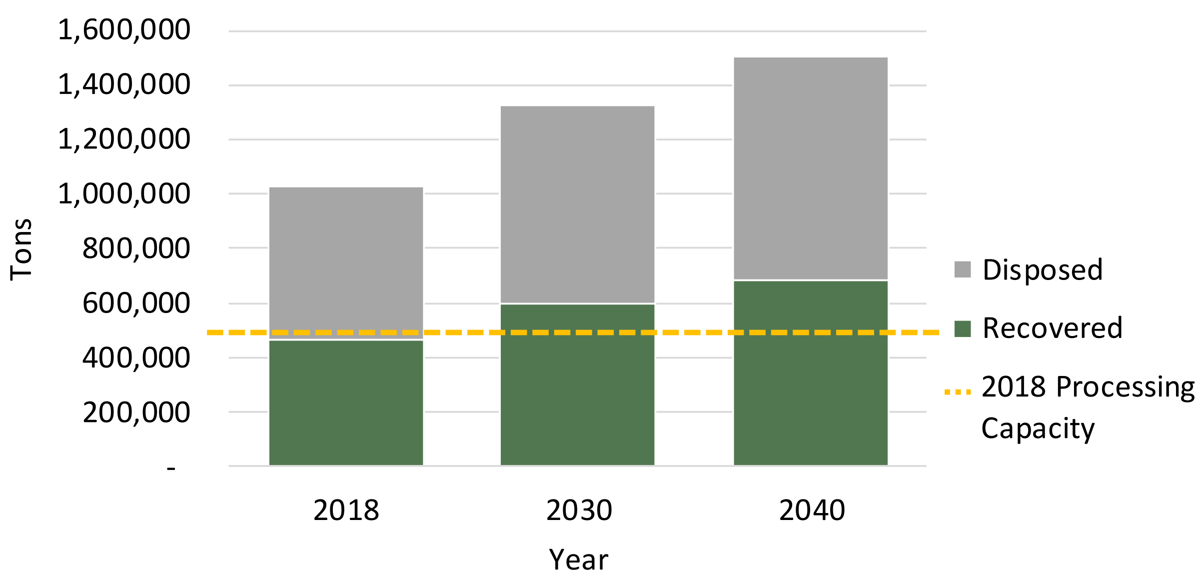


Table 2. Regional organics disposal and recovery projections through 2040 (King County, Seattle, and Snohomish County). Projections are based on current generation and disposal trends.

	Organics Tons		
Year	Disposed	Recovered	Generated
2018	562,400	469,800	1,032,300
2030	723,200	604,100	1,327,300
2040	822,200	686,800	1,509,000

King County Organics Data

This section provides more disposal and recovery data on organic materials specific King County (excluding Seattle). The analysis of available tonnage reports and composition data show that King County generated an estimated 563,800 tons of organics in 2018. This tonnage reflects both organics disposed to landfill and material collected for composting through curbside programs or at the transfer station. Figure 6 shows organics generation in King County by sector. Single-family residents generate the most organics (45% of generation), followed by the commercial sector (34%).

Figure 6. Organics generation by sector, King County

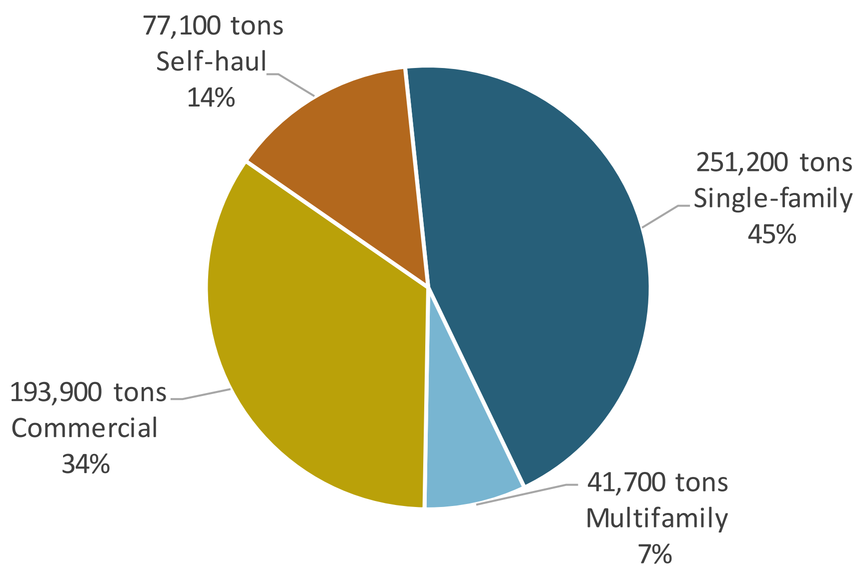
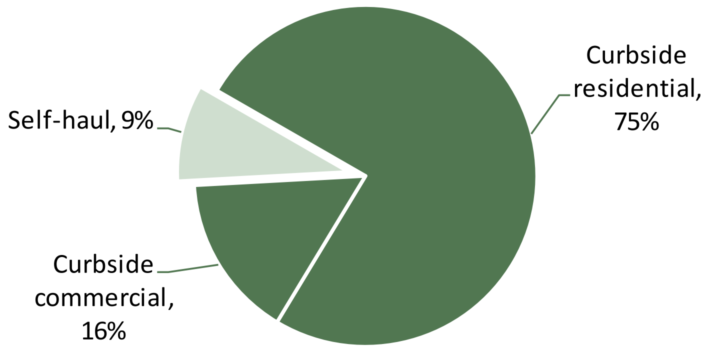


Figure 7 shows organics generation in King County by collection type. Most material is collected at curbside through private haulers or haulers under County contract, while approximately 9 percent is managed through King County transfer stations (self-haul).

Figure 7. Recovered organics by collection type (curbside vs. self-haul)



As shown in Figure 8, generated organics are mostly food and yard debris, with food waste accounting for over 40 percent of the overall composition.

Figure 8. Organics generation by material type, King County

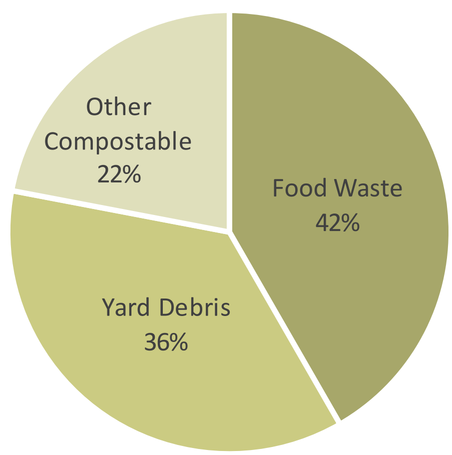
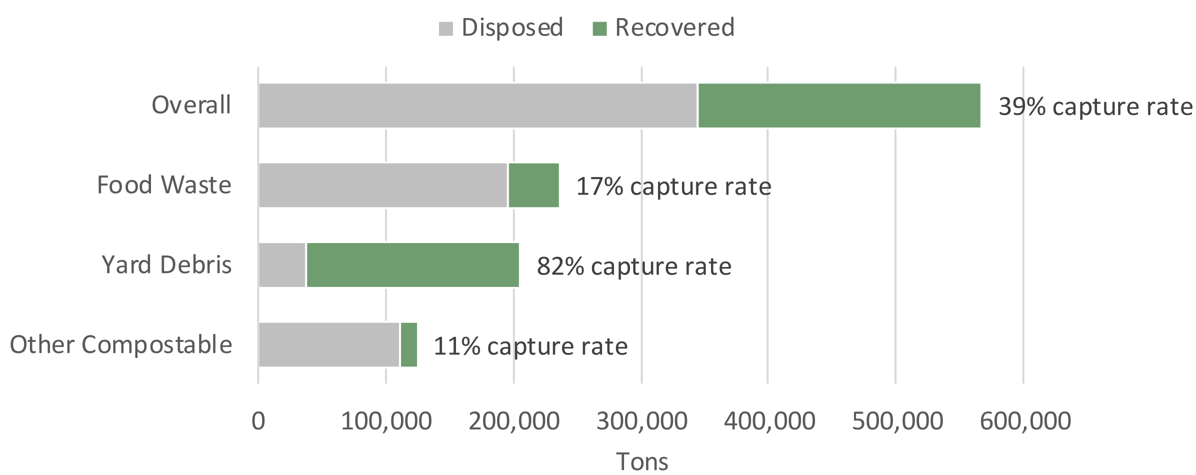


Figure 9 provides more detail about generated organics overall, showing the 2018 organics tons disposed and recovered and the corresponding capture rates by material type. Overall, 39 percent (222,900 tons) of generated organic material was recovered for processing.

Most of the *recovered* organics (by weight) is yard debris; however, food waste is the most prevalent organic material *generated* (both disposed and recovered) in King County by weight. The capture rate is the percentage of material recovered (e.g., through composting) out of the total quantity generated. As shown, King County residents and businesses recover over 80 percent of the yard debris they generate but recover less than 20 percent of food waste generated.

Figure 9. Organics disposal, recovery, and capture rates by material type, King County



PROJECTED KING COUNTY ORGANICS SUPPLY THROUGH 2040

King County Solid Waste Division provided projections for organics disposed and recovered through 2040. The projections assume that the amount of organic material in the waste stream per capita remains the same and that the proportion of organics recovered stays constant as well. The projections are shown in Table 3 below. Ranges are provided to reflect the uncertainty of forecasting.

Table 3. Projected Organics Tons Recovered and Disposed in King County (excluding Seattle)[1]

	2018	2030	2040
Recovered	220,000	307,000	365,000
Disposed	343,900	430,000–475,000	454,000–564,000
Total Recoverable Materials	563,800	737,000–782,000	819,000–929,000

[1] Projections provided by King County Solid Waste Division.

Section 2. King County Organics Market Assessment

Cascadia also conducted a 2019 organics market assessment specific to King County, providing an update of organics market conditions as documented in 2015 and 2017. This section documents findings from the market assessment, covering relevant trends related to King County's organics supply, processing infrastructure, and end markets for processed organics.

Supply of organics for processing and recovery

As shown in Section 1, King County (excluding City of Seattle) generated an estimated 563,800 tons of organics in 2018, primarily food and yard debris. Of this material, approximately two-fifths (39%) was collected for recovery (composting), either through curbside collection programs or self-hauled to local transfer stations. There remains opportunity for King County to increase organics recycling rates and divert more material—during the most recent residential curbside study, less than half (47%) of the single-family households who subscribe to organics service in King County set out their food and yard waste container for collection, and less than 40 percent of King County single-family households overall set out an organics cart for collection. These figures, along with a relatively low capture rate for organics overall, indicate more opportunity to collect recoverable organics through increased residential participation in available programs. However, additional processing infrastructure would be needed to handle significant increases in organics recovery in the short-term: the organic tonnages recovered in 2018 represent 85 percent of the combined annual permitted capacity for the region's three major composters.

FACTORS AFFECTING FUTURE SUPPLY OF ORGANICS FOR RECOVERY

- **Efforts are increasing to measure and reduce edible food in the waste stream, both locally and in the region.** King County has estimated the quantities of edible food disposed from residents and businesses based on organics characterization studies completed in 2018 and 2019. The estimates are a wide range due to limitations of currently available data, and the estimates are presented in Appendix A. King County Organics Disposal and Recovery Data by Sector. Seattle Public Utilities has organized a series of Food Rescue Innovation Labs to bring together a varied group of stakeholders (such as local government, chefs, groceries, hunger relief agencies, and public health representatives) into discussions about food loss and food rescue, identify barriers, and develop innovative strategies. King County collaborates with Seattle to identify food rescue efforts to support. Additionally, King County has a focus in waste prevention through its programs, including grants aimed at commercial foodwaste.
- **There are new and growing state and regional commitments reduce food waste and increase diversion.** Newly adopted House Bill 1114 sets a goal of reducing food waste by 50

percent below 2015 levels by 2030.[2] The food waste reduction target mirrors the commitment Washington State and Seattle have made as a members of the Pacific Coast Collaborative,[3] a partnership of west coast states and jurisdictions to act on climate change. Diversion goals set by King County and member cities will also impact the supply of organics. For example, the King County Strategic Climate Action Plan outlines several diversion goals that prioritize approaches to reduce climate impacts from food production and consumption.[4]

- **Seattle continues to promote and implement efforts around food scraps diversion and management of food-service packaging.** Seattle Ordinance #124582, effective January 1, 2015, mandated organics recovery by prohibiting the disposal of food waste and compostable paper from residential, commercial, and self-haul generators in the City of Seattle. This has contributed to increases in the recovery of organics from disposal in Seattle. Seattle Public Utilities is also working on targeted efforts around food-service packaging that will also affect the supply of organics and compostable material, transitioning packaging materials to compostable material (to promote capture of food and reduce confusion) and promoting the use of durable goods.
- **The list of materials accepted for composting continues to be in transition.** Regional commercial composting facilities manage a mix of food, yard debris, and compostable packaging from King County, Seattle, and Snohomish County generators. The specific materials accepted for composting can vary across jurisdictional lines, creating confusion for customers and potentially contributing to contamination challenges. In the first King County Organics Recycling Summit (March 2019), participants reported that one challenge was that processing agreements between haulers and processors and those between haulers and jurisdictions differed in terms of accepted material, such as for compostable packaging. Greenwashing claims listed on packaging like "biodegradable" and the rapidly changing packaging mix in the market also contribute to the confusion.

  It is possible that the challenges associated with acceptance of compostable packaging—either due to confusion leading to contamination, concerns about the presence of chemicals in paper foodservice packaging, or other issues—will lead to changes in the list of materials accepted for composting and, in turn, changes in the amount of organic material available and acceptable for composting by local processors.
- **Participation in residential composting programs in King County still has room to increase,** and there is high potential for additional supply of organics for processing, especially food and food-soiled paper. The 2018 King County Residential Curbside

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[2] https://app.leg.wa.gov/billsummary?BillNumber=1114&Year=2019

[3] http://pacificcoastcollaborative.org/

[4] 2015 King County Strategic Climate Action Plan. https://your.kingcounty.gov/dnrp/climate/documents/2015_King_County_SCAP-Full_Plan.pdf

Characterization Study included an analysis of organic set-out rates (the percentage of households with curbside service who physically placed their organics carts out for collection at the time of the study). The overall set-out rate for the organics cart for all households in King County was 37 percent though the set-out rate is higher in jurisdictions where organics service is embedded in garbage service rather than provided by subscription as a separate service. Comparatively, residential curbside recycling set-out rates were estimated at 74 percent of households in 2018.

Even among households that set out organics carts for collection, there is potential for increased diversion, as most King County households that set out organics carts still place the majority of food scraps and food-soiled paper generated in their garbage carts; less than one-quarter (23%) of organics-participating households placed 80-100% of their food scraps and food-soiled paper in the organics cart for composting.[5]

Processing

OVERVIEW OF CURRENT PROCESSING SYSTEM (BASED ON 2017 REPORTED FACILITY DATA)

Three composting facilities (Cedar Grove Composting in Maple Valley, Cedar Grove in Everett, and Lenz Enterprises) accept and process organic material from regional generators. These composting facilities are already operating near permitted capacity. While regional composting capacity is able to meet current demands, it is not adequate to handle an increasing quantity of organics generated within King County. Based on the regional analysis presented in Section 1, King County, Seattle, and Snohomish County recovered 469,800 tons of organics in 2018, or approximately 85 percent of current permitted capacity.

This analysis is supported by available 2017 composting facility reports submitted to the the Department of Ecology (2017 is the most recent year this data has been published). As shown in Table 4 below composters received nearly half a million tons of organics for processing, representing 80 percent of current permitted capacity.

[5] 2018 King County Residential Curbside Characterization Study, p.45. https://kingcounty.gov/~/media/depts/dnrp/solid-waste/about/documents/waste-characterization-study-2018.ashx?la=en

Table 4. Permitted Capacity and Tons Received in 2017 by Local Organics Processors[6]

Facility	2017 Received (Tons)	Permitted Capacity (Tons)
Cedar Grove Maple Valley	231,639	250,000
Cedar Grove Everett	139,825	228,000
Lenz Composting	73,359	75,000
Total	**444,823**	**553,000**

There remains significant opportunity to increase regional organics recovery, which will require more processing capacity. As documented in Section 1, the analysis estimates that King County, Seattle, and Snohomish County together recovered approximately 469,800 tons of organics for processing in 2018 (85 percent of current permitted processing capacity)—and disposed of 562,400 tons of organics. Additional processing capacity will be needed to manage recoverable organic material that is currently disposed.

NEW AND EMERGING REGIONAL PROCESSING TRENDS

- **Processors are recognizing and acting on the need for more robust processing systems to accommodate higher levels of contamination.** Processors report significant new investment to manage contamination in inbound streams, and participants at the King County Organics Recycling Summit (April 2019) talked about how contamination challenges have led to changes at processing facilities in how they managed inbound streams. For example, Cedar Grove has developed a custom vacuum and conveyor system on site for plastics removal and added new staff on site to monitor the quality of inbound material at the tipping building. Processors also report investment in new screens to remove small objects during processing as well as new procedures to reject highly contaminated inbound loads. As noted in the 2017 Washington State Organics Contamination Reduction Workgroup Report and Toolkit, other technologies are on the market (though not currently in use at regional processors) to identify and remove contamination, such as flotation separation, air knifes, disc screens, eddy current separation, infrared optical sorting and removal methods, and other proprietary processes. However, composters cited costs and hesitancy to invest in unproven technologies as current barriers to their adoption, and Cascadia did not obtain data on the effectiveness or cost of these systems.
- **The role of anaerobic digestion for organics management in King County still requires further study and analysis.** In 2017, HDR completed a feasibility study of anaerobic digestion systems for King County to understand its potential, cost, and environmental

[6] Washington Department of Ecology. Washington composting facilities and material types – 2017. https://ecology.wa.gov/Asset-Collections/Doc-Assets/Reducing-and-recycling/Organic-materials/Washington-compost-facilities-and-material-types-2

impacts. This assessment evaluated three specific scenarios: (1) small, distributed systems, each managing approximately 1,000 tons per year, (2) anaerobic digestion at the South Wastewater Treatment Plant of pre-processed, mixed MSW, and (3) dedicated anaerobic digestion at County Transfer Stations, also for pre-processed mixed MSW. Overall, the study found that anaerobic digestion is “complex and expensive, relative to landfilling or composting.” However, accessing source-separated organics feedstock appropriate for this technology through partnerships with local private composters (which have robust infrastructure and supply of source-separated material already) could be one strategy to mitigate costs.[7] Areas where anaerobic digestion in King County could benefit from additional study and analysis include the environmental impact and potential greenhouse gas emissions reductions relative to landfilling food waste, as well as opportunities for co-digestion of wastewater and solids to enhance production of biogas in existing systems, while expanding available options for processing food waste. Benefits of co-digestion include diversion of organic material from landfill and generation of a renewable energy source. King County Wastewater Treatment division estimates that co-digesting a food waste slurry with wastewater would increase the energy production by about 50 percent, enabling Wastewater Treatment Division to offset a larger portion of its current energy use with its own biogas.

- **Use of small-scale, on-site organics management systems is emerging regionally**, but data on the quantity of organics currently managed by them (including backyard composting) is unknown, and extent of future growth is uncertain. Impact Bioenergy and WisERG are two examples of regional companies that offer a commercial, on-site solution for food scrap management, processing organic material into soil amendment. Impact Bioenergy has previously received grant funding from King County to test its digester in Auburn, WA and to evaluate the feasibility of an on-site digester project on Vashon Island.[8] Impact Bioenergy has since partnered with a tofu producer on Vashon Island (Island Spring Organics) for a demonstration project for community-scale anaerobic digestion. Commissioning and digester start-up began in April 2019, and results from the 12-month demonstration project will provide valuable lessons around feasibility and considerations for replicability of similar community-scale decentralized AD projects in the region.

[7] https://kingcounty.gov/~/media/depts/dnrp/solid-waste/about/planning/documents/anaerobic-digestion-feasibility-study.ashx

[8] https://kingcounty.gov/depts/dnrp/solid-waste/garbage-recycling/compost-more/commercial-grant.aspx

PROCESSING CONSTRAINTS AND BARRIERS

- **Managing contamination remains a significant concern to processors.** Maintaining finished product quality is key to maintaining adequate market demand for compost. Processors must balance the cost of adding processing steps with maintaining competitive market prices.[9] Stakeholders at the King County Organics Recycling Summit in April 2019 recognized that contamination is a significant challenge and requires collaboration and work across the supply chain. One information gap as stakeholders work to identify strategies to manage organics contamination is a better understanding of the major contaminants in the inbound stream and which specific contaminants to target (taking into account what processors are already successful in removing) to best set up the system for success.
- The 2018 King County Residential Curbside Characterization Study found that organics contamination was 4.6 percent of the stream. Table 5 below lists the contaminant materials and their percentages by weight of residential organics. While the composition data can be used to provide information on the quantity of contaminant material, most contaminants fall into "Other Materials," a catch-all category in the study for material that does not fit into the other defined study types. Examples of "other materials" in this study include non-compostable bags, non-compostable plastic-coated paper, textiles, pet waste, loose soil and rocks, and non-recyclable metal and glass.

Table 5. Non-compostable material types and compositions from the 2018 King County Residential Curbside Characterization Study

Material	Est. %	+/-
Recyclable Materials	**0.6%**	
Recyclable Paper	0.4%	0.2%
Recyclable Plastic	0.1%	0.1%
Recyclable Metal	0.0%	0.0%
Recyclable Glass	0.1%	0.1%
Other Materials	**4.0%**	
Other Materials	4.0%	2.4%

- Processors report that the most common, problematic, and persistent types of contaminants are **plastic film**, **rigid plastics** (non-compostable), and **glass**. As noted in the 2017 Organics Contamination Reduction Workgroup report, while glass is a less prevalent contaminant material by weight, it can be as problematic to composters as more voluminous contaminants because it is difficult to identify and remove, especially after the grinding process.[10]

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[9] King County LinkUp Mini-Market Assessment 2017. Cascadia Consulting Group.

[10] Washington State Organics Contamination Reduction Workgroup. Report and Toolkit. June 2017. https://static1.squarespace.com/static/585c2db75016e175c9d685b7/t/59932c0be4fcb58c9335fec5/1502817295485/Washington+State+Organics+Contamination+Reduction+Workgroup_FINAL.pdf

- **Processing capacity for compostable packaging and products may be limited in the future if contamination cannot be addressed.** If contamination cannot be adequately addressed, it is possible that the processing capacity for certain types of organic materials may be reduced, especially for compostable packaging and products. In Oregon, composters published a joint statement in March 2019 outlining their concerns about the presence of compostable packaging in the organics stream and stating their intent to exclude compostable packaging from their acceptance lists.[11] Local composters serving King County have so far not made such a formal statement and the Washington State Legislature recently passed a bill to improve labeling of compostable products and packaging that is intended to reduce confusion and contamination and will take effect July 1, 2020.[12] This bill (ESHB 1569) will require clear and easy to understand labeling on compostable products (such as food service ware and plates) that are sold in Washington. In addition, with the intent to minimize customer confusion between compostable and non-compostable film plastic, only compostable film bags can be tinted green or brown in Washington. Compostable plastic products must meet industry standards for compostability (ASTM D6400 or D6868) and be certified (and labeled) by a recognized third-party independent verification body, such as the Biodegradable Products Institute (BPI).
- **Expanding processing capacity for composting is challenging** for reasons that include land use for potential new or expanded sites, the cost of land, concerns from neighboring residents about odors from a compost facility, and what could be a lengthy time frame to complete permitting.
- **Increased diversion of food waste may pose processing challenges, even if processing capacity is technically available.** While local processors have struggled with increases in contamination that has accompanied the acceptance of food and other compostable materials in organics collection programs, the inclusion of food waste itself has not be an issue since processors established permitted capacity to receive and process food as part of their compost operations. However, there is some potential that the proportion of food relative to yard debris may become an area of concern if diversion of food waste increases substantially and leads to a significant change in the composition of incoming organic feedstock for processing at local facilities, which is currently approximately three-quarters yard debris.
- A recent statewide survey of composters in California (where commercial composting operations accepting food waste are among the most mature in North America) indicated that very few facilities there receive feedstock in which food comprises more than 30 percent of incoming material. Despite the recent statewide mandates for food waste diversion adopted as part of SB 1383, the majority of composters surveyed said they did not have

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[11] http://ncrarecycles.org/2019/03/oregon-composters-push-back/

[12] http://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/House%20Passed%20Legislature/1569-S.PL.pdf#page=1

capacity nor interest to increase the proportion of food scraps received and cited multiple concerns associated with increasing the amount of food scraps received at their facilities.[13]

Markets for processed organics

OVERVIEW OF MARKETS

Almost all organic materials generated within King County that are processed are being converted into compost products, which are primarily used as soil amendments sold through retail and wholesale outlets to residential and commercial customers as well as state and local agencies. Local processors continue to seek to expand and diversify their markets for finished product and to encourage increased engagement of local agencies in market development efforts, such as through preferred purchasing policies for locally generated compost products.

CURRENT MARKETS

The 2017 Washington State Organics Contamination Reduction Workgroup reported that, on average, commercial composters sell their products to customers within a 50-mile radius of where it is made.[14] Most processed organics currently sold are used as soil amendments and landscaping material purchased by residential and commercial customers. In the 2015 King County Recycling Market Assessment, processors interviewed stated that residential demand ranged from 15 to 50 percent of their compost sales, and reported agriculture ranged from five to 10 percent. The remainder of the product is reportedly used by government agencies or landscapers. In 2018, one processor reported that agriculture and direct municipal purchasing currently are estimated to each make up less than one percent of sales.

Current reported local markets and common applications for compost include:

- Residential and commercial soil amendments and other landscaping applications, including use by nurseries.
- Construction, land clearing and grading, and other site development projects for use in erosion control and for topsoil blending or as a soil amendment for reestablishing vegetation and/or landscaping.
- Transportation projects for erosion control, stormwater management, and for reestablishing vegetation.
- Public and private sector green stormwater infrastructure projects such as rain gardens, bioswales, and green roofs.

[13] CalRecycle, "SB 1383 Infrastructure and Market Analysis: Contractor's Report." April 2019, Figures 6-9. https://www2.calrecycle.ca.gov/Publications/Details/1652

[14] Washington State Organics Contamination Reduction Workgroup. Report and Toolkit. June 2017. https://static1.squarespace.com/static/585c2db75016e175c9d685b7/t/59932c0be4fcb58c9335fec5/1502817295485/Washington+State+Organics+Contamination+Reduction+Workgroup_FINAL.pdf

The trends related to demand for compost from each of these applications is not known, but a more detailed description of examples, benefits, and considerations of different compost applications are included in Appendix C. Compost Use Best Practices Literature Review.

Some interviewees from the 2015 Market Assessment noted that there was an increased emphasis in outreach communication to contractors on the benefits and potential for cost savings through the use of compost to meet two soil-related project development requirements—for erosion control and for soil amendment, but it is not known if this has had a measurable effect on commercial demand for compost.[15,16] Other current considerations for local organic markets include the below.

- **Local government applications are reported to represent a small portion of current compost markets**, but because much of what is used for public projects is purchased and managed by commercial contractors, it is not clear how much of what is sold to "commercial" customers is used for local government applications. Recent adoption of low-impact development code updates and increased investments in green stormwater infrastructure projects by local jurisdictions suggest that local government demand for compost may be increasing but the extent of this increase is unknown as there is not currently a system in place for tracking the amount of compost procured by local government agencies in King County.
- **WSDOT is historically a significant user of compost**, but demand is variable and dependent on the number and location of road construction projects funded each year. WSDOT is among the most active state transportation agencies in compost use and has been highlighted as a national leader by BioCycle.[17] However, since 2015, WSDOT's compost use (as tracked through the awarded contracts) has decreased from over 60,000 cubic yards to 20,000-30,000 cubic yards a year. As reported in 2015, WSDOT continues to design for and purchase primarily medium and fine compost to limit visible contamination. With the switch to finer compost, the interviewee reported that they have not heard reports or negative feedback about contamination from use of compost. WSDOT reported that one of their current challenges with compost use is the difference in cost and availability of compost in eastern vs. western Washington. The interviewee noted that while costs of compost products have not been an issue for projects in western Washington, compost can cost up to two to three times more across the mountains.
- **Agricultural applications represent a small portion of current markets but with potential for growth.** The Compost Outreach Project—an initiative by the WSU Cooperative Extension in Snohomish County—has collaborated with local compost producers, county

[15] Building Soil. When to Amend? http://www.buildingsoil.org/tools/When_to_Amend.pdf

[16] Building Soil. Erosion Control with Compost. http://www.buildingsoil.org/tools/Erosion_Control.pdf

[17] Ryan Batjiaka, "Compost Use by State DOTs," BioCycle, October 2016. https://www.biocycle.net/2016/10/24/compost-use-state-dots/.

offices and local conservation districts since 2011 to promote and evaluate use of commercial food scraps and yard trimmings compost on farms in Snohomish and northern King County through compost use trials. A report on the project published in 2016 reported that agricultural markets made up less than five percent of the total compost market in Washington State and found that 81 percent of farmers surveyed had not previously used food scraps and yard trimmings compost.[18] Research and demonstration trials carried out by the project have succeeded in documenting positive effects of compost use on crop production and soil quality, and outreach by project partners continues to educate area farmers about the benefits of compost use.

NEW AND EMERGING MARKETS

Additional details about the benefits of compost in current and emerging market applications, as well as barriers to compost use identified as part of the literature review conducted for this market assessment update can be found in Appendix C. Compost Use Best Practices Literature Review.

- Agricultural applications in central and eastern Washington are viewed as a robust, large-scale potential end market for compost, but whether it is economically feasible to serve this market with material generated in western Washington requires more evaluation. In addition to the cost of transportation and delivery of material over the required distances, a researcher from the University of Washington also notes competition with the quality and consistency of compost of material already produced in eastern Washington, such as in Yakima. This researcher also notes that these facilities have stronger local relationships to support their end markets.[19] These facilities, however, produce much less compost than the major facilities in Western Washington—Natural Selection Farms in Yakima reported handling 49,700 tons of compostable material in 2017—so it is possible that additional compost supply may be needed if demand in this area grows substantially.
- **Research continues to demonstrate compost use as a method of carbon sequestration.** For example, the Marin Carbon Project in California has partnered with farms and universities to assess the lifecycle carbon impact of compost application and soil carbon sequestration potential, linking compost use and land management practices to efforts to reduce climate change impacts. As part of this work, the Marin Carbon Project developed a carbon accounting protocol for compost use on grazed grasslands in 2014. This enables ranchers to use the protocol to have compost use for carbon sequestration on their lands independently

[18] Doug Collins, Hallie Harness and Andy Bary, WSU. "Commercial Compost Application on Western Washington Farms." July 8, 2016. https://snohomishcd.org/blog/2016/7/8/commercial-compost-application-on-western-washington-farms.

[19] Dr. Sally Brown. Value of Compost in Agricultural Uses. King County Organics Recycling Summit Day 2. April 17, 2019. https://kingcounty.gov/depts/dnrp/solid-waste/programs/linkup/organics/summits.aspx

verified and generate carbon offset credits that can be traded in carbon markets.[20] There is interest and exploration of linking soil carbon sequestration to market mechanisms. For example, the 2018 Farm Bill passed by Congress includes a pilot program to incentivize and reward carbon performance on farms, such as cover crops, crop rotation, and other practices that enhance carbon storage in soils.[21]

- **Local processors are interested in seeing more demonstrated leadership from King County and other agencies in the use of compost produced from locally generated organic waste.** These opportunities are described in more detail in the next section (Potential Public Sector Actions under Section 4), but they can include more enforcement of existing soil amendment policies and implementation of environmental preferred purchasing policies.

MARKET CONSTRAINTS AND BARRIERS

Contamination in compost products diminishes marketability for certain applications. The need to manage upstream contamination adds to finished product cost and makes it a challenge to maintain product quality. Maintenance of finished product quality is needed to ensure availability of end markets for compost produced from local organic wastes. For example, the interviewee from WSDOT noted that visible contaminants in compost used on roadways can be considered litter and therefore a potential barrier to compost use by WSDOT if quality cannot be maintained. Recent research on barriers to and adoption of low-impact development practices among developers found that one of their project motivators is aesthetics, specifically things that are pleasing and visible to tenants.[22] While soil amendment with compost was not explicitly called out in this research, visible contamination in compost—which negatively affects project aesthetics—could be a barrier to increased compost use for this audience as well.

Local processors have voiced concerns about the growing amount of contamination in compost products that has accompanied acceptance of food and other compostable materials beyond yard waste as part of organics collection programs, including in the 2017 Organics Contamination Reduction Workgroup Report and Toolkit.[23]

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[20] Marin Carbon Project. Rangeland Compost Protocol. https://www.marincarbonproject.org/policy/rangeland-compost-protocol

[21] NRDC. Spring has come – for soil carbon markets. https://www.nrdc.org/experts/lara-bryant/spring-has-come-soil-carbon-markets

[22] Cascadia Consulting Group. Building Green Cities – Social Marketing Report (DRAFT). March 2019.

[23] 2017 Organics Contamination Reduction Workgroup: Report and Toolkit. June 2017. https://static1.squarespace.com/static/585c2db75016e175c9d685b7/t/59932c0be4fcb58c9335fec5/1502817295485/Washington+State+Organics+Contamination+Reduction+Workgroup_FINAL.pdf

The challenging relationship between contamination and compost marketability has also been highlighted in a recent assessment of composting infrastructure and markets in California. The assessment revealed that composters in the Bay Area region, which leads the state in acceptance of food scraps in organics collection programs, market far less of their finished material as compost or mulch compared to other regions in the state. These product types represented just over half (52%) of products produced by Bay Area composters in contrast to composters in other regions of the state, which reported between 70-93 percent of production as compost or mulch products. Instead, Bay Area composters report that 41 percent of their production goes to alternative daily cover (ADC) at regional landfills.[24]

Despite contamination challenges, local compost processers serving King County report marketing the majority of their materials as compost or mulch products, but meeting customer expectations around visible contamination is an increasing challenge to the marketability of these products made from feedstocks that include food and other compostable materials (and accompanying contaminants).

Other constraints and barriers related to organics markets include:

- **Market demand for compost products is volatile and highly seasonal.** Seasonality and construction project timelines continue to be factors that affect market demand. For example, WSDOT's use of compost varies with new project funding since their current uses are tied to construction activities. Total annual compost use, as tracked by the quantities specified in bid awards, have ranged from 35,000 to 105,000 cubic yards per year (a 3x difference) over the last 10 years. Stakeholders at the King County Organics Recycling Summit in April 2019 noted potential for more routine applications of compost or other soil amendments for parks, city landscaping, and on roadsides, but these are not standard practices and/or do not represent significant quantities of compost at this time.
- **Lack of uniformity of specifications and limited awareness of opportunities for procurement hamper greater use of compost by local jurisdictions.** Local agencies currently use a wide variety of specifications related compost procurement, and the lack of uniformity in specifications can pose challenges for agencies interested in increasing the quantity and scale of compost use. In addition, lack of internal expertise or education on how and when to use or procure compost within local agencies, as well as concerns about compost use (e.g., perceptions about contamination or odor) can pose barriers to greater use of compost. City of Seattle has a well-researched, tested and practical standard specification for compost, similar to the specification used by WSDOT and the Department

[24] CalRecycle, "SB 1383 Infrastructure and Market Analysis: Contractor's Report." April 2019, p.48, Figures 11B-E. https://www2.calrecycle.ca.gov/Publications/Details/1652

of Ecology.[25] Seattle's specification could inform the specifications developed by King County, as well as those used regionally by other jurisdictions.

- **Increasing agricultural use must address multiple barriers faced by farmers.** The WSU Compost Outreach Project notes that farmers have continually pinpointed compost price, spreading (equipment and time required), compost delivery, plastic contamination of compost, and lack of information about how to use compost as barriers.[26]

  Similar barriers were identified for agricultural use of compost in California during a one-day workshop organized in early 2018 by BioCycle and R. Alexander Associates, Inc. to discuss gaps and opportunities for California's compost markets. In the agricultural sector, participating stakeholders identified the following barriers: costs of compost (including transportation); a lack of understanding for how compost affects nutrient management plans; and need for better enforcement around pathogen and weed management in finished product.[27]

- **Acceptance of certain compostable** paper and packaging materials in organics collection **programs may also pose challenges for growth in agricultural markets.** Under guidelines set out by the National Organic Program (NOP), compost produced from certain recyclable papers (such as waxed cardboard) and compostable plastics is not eligible for organic certification, which poses challenges for marketing compost produced with feedstocks from these programs to farms operating under or seeking organic certification.

- **High costs of transporting compost produced in western Washington for applications in central and eastern Washington makes compost less competitive**. Interviewees and summit attendees mentioned the costs and associated marketing challenges for applications that require long-distance transport of compost. This challenge is relevant for both agriculture markets and public projects like road construction in central and eastern Washington.

  In addition, one researcher from the University of Washington who attended the April 2019 summit noted that compost from western Washington must compete with the quality and consistency of compost of material already produced in eastern Washington, such as Natural Selection Farms in Yakima, which reported handling 49,700 tons of compostable material in 2017. This researcher also noted that these facilities have stronger local relationships to support their end markets, although it is not known whether these facilities have available

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[25] City of Seattle 2017 Standard Specifications. Compost specifications are covered under Section 9-14.4(8). https://www.seattle.gov/Documents/Departments/SPU/Engineering/2017StandardSpecifications.pdf

[26] Doug Collins, Hallie Harness and Andy Bary, WSU. "Commercial Compost Application on Western Washington Farms." July 8, 2016. https://snohomishcd.org/blog/2016/7/8/commercial-compost-application-on-western-washington-farms.

[27] BioCycle, "Compost & Digestate Volumes Are Increasing -- Are California Markets Ready?," 2018. http://www.biocycle.net/wp-content/uploads/2018/08/BCWC18_Workshop.pdf

feedstock and potential future growth in capacity to meet all potential demand for compost in central and eastern Washington.[28]

- **New soil amendment products that compete with compost and biosolids-derived compost are entering the market.** WSDOT mentioned availability of new products like biotic soil amendments (engineered topsoil alternatives) on the market that are designed for similar revegetation and erosion control applications. While local interviewees did not cite competing *new* products as a concern at this time, there is a wide range of potential soil amendment products on the market, from bark, wood mulch, and worm castings to biochar, digestate from anaerobic digestion, and engineered hydro-mulch. Buyers of soil amendment products may not know what type of material to choose and why, and this can be another challenge to markets for recycled organics products. Ongoing customer education and product differentiation is needed.[29]

[28] Dr. Sally Brown. Value of Compost in Agricultural Uses. King County Organics Recycling Summit Day 2. April 17, 2019.

[29] Ron Alexander. Emerging Products in the Marketplace. Presentation, BioCycle West 2019.

Section 3. Summary and Recommendations

Conclusion

To realize the vision set out in the Organics Recycling Summits in 2019—where *organic material is prevented, reduced, recycled and ultimately reused locally, creating a self-sustaining regional organics system that minimizes waste, promotes healthier soils and protects the environment*—work is needed across the system to address known challenges, continue to nurture robust and sustainable processing infrastructure, and grow end markets for finished product. These challenges include a need to expand processing capacity to meet future supply of organics that are currently disposed, addressing contamination challenges, and "closing the loop" for local recycled organics products.

The following section highlights potential actions identified as relevant and applicable for King County given the current and emerging trends and challenges related to the organic material management system.

Potential Public Sector Actions

Some actions described below can be taken by King County and/or other local governments on their own while other actions require collaboration with stakeholders across the supply chain.

SUPPLY

- Continue to work collaboratively on organics industry challenges across the supply chain, especially related to addressing contamination and market development. Realizing the environmental benefits of both organics diversion from landfill and use of compost depends on the ability of local processors to produce high quality products that have robust local markets. King County has already been participating in collaborative initiatives, such as the Organics Contamination Reduction Workgroup in 2016/2017 and the recent King County Organics Recycling Summits (Spring 2019). King County should continue to support opportunities to bring regional stakeholders together on this topic.
- Continue to educate customers on what can and cannot be placed in their curbside organics collection carts to reduce contamination of the stream. Participants at the King County Organics Recycling Summit noted, "garbage in, garbage out" with regards to processing organic material, and they noted responsibility for contamination management at *all* supply chain stages, not just in processing. One area of opportunity that participants identified is to get the public to draw a stronger connection between what they place in the carts and what then becomes compost that gets applied to local land.

PROCESSING

- To mitigate challenges to expanding processing capacity, review the potential for siting organic composting facilities in King County. Consider rural area zones and consider property-specific conditions that would be appropriate for organic composting facilities on these sites. An alternative may also be to consider areas zoned for mineral use (for extraction and processing of mineral and soil resources), and either modifying land use and zoning to be suitable for organics processing or changing the designation for these zones to Rural Area, as feasible and appropriate.

MARKETS

- **Continue to communicate and quantify the broader environmental impacts of compost use beyond solid waste management,** such as its role in building healthy soil, promoting water conservation, and its potential for sequestering carbon. As agencies and organizations begin to set broader environmental goals, such as greenhouse gas emissions reductions, water conservation, and stormwater pollution prevention, the value of compost use should be understood and factored into public agencies' activities related to project planning, procurement, and program investments to expand and diversify markets across potential compost applications.

  One component of this communication may involve more clearly articulating documented benefits of compost use in various applications. Research results demonstrating many of these benefits are synthesized in the accompanying literature review, found in the Appendix.

  Another component of this communication may involve shaping the expectations of compost buyers—specifically, to remind buyers of finished compost that there is some tolerance for inert contaminants in the allowable specifications and to remind buyers that they are purchasing a recycled end product to help gain acceptance for some (limited) level of contamination in the product.

- **Continue to promote the use of *locally produced* compost to residents and businesses.** King County and other local jurisdictions already call on residents and businesses to purchase and use compost as part of messaging around solid waste management, soil health, water quality, and green infrastructure. In certain places, this message can be strengthened to focus specifically on *locally produced* compost, potentially calling out local compost producers or products made with organics generated within the county by name.

- **Continue to research compost benefits and invest in pilot projects to test and demonstrate the research** for compost use. Stakeholders at the King County Organics Recycling Summit noted that one way in which biosolids (and biosolids-derived compost) from the Wastewater Treatment Division have been able to more readily establish end markets is because of a strong research foundation and extensive engagement with early adopters and innovators for the product. We've heard from these stakeholders, as well as those in municipal agencies who work to promote soil amendment with compost, that obtaining buy-in from an engaged user within the target industry is critical to broader adoption of compost use within a market. A body of research and projects that demonstrate why and how to use locally produced compost successfully are tools to engage end users and encourage them to adopt new practices. Some of this research is underway—Washington State University is conducting research on the economic costs and benefits of compost use on farms, and University of Washington and the Northeast Biosolids & Residuals Association have conducted an analysis of the carbon sequestration benefits of compost use in urban contexts—but additional proactive market outreach and support for pilot projects is likely needed to advance compost use in these areas.[30]
- **Identify opportunities for increased compost use in appropriate public projects,** through direct agency contracts and procurement policies, analogous to environmentally preferred purchasing policies for recycled content goods. Where possible and appropriate, incorporate specifications and procurement preference for locally produced compost, derived from waste material generated by King County residents and businesses. Increasing the use of compost in public projects provides the opportunity to lead by example and demonstrate more "circular" management of the region's organic waste. Large-scale procurement also has the potential to reduce procurement costs for all agencies by increasing the scale of purchasing and centralizing pricing negotiations.

  Public projects with the potential for increased compost use include green infrastructure installations and other stormwater management and erosion control projects, habitat and site rehabilitation, park landscaping, and turf and tree maintenance.

  Support for increased use on public projects could also involve establishing or updating environmentally preferred purchasing policies, creating more uniform specifications to support simplified procurement, and developing model ordinances for local jurisdictions. Investing in additional education for procurement staff and project managers from local agencies on compost applications and benefits can also work to address and overcome

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[30] Both bodies of research are not yet published at the time of this draft (April 2019). Research efforts were mentioned at the King County Organics Recycling Summit in March and April 2019. The UW/NEBRA research was presented at the 2019 BioCycle West conference on carbon benefits of compost use in urban contexts. Key findings include that compost derived from biosolids earn some soil carbon credit relative to use of fertilizer on both new and established lawns and for urban tree planting. The impact of the action (earned carbon credits) are higher when applied to new plantings (new lawns, new trees) relative to established vegetation.

perception barriers to use of recovered organics products like compost, such as concerns about contamination or odor, especially as processing technologies continue to improve.

- **Support monitoring and reporting on compliance with current requirements to amend post-construction soils with compost.** King County Code 16.82 requires that construction projects submit a soil management plan to the Department of Local Services, Permitting Division with all permit applications. These plans must document the amount of compost or compost-containing topsoil mix used, along with receipts for material delivered to the site.[31] There is not currently a consistent system for tracking and recording compliance, so additional collaboration with the Permitting Division is needed to gather data on the current level of compliance and the amount of compost use associated with this requirement. The process of compliance monitoring may also help to identify potential barriers to compliance, such as awareness of requirements or a need for standardization of similar policies for local jurisdictions. Seattle has a similar post-construction soil amendment policy, and they describe an inspection process prior to building permit final approval that includes verification of compost, topsoil, and mulch delivery at the project site that match approved plans.[32]
- **Tie compost use directly to support of climate action goals.** As agencies and organizations begin to measure progress toward climate action goals, such as greenhouse gas emissions reductions, the benefits of compost use can be quantified to further justify compost procurement by public and private sector stakeholders. King County already uses the lens of climate change as a way to show the benefits of using Loop® biosolids, estimating that the use of Loop biosolids offsets the majority of the greenhouse gas emissions from Wastewater Treatment Division's operations.[33] A similar approach might be considered to motivate greater procurement of compost by public sector agencies.

[31] King County. Achieving the Post-construction Soil Standard. https://kingcounty.gov/~/media/depts/dnrp/solid-waste/green-building/documents/Post-Construction-Soil-Standard.ashx?la=en

[32] Seattle Department of Construction and Inspections. Green Stormwater Infrastructure on Private Property: Post Construction Soil Management. https://www.seattle.gov/DPD/Publications/CAM/cam531.pdf

[33] King County. Using biosolids to fight climate change. https://www.kingcounty.gov/services/environment/wastewater/resource-recovery/loop-biosolids/carbon.aspx

- **Explore feasibility of linking compost use to carbon markets through quantification of carbon sequestration benefits.** King County has begun exploring ways to tie forest health to carbon credits, launching the nation's first forest carbon credit program in 2019. King County sells verified carbon offsets from forest land that it purchases and manages and uses revenue from sale of carbon offsets to protect more forest land.[34] There may be opportunities to explore opportunities for incentivize compost use and soil carbon sequestration locally through carbon financing methods.
- **Continue to monitor and draw on best management practices, tools, and market development strategies elsewhere,** such as those shared at conferences like the one organized by the U.S. Composting Council. For example, California policies include similar requirements for local governments to develop plans for compost use that can inform opportunities applicable to King County. For example, AB 2411 requires CalRecycle to develop and implement a plan to maximize the use of compost after wildfires to stabilize slopes and establish vegetation by December 2019, and SB 1383 will include requirements for jurisdictions to meet purchasing targets for recycled organic content products.[35,36] One interviewee also suggested that King County be open to non-traditional approaches and innovations in market development. As an example, social media marketing could be one opportunity to engage the public and other potential users of compost, highlighting the various opportunities to use compost at home, in school gardens, for restoration of public lands, on development job sites, and other uses. Other strategies that could be explored include institutional challenges and community competitions related to compost use.

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[34] King County. Forest Carbon Program. https://kingcounty.gov/services/environment/water-and-land/land-conservation/forest-carbon.aspxhttps://www.kingcounty.gov/elected/executive/constantine/news/release/2019/May/9-forest-carbon-program.aspx

[35] California Legislative Information. Assembly Bill No. 2411. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB2411

[36] CalRecycle. SB 1383 Education and Outreach Resources. https://www.calrecycle.ca.gov/organics/slcp/education

Appendix A. King County Organics Disposal and Recovery Data by Sector

This appendix expands on the King County (excluding Seattle) organics disposal and recovery analysis presented in Section 1, presenting the available data by sector. The sectors included in the analysis are:

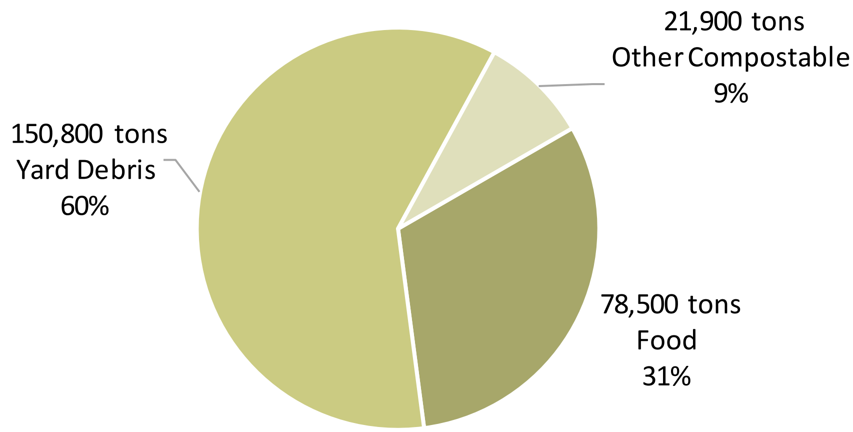
- **Residential**: Materials generated and collected at the curbside from King County residences. For analysis, residential is split into two subsectors:
  - **Single-family**: Material from single-family homes.
  - **Multifamily**: Material from multifamily dwellings, including apartments and condominiums.
- **Commercial**: Non-residential waste materials, generated at and collected from businesses, schools, government offices, and other types of non-residential sectors.
- **Self-haul**: Material that residents or businesses brings themselves from the point of generation (e.g., home or business) to the transfer station.

SINGLE-FAMILY RESIDENTIAL

This section summarizes estimates of single-family organics disposal and recovery in King County. This data is based on tonnages reported by haulers to the King County Solid Waste Division and the latest available waste characterization data for this sector, the 2018 King County Residential Curbside Characterization Study.

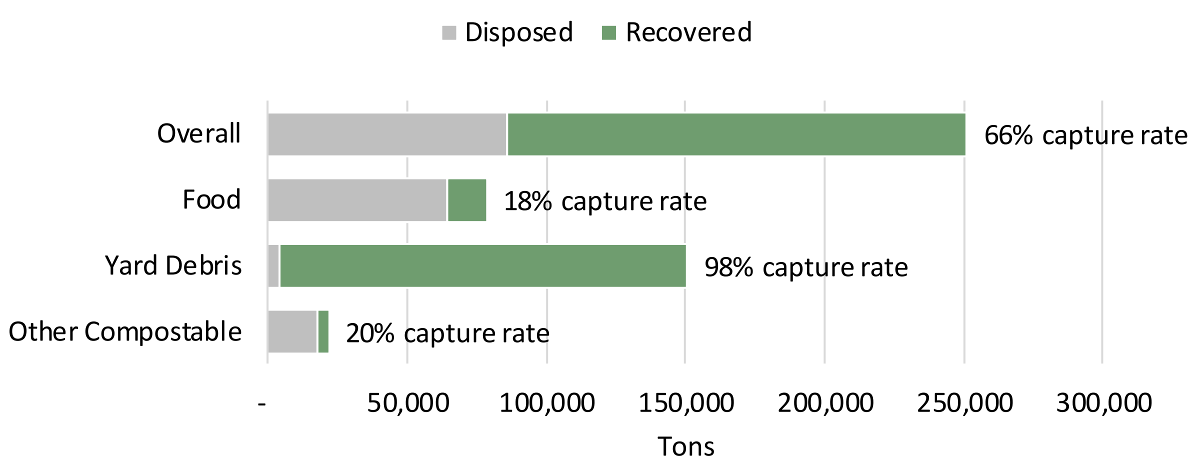
In 2018, King County's single-family residents generated approximately 251,200 tons of organic materials. Figure 10 shows the composition of generated organics by material type. Approximately three-fifths (60%) of this material was yard debris.

Figure 10. King County organics generation, single-family residential



Approximately two-thirds (66%) of generated organics in the single-family residential sector was captured for composting through curbside collection programs. Figure 11 shows the quantity of organic material disposed and recovered by material type. The figure also includes capture rates. As shown, nearly all yard waste generated by single-family residents in King County is captured for composting (98% capture rate); however, less than two-fifths (18%) of generated food waste by single-family residents is recovered.

Figure 11. King County organics disposal, recovery, and capture rates by material type, single-family residential



Annual hauler reporting to King County for 2018 shows that haulers collected 173,500 tons of organics at curbside from single-family residents. Based on the available composition data, Cascadia estimates that nearly 8,000 tons (4.6%) of this material is contamination. Table 6 shows the composition of the stream by the recoverability of the material (e.g., recyclable, compostable, or non-recoverable).

Table 6. Composition of King County organics stream by recoverability, single-family residential

Recoverability	% by Weight	Tons
Compostable	95.4%	165,600
Recyclable	0.6%	1,000
Non-recoverable	4.0%	6,900
Total	**100%**	**173,500**

The detailed composition available for King County single-family organics is shown below. Percentages shown are of total weight.

Table 7. Detailed composition of King County organics stream, single-family residential

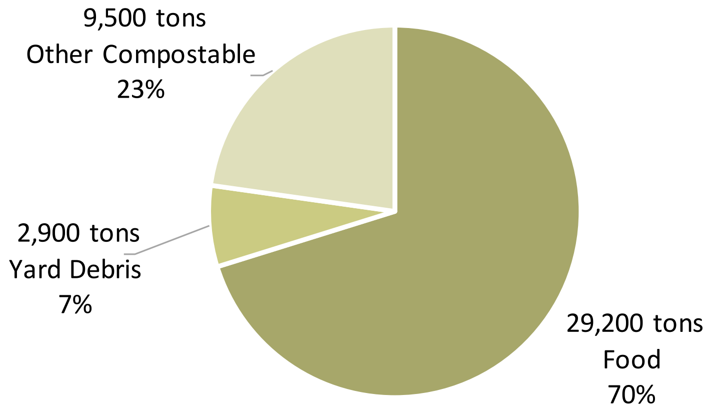
Material	Est. %	+/-	Material	Est. %	+/-
Compostable	**95.4%**		**Recyclable**	**0.6%**	
Fruits and Vegetables, Edible	1.5%	0.4%	Recyclable Paper	0.4%	0.2%
Fruits and Vegetables, Non-edible	3.6%	0.8%	Recyclable Plastic	0.1%	0.1%
Homegrown Fruits and Vegetables	0.2%	0.2%	Recyclable Metal	0.0%	0.0%
Meat, Edible	0.4%	0.1%	Recyclable Glass	0.1%	0.1%
Meat, Non-edible	0.4%	0.1%	**Other Materials**	**4.0%**	
Mixed/Other Food Waste	2.3%	0.7%	Other Materials	4.0%	2.4%
Compostable Paper	2.1%	0.4%			
Compostable Plastic	0.1%	0.0%			
Other Compostables	0.3%	0.4%			
Yard Debris	84.5%	3.2%			

MULTIFAMILY RESIDENTIAL

This section summarizes estimates of multifamily organics disposal and recovery in King County. This data is based on tonnages reported by haulers to the King County Solid Waste Division. Estimates of organics in garbage from multifamily residents are based on the 2015 King County Waste Characterization and Customer Survey Report. Because King County has not conducted a characterization study of the multifamily organics stream, the estimates for multifamily organics in King County are modeled with data from the City of Seattle from 2012, prior to the implementation of Seattle’s mandatory food waste requirements.

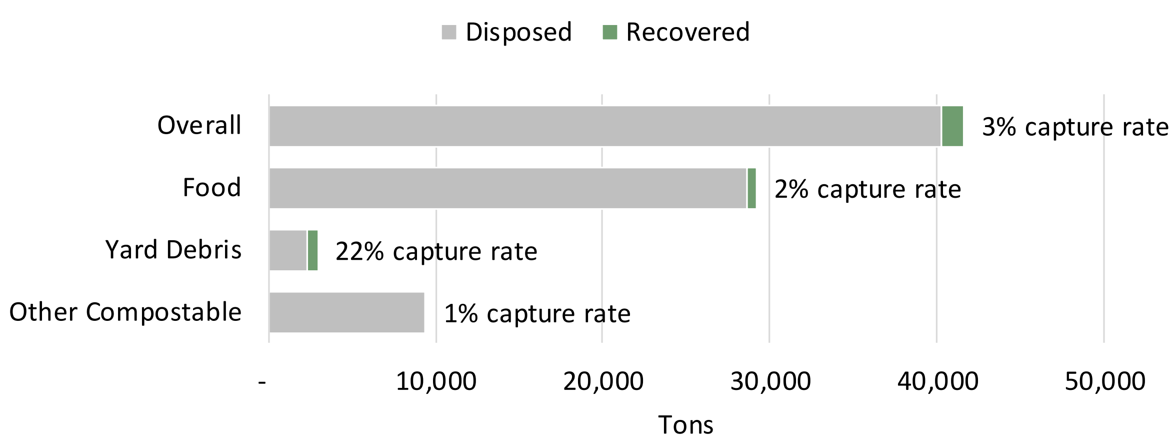
In 2018, King County’s multifamily residents generated approximately 41,700 tons of organics. As shown in Figure 12, over two-thirds (70%) of the generated organics is food. Less than one-fifth (7%) of organics generated by the King County multifamily sector is yard debris.

Figure 12. King County organics generation, multifamily residential



Approximately 3 percent of organic material generated by multifamily residents is captured for composting through curbside collection programs. Figure 13 shows the quantity of organic material disposed and recovered and the capture rate by material type. The analysis shows that 22 percent of yard debris generated by multifamily residents in King County is captured for composting, while other organics are primarily disposed (<2% capture rate for all other recoverable material types).

Figure 13. King County organics disposal, recovery, and capture rates by material type, multifamily residential

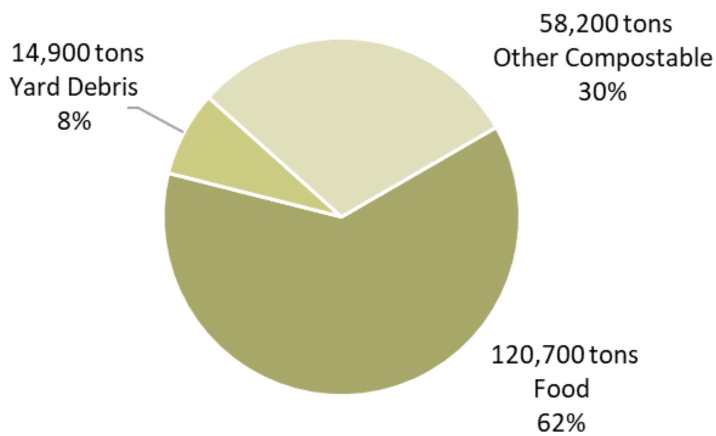


COMMERCIAL

This section summarizes estimates of commercial organics disposal and recovery in King County. This data is based on tonnages reported by haulers to King County, as well as from tonnages Cascadia requested directly from commercial organics haulers. Composition estimates for organics in garbage from the commercial sector are based on the 2015 King County Waste Characterization and Customer Survey Report. Composition estimates for recovered commercial organics collected in curbside carts are based on a single-season, King County commercial organics study in March 2019.[37]

In 2018, King County's commercial sector generated approximately 193,900 tons of organics. As shown in Figure 14, over two-fifths (62%) of the generated organics is food, and nearly one-third (30%) is other compostable material, such as compostable paper or plastic.

Figure 14. King County organics generation, commercial sector



Nearly one-fifth (17%) of organic material generated by the commercial sector in King County is captured for composting through curbside collection programs. Figure 15 shows the quantity of organic material disposed and recovered and the capture rate by material type. This figure shows that King County commercial organics generators are not recovering yard debris through curbside collection programs and that they are capturing approximately one-fifth (20%) of generated food. This data indicates there is still significant opportunity to increase commercial sector participation in organics diversion programs. One limitation of this analysis is that the commercial sector organics data is based on one season only, from March 2019. Generation of yard debris is highly seasonal, and the seasonal variation is not reflected in the available data.

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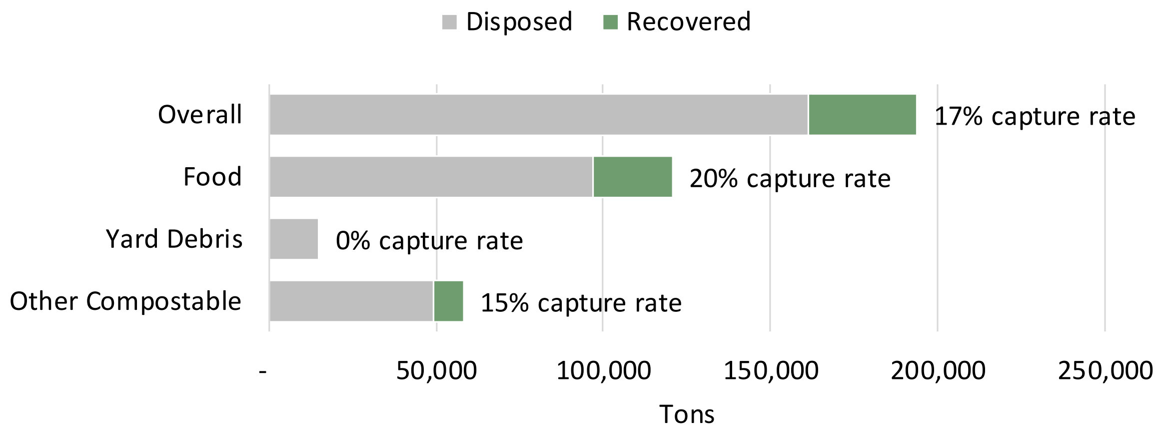
[37] King County. *Commercial Organic Materials Characterization.* August 2019. Available from https://www.kingcounty.gov/depts/dnrp/solid-waste/about/waste-monitoring/waste-documents.aspx.

Figure 15. King County organics disposal, recovery, and capture rates by material type, commercial sector



Hauler reports to King County and data that Cascadia requested from private haulers for 2018 shows that haulers collected approximately 37,200 tons of organics at curbside from commercial generators. Approximately 1,200 tons (3.4%) of the material collected at curbside is non-recoverable material, while 3,300 tons (8.8%) are recyclable. Both recyclable and non-recoverable material are generally considered contaminants in the organics stream, though the recyclable portion includes recyclable paper such as newspaper and cardboard that could be processed in existing composting facilities. However, recycling remains the preferred end use for recyclable paper.

Table 8. Composition of King County organics stream by recoverability, commercial sector

Recoverability	% by Weight	Tons
Compostable	87.9%	32,700
Recyclable	8.8%	3,300
Non-recoverable	3.4%	1,200
Total	**100%**	**37,200**

The detailed composition available for King County commercial organics is shown below. Percentages shown are based on weight.

Table 9. Detailed composition of King County organics stream, commercial sector

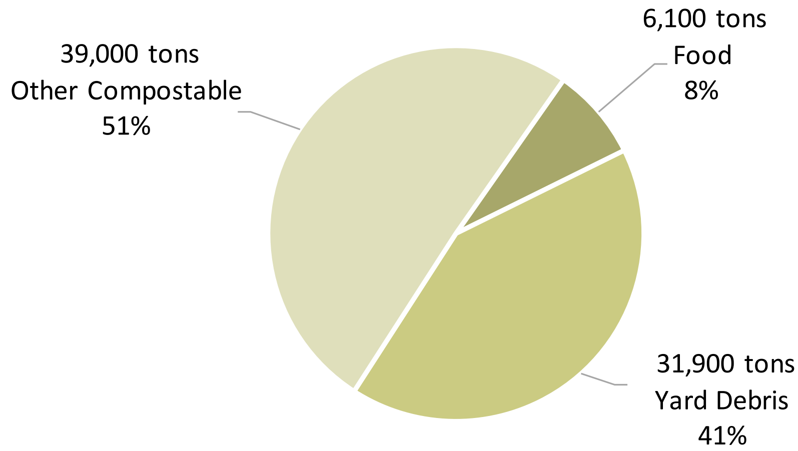
Material	Est %	+/-	Material	Est %	+/-
Compostable	**87.9%**		**Recyclable**	**8.8%**	
Fruits and Vegetables, Edible	11.2%	4.3%	Recyclable Paper	7.3%	3.0%
Fruits and Vegetables, Non-edible	13.7%	2.6%	Recyclable Plastic	0.9%	0.2%
Homegrown Fruits and Vegetables	0.0%	0.0%	Recyclable Metal, Ferrous	0.1%	0.1%
Meat, Edible	3.1%	1.2%	Recyclable Metal, Non-Ferrous	0.2%	0.1%
Meat, Non-edible	2.6%	1.8%	Recyclable Glass	0.3%	0.2%
Mixed/Other Food Waste, Edible	19.1%	3.0%	**Other Materials**	**3.4%**	
Mixed/Other Food Waste, Non-edible	14.4%	3.9%	Other Plastic	1.9%	0.4%
Single-use Food Service Comp. Paper	7.3%	1.9%	Other Metal	0.1%	0.0%
Other Compostable Paper	11.1%	1.9%	Other Glass	0.1%	0.1%
Compostable Plastic Bags and Film	2.5%	0.4%	Other Materials	1.3%	1.2%
Compostable Plastic Food Packaging	0.8%	0.3%			
Yard Debris	0.0%	0.0%			
Compostable Plastic Utensils/Straws	1.4%	0.3%			
Other Compostables	0.7%	0.8%			

SELF-HAUL

This section summarizes estimates of organics disposal and recovery from the self-haul sector in King County. This data is based on tonnages reported by the King County Solid Waste Division and from waste composition data for the self-haul sector in the 2015 King County Waste Characterization and Customer Survey Report.

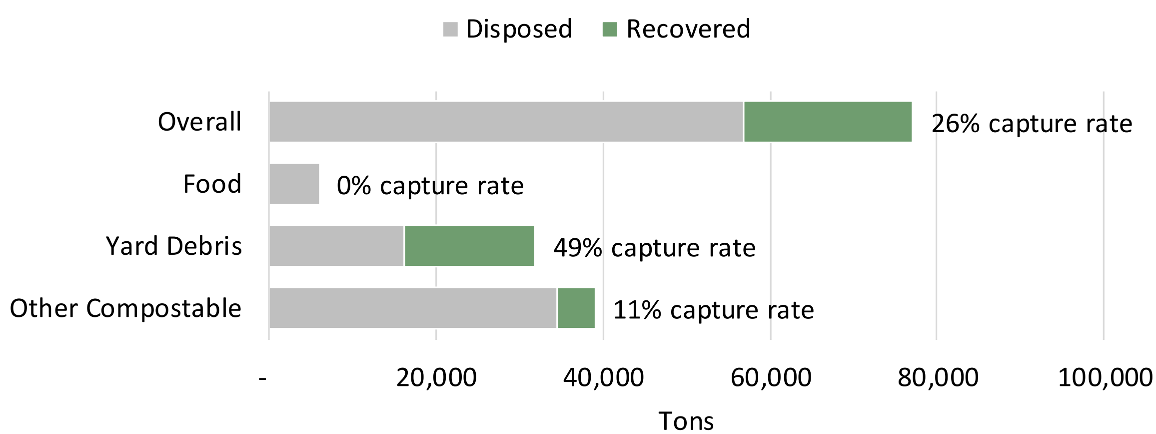
In 2018, King County's self-haul sector generated approximately 77,100 tons of organics. Figure 16 shows the composition of organics disposed or recovered through self-haul to County transfer stations by material type. Over half of this material is other compostable material, primarily clean wood and over two-fifths (41%) is yard debris.

Figure 16. King County organics generation, self-haul



Approximately one-fifth (26%) of organic material generated by the self-haul sector is recovered, diverted for composting through source-separated drop-off options at transfer stations. Figure 17 shows the quantity of organic material disposed, recovered, and the capture rate by material type. As shown, nearly half of self-hauled yard debris (49%) is captured for composting; the remaining yard debris is landfilled.

Figure 17. King County organics disposal, recovery, and capture rates by material type, self-haul



Edible Food Disposal Estimates

BACKGROUND

The Pacific Coast Collaborative—a partnership within which Washington State is a member—has made a commitment to halve food waste by 2030 relative to 2015 levels. In April 2019, the state legislature passed HB 1114, which codified the commitment.

In support of both King County's Local Food Initiative food loss reduction targets as well as regional commitments, Cascadia Consulting Group produced a *Food Loss and Rescue Measurement Roadmap* in late 2018. This document provided a methodology for the County to establish a baseline for food loss and rescue and to measure ongoing progress towards its target. For food loss, the report looked at the following questions:

- How many tons of edible food are currently wasted (that is, disposed, not consumed by humans) in King County?
- Where does wasted edible food ultimately end up (for example, landfill, material recovery facility (MRF), compost facility, wastewater treatment plant)?
- What are the sources of wasted food, and how much does each generating sector and/or point on the supply chain account for (for example, agriculture, wholesale, retail, consumer)?

As this report notes, while many local, regional, and national entities have completed characterization studies to measure food loss and waste, until recently few have distinguished between edible and inedible food. King County began incorporating this distinction into its characterization work in 2017. The table below, adapted from the *Food Loss and Rescue Measurement Roadmap,* lists King County studies that distinguish edible and inedible food.

Table 10. List of King County waste composition studies that distinguish edible and inedible food

Publication date	Study	Food Materials Listed	Sectors/ Generator Groups	Streams Studied
2019	*2019 King County Commercial Organic Material Characterization*[38]	7 food categories, including distinctions between edible and inedible for meat and vegetative items.	Commercial	Compost
2018	*2018 King County Residential Curbside Characterization Study*[39]	6 food categories, including distinctions between edible and inedible for meat and vegetative items.	Single-family residential	Compost, Landfill, Recycling
2017	*2017 King County Targeted Business Characterization Report*[40]	2 food categories: edible and inedible, as defined by the Food Loss and Waste Standard.	Restaurants, Services – Management	Compost, Landfill, Recycling

The King County studies that distinguish edible and inedible waste use a definition established in the World Resources Institute's Food Loss and Waste Protocol, the methodology developed by a multi-stakeholder group for consistent and standard reporting food loss and waste.[41] Edible food is defined as ***any substance that is intended for human consumption, regardless of whether it was spoiled or partially consumed at the time of disposal.***

KING COUNTY ESTIMATES

This section summarizes the available data on edible vs. inedible food disposed to landfill or to regional processing facilities, and it provides estimated quantities of edible food disposal. As with the estimates for overall organics generation, the estimates for edible food cover only material managed in the King County solid waste stream—that is to say, edible food that is disposed through garbage, recycling, or organics streams. The tonnages associated with edible food recovery and rescue, such as through gleaning, food donation, and related activities are not included in the analysis.

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[38] King County. *Commercial Organic Materials Characterization.* August 2019. Available from https://www.kingcounty.gov/depts/dnrp/solid-waste/about/waste-monitoring/waste-documents.aspx.

[39] King County. *Residential Curbside Characterization.* 2018. http://kingcounty.gov/~/media/depts/dnrp/solid-waste/about/documents/waste-characterization-study-2018.ashx?la=en.

[40] King County. *2017 King County Targeted Business Characterization Report.* 2017. http://kingcounty.gov/~/media/depts/dnrp/solid-waste/about/documents/business-characterization-2017.ashx?la=en.

[41] Food Loss and Waste Protocol. *Food Loss and Waste Accounting and Reporting Standard.* 2016. http://flwprotocol.org/wp-content/uploads/2017/05/FLW_Standard_final_2016.pdf

King County residents and businesses generated 234,600 tons of food in 2018 (shown in King County Organics Data above). Of the generated food waste, Cascadia estimates that 39 to 70 percent of the material—approximately 91,300 to 163,400 tons—is edible food waste, where edible food is defined as any material intended for human consumption, regardless of whether it was spoiled or partially consumed at the time of disposal. The wide range is due to the limited available reference studies that distinguish between edible and inedible food, and data gaps remain. The available data, assumptions, and remaining data gaps are discussed in subsequent sections.

Residential Sector Edible Food Data, King County

Table 11. Estimates and data sources for residential edible food generation in King County

	Food Tons	% Edible	Edible Food Tons	Data Source (for % edible)
Food in garbage	93,000	31-70%	24,000-65,100	2018 King County Residential Curbside Characterization Study
Food in organics	14,800	25-53%	3,700-7,800	
Calculated total	**107,800**	**26-68%**	**27,700-72,900**	

This analysis is based on several assumptions, given limitations of the available data:

- There is no composition study data available that distinguishes edible and inedible food among multifamily residents—the 2018 King County Residential Curbside Characterization Study includes single-family residential waste only. The analysis assumes that multifamily residents generate the same proportion of edible food to inedible food as single-family residents.
- There are two food material types in the 2018 King County Residential Curbside Characterization Study that are not clearly defined as edible or inedible. The way these materials are classified can affect the estimates of edible food waste in King County. These materials include:
    - *Homegrown fruits and vegetables*, defined as "fruit that comes from a plant growing on or cleared from the customer's property." Examples include fruits and vegetables dispose of in the set-out because of falling or pruning from trees and gardens." This analysis assumes that all homegrown fruits and vegetable waste is edible food. This material represents only a small portion of food material in the waste stream.
    - *Mixed/other food*, a catch-all category for foods that do not fit into the other food material type definitions in the study (fruits and vegetables or meat). Examples of mixed/other food in the source study include coffee grounds, tea packets, grains, crackers, bread, dairy, and cereal—a mix of edible and inedible foods. The percentage range presented in Table 11 is based on treating mixed/other foods as all inedible (on the low range of edible food estimates) or all edible (on the high range). In the 2018 residential study, mixed/other food was 42% of all food

type materials generated by weight, so the classification of this material affects the results.

Commercial Sector Edible Food Data

Based on Cascadia's estimates from available tonnage reports and composition data, the commercial sector in King County generated 120,700 tons of food waste in 2018. Data is limited on commercial edible food in King County, but two studies provide some initial estimates, suggesting that edible food is 53 to 75 percent of food waste by weight in the commercial sector. Based on these estimates, King County generated an estimated 63,500 to 90,600 tons of edible food waste. The sources for the estimate and associated data limitations are documented below:

- In 2019, Cascadia Consulting Group conducted a one-season study of commercial organics in King County, based on random sampling of material set out for collection by businesses in King County that subscribe to organics collection through a private hauler.[42] This study found that 53 percent of the food waste in the organics stream is edible food waste. This study is of the organics stream only; there is no corresponding data for edible food in garbage for the commercial sector in King County.
    - Because there is no corresponding garbage data, the analysis assumes that the proportion of edible food waste in the organics stream is the same as the proportion of edible food waste in the garbage.
- In 2017, Cascadia Consulting Group conducted a study on targeted business groups—restaurants and management service-based businesses (e.g., administrative and support services, management, and social assistance). The study found that for both business groups, edible food was approximately three-quarters of the food waste generated in all three streams (garbage, recycling, and organics).
    - The sampling sizes for this study are small, limiting the representativeness of this data set. The study results are based on 8 samples of garbage and 1-2 samples of the organics stream for each business sector.
    - These sectors were selected as high generators of food waste, and the types and quantities of food waste produced by restaurants and service management businesses are not representative of the whole King County commercial sector.

Other Sectors

Adequate information is not available at this time to make estimates of edible food disposed to landfill or to composting facilities in the self-haul sector.

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[42] King County. *Commercial Organic Material Characterization*. August 2019. Available from https://www.kingcounty.gov/depts/dnrp/solid-waste/about/waste-monitoring/waste-documents.aspx.

Appendix B. Organics Disposal and Recovery Analysis Methodology

This appendix summarizes the methodology used to estimate organics disposal and recovery in the region (King County, Seattle, and Snohomish County), as well as for sector-specific trends in King County. The results of the analyses are presented in Section 1 and Appendix A.

Definitions

Cascadia Consulting Group obtained data from King and Snohomish counties on 2018 tonnages for all garbage disposed and for organic material collected for composting. For Seattle, Cascadia based its analysis on annual tonnage data available online from Seattle Public Utilities.

ORGANIC MATERIAL DEFINITIONS

To estimate the quantities and types of organic materials disposed to landfill and recovered for processing, Cascadia used the most recent available waste and organics composition studies, as referenced in the Appendix. Cascadia reviewed material lists from these composition studies and identified the following categories of comparable material types:

- **Organics**: The material accepted by regional processors (composters). Examples of organics include food scraps and food-soiled paper, approved compostable plastic kitchenware and bags, yard debris, and recoverable wood.
- **Food**: Food material resulting from the processing, storage, preparation, cooking, handling, or consumption of food. Examples include discarded meat scraps, dairy products, eggshells, fruit or vegetable peels, and other food items from homes, stores, and restaurants.
- **Yard Debris**: Leaves, grass clippings, sod, grass, prunings, logs, and clumped soil and rocks associated with yard debris. Does not include stumps or non-yard wood wastes.
- **Other Compostable**: Includes food-soiled compostable paper, compostable plastics (marked with the words “compostable” or “#7 PLA”), and recoverable wood wastes.

WASTE MANAGEMENT SYSTEM DEFINITIONS

The study uses the following definitions relevant to the analytical approach and findings:

- **Organics generation**: The quantity of organics discarded to any stream—garbage, recycling, or compost.
- **Recovery**: The collection of material for recycling (including composting), such as through curbside collection programs for single-stream recycling and organics. Unless explicitly stated, recovery data presented in this analysis *excludes* contaminant material.
- **Organics contamination**: Describes material discarded to the organic stream (e.g., collected at curbside or through source-separated programs at the transfer station) that

is not accepted in the processing system, such as glass and non-compostable paper and plastics.

- **Capture rate**: How much of a material is recycled or composted out of the total generation, expressed as a percentage. For example, the capture rate of food scraps is calculated as follows: tons collected for composting / (tons composted + tons recycled + tons disposed). In this example, food scraps in the recycling bin do not count towards the capture rate because food scraps are a contaminant to the commingled recycling stream and would be disposed.

Overview of Methodology

This analysis estimates the quantity of organic materials present in the garbage, recycling, and organics streams. The analysis includes the following generator groups; single-family residents, multifamily residents, commercial generators, and self-haul. Construction and demolition waste is not included.

The analysis is conducted at two levels:

- A high-level regional level, which includes overall organics generation data for King County, Seattle, and Snohomish County in aggregate.
- A more detailed King County analysis, which presents organics generation for the County overall as well as for individual sectors.

The modeling methodology includes the below major steps:

1. Obtain 2018 tons on which to base the analysis for disposal and recovery.
2. Identify best available composition data.
3. Apply composition data to estimate organics tons.
4. Develop projections as needed.

OBTAIN 2018 TONS

Cascadia requested 2018 tonnage reports from King County and Snohomish County, which are based on annual reports from haulers and transfer station data. The City of Seattle publishes annual tonnages for disposal and organics online.[43]

IDENTIFY BEST AVAILABLE COMPOSITION DATA

Cascadia identified the most recent available composition studies for the jurisdictions included in the analysis for garbage and organics. The reference studies used for the analysis are listed and linked in the tables below. Assumptions are documented where composition studies are not available for a specific jurisdiction and sector.

[43] Seattle Public Utilities. Solid Waste Quarterly Program Reports. http://www.seattle.gov/utilities/documents/reports/solid-waste-reports

Table 12. Waste compositions used to model sector-specific garbage for the analysis.

GARBAGE			
Jurisdiction	**Sector**	**Study**	**Year**
King County	Single-family	King County Residential Curbside Characterization Study	2018
	Multifamily	King County Waste Characterization and Customer Survey Report	2015
	Commercial		
	Self-haul		
Seattle	Single-family	Seattle Residential Waste Stream Composition Study	2014
	Multifamily		
	Commercial	Seattle Commercial Waste Stream Composition Study	2016
	Self-haul	Seattle Self-Haul Waste Stream Composition Study	2018
Snohomish County	Single-family	Waste Management Behavior Study	2013
	Multifamily	*Not included in this analysis*	*NA*
	Commercial	*Assumed to be the same as King County*	2015
	Self-haul	*Not included in this analysis*	*NA*

Table 13. Waste compositions used to model sector-specific organics for the analysis.

ORGANICS			
Jurisdiction	**Sector**	**Study**	**Year**
King County	Single-family	King County Residential Curbside Characterization Study	2018
	Multifamily	Seattle Organics Stream Composition Study[44]	2012
	Commercial	King County Commercial Organic Material Characterization[45]	2019
	Self-haul	Based on reporting from King County Solid Waste Division on transfer station organics collection (yard debris and recovered wood).	*NA*
Seattle	Single-family	Organics Waste Stream Composition Study	2016
	Multifamily		
	Commercial		
	Self-haul	Assumed to be primarily yard waste	*NA*
Snohomish County	Single-family	*Assumed to be the same as King County*	2018
	Multifamily	*Not included in this analysis*	*NA*
	Commercial	*Not included in this analysis*	*NA*
	Self-haul	Based on reports from Snohomish County	2018

APPLY COMPOSITION DATA

Cascadia applied composition study data to the annual tons by stream and by generator group to estimate the 2018 tons by material type. Because different studies use different material lists, Cascadia reviewed the material lists from the studies from which the analysis is based and developed a condensed list of comparable material types. Table 14 lists the condensed material types and shows examples of how material types in the individual composition studies are classified for the analysis.

[44] King County has not completed a study of the multifamily organics stream. To obtain a representative composition, Cascadia used organics composition studies from the City of Seattle from 2012—prior to Seattle's implementation of a disposal ban on recycling and organics—to inform estimates for this sector
[45] King County. *Commercial Organic Material Characterization*. August 2019. Available from https://www.kingcounty.gov/depts/dnrp/solid-waste/about/waste-monitoring/waste-documents.aspx.

Table 14. Roll-up material types used for regional organics analysis.

Food	All food material types included in the studies (if broken out into sub-types), including packaged food. Includes homegrown fruits and vegetables.
Yard Debris	Includes grass/leaves, prunings, and branches and stumps. Does not include loose soil or rocks.
Compostable Paper	Includes compostable/soiled paper and paper products that could be composted, such as waxed OCC and shredded paper.
Compostable Other	Compostable plastic and compostable wood food service products (e.g., toothpicks, chopsticks). Excludes animal manure, animal bedding, and loose soil or rocks.
Recoverable Wood	Includes clean dimension lumber, clean engineered wood, pallets and crates.

The last three materials—compostable paper, compostable other, and recoverable wood—are combined in the analysis and shown as **compostable other**; taken together, they represent only a small portion of regional organics generation.

DEVELOP PROJECTIONS

Cascadia requested projections of organics generation (including disposed and recovered tons) for compostable material in 2030 and 2040. King County Solid Waste Division provided the estimates for King County below:

Table 15. Projections for organics recovery and disposal, King County

Organics tons	2018	2030	2040
Recovered	220,000	307,000	365,000
Disposed	343,900	430,000–475,000	454,000–564,000
Total Recoverable Materials	563,800	737,000–782,000	819,000–929,000

The King County forecasting is based on the following:

- King County current projections for future disposal (of all materials) show an increase over 2018 tons of 38% (+15%/-10%) in 2030 and 64% (+29%/19%) in 2040.
- The analysis assumes that the portion of organics in the garbage stream remains the same in 2030 and 2040 as in 2018. The analysis also assumes that the portion of recoverable organics is the same in 2030 and 2040 as in 2018.
- The analysis for recovered organics is based on the lower boundary of the overall disposal forecast. This is because a large portion of the organics waste stream is yard waste, which does not vary as much with changes in economic activity, jobs, or population.

Where not directly provided by jurisdiction staff, Cascadia forecasted future organics generation using the following approach:

1. Population growth is modeled available population estimates and forecasts. Projections for Seattle are based on Washington State Office of Financial Management official population estimates and population forecasts, and Snohomish County population estimates are derived from Puget Sound Regional Council data.[46,47]
2. A 2018 per-capita organics generation rate (organic tons/person/year) was calculated for each generator. The per-capita generation rates were applied to 2030 and 2040 population estimates to estimate future organics generation. The table below shows the basis for the calculated per-capita generation rates used in the analysis.

Jurisdiction	2018 Population	Organics Generation	Per-capita Generation Rate
Seattle	758,269	291,800	0.38
Snohomish County	798,328	176,600	0.22

3. To estimate recovered organics, Cascadia applied the same capture rates for organics in 2018 to the forecasted organics generation. This analysis does not account for any potential future changes in organics diversion behavior (e.g., as a result of new programs or policies).
4. Cascadia summed projected organics tonnages for Seattle and Snohomish County and the ranges provided by the King County Solid Waste Division to produce estimates for future organics generation, disposal, and recovery in 2030 and 2040.

46 Washington Office of Financial Management. Growth Management Act county projections. https://www.ofm.wa.gov/washington-data-research/population-demographics/population-forecasts-and-projections/growth-management-act-county-projections
47 Puget Sound Regional Council. Projections for Cities and Other Places. https://www.psrc.org/projections-cities-and-other-places

Appendix C. Compost Use Best Practices Literature Review

Introduction

To support King County efforts to expand local markets for compost, Cascadia Consulting Group conducted a literature review to identify and document best practices for compost use across the United States. This review focused on the following existing and emerging areas for compost use:

- Stormwater Management and Low-Impact Development
- Habitat Restoration
- Site Remediation and Reclamation
- Urban Forestry, Public Landscape and Park Land Management, and Turf Maintenance
- Carbon Sequestration
- Transportation
- Agriculture

Section C.1 describes how and why compost is used in each of these types of applications and summarizes key benefits of compost use in each area identified through prior research.

Section C.2 summarizes research on potential drawbacks of compost use and barriers faced to increasing compost use across the applications discussed in Section 1.

Research efforts were primarily focused on compost uses by government agencies and in North America, but Cascadia pulled from other sources where the data were relevant (or otherwise limited). Where available, Cascadia provided specific examples of compost use by a government agency or other entity within each application discussed.

Section C.3 describes state and local policies and incentives that promote compost use. The section includes policies and incentives used locally in Washington State, King County, and City of Seattle, as well as policies elsewhere.

C.1 Compost Uses

STORMWATER MANAGEMENT AND LOW-IMPACT DEVELOPMENT

Compost is a central component of best management practices associated with onsite stormwater management, and in green stormwater infrastructure (GSI) and low-impact development (LID) projects. Compost applications related to stormwater management can be grouped into two different types of application:

1) As a soil amendment to repair damaged soils and to improve the quality and vegetative development of soil after construction or following clearing/grading.
2) As part of proactive onsite green stormwater infrastructure and other stormwater management installations. In these applications, compost is often used via berms, compost socks, and blankets to manage runoff and provide direct soil protection, including erosion control. Compost is also used as a soil amendment in green stormwater infrastructure such as rain gardens, bioswales, and green roofs.

Benefits

Compost increases soil's ability to retain water and provides biofiltration for non-point source pollutants, making it a useful strategy to meet federal and state mandated stormwater management and water quality requirements such as total maximum daily load (TMDL) limits.

Compost is highly porous and can absorb moisture more quickly than most soil, so the use of compost as a soil amendment can enhance the absorption capacity of turf and landscaped areas. This is especially important in post-construction applications where natural vegetation has been cleared or where soils have been disturbed and compacted, thereby diminishing their absorption potential.

The use of compost as a flow barrier, either as a berm or compost sock, has been shown in studies to reduce pollution concentrations in stormwater by nearly 100 times as much compared with bare soil [1]. A study of compost filter socks on peak flow rate and sediment removal capacities showed that they removed an average of 95 percent of total solids and hydrocarbons, and 85-99 percent of motor oil [1].

Compost is also a used as a soil amendment in bioretention systems, shallow planted depressions that are designed to receive stormwater and remove a variety of pollutants as well as reduce stormwater flows. Compost in this application helps to take up water, absorb and filter nutrients and metals, and mitigate pollutants in the runoff by 60-95 percent [2]. In one study, a leaf mulch compost bioretention system reduced copper and zinc concentrations by 92 percent, phosphorus by 80 percent, and nitrogen by 75 percent [1].

Researchers at Washington State University have demonstrated the effects of polluted stormwater on Coho salmon. Dr. Jen McIntyre and her team of scientists filled tanks with stormwater run-off from roads and highways in Washington and placed salmon in the tanks. The study found that the Coho salmon sickened and nearly died within hours of exposure to the polluted stormwater [3]. The research team then looked at whether treatment of polluted stormwater prevented the negative effects on salmon, running stormwater through bioretention columns with a sand/compost mix (60% sand, 40% compost). Coho salmon placed in tanks with treated water did not show symptoms of sickness or other toxicological impacts, and behavior of salmon in treated water was indistinguishable from salmon in the control group, placed in clean well water [4]. This body of work helps to illustrate the connection between actions in urban environments and environmental outcomes and to reinforce the need for stormwater management and low-impact development practices. The Washington Stormwater Center continues to support research on cost-effective ways to treat stormwater.

Examples of compost use in stormwater management

Examples of existing requirements and/or standards for compost use in stormwater management and low-impact development contexts include:

- **Soils for Salmon** is a cooperative project led by the Washington Organic Recycling Council (WORC) begun in 1999 to help developers preserve native soil and restore disturbed soil using stormwater management best management practices. Their "Building Soil" campaign works with local governments to advocate for adoption of soil BMPs into local codes when they are updated, as well as with developers to help them utilize these practices before they become mandated [5]. King County has adopted these BMPs into codes and is now working with multiple stakeholders on full compliance.
- **The Washington State Department of Ecology** includes soil BMPs in its Stormwater Management Manual for Western Washington, which in turn serves as the basis for local jurisdictions' stormwater codes. BMP 7.3 provides guidelines for compost as part of bioretention soil mix to improve soil quality and organic matter and provides compost quality standards, including a minimum of 40 percent organic matter content [6].
- Several **green building rating and certification systems** include requirements or credits for systems and strategies that use compost. The Living Building Challenge, LEED, and SITES, a comprehensive sustainable landscape rating system developed in collaboration with the USGBC, require strategies that explicitly or implicitly include compost to control erosion and stabilize slopes during construction, to amend disturbed soil, and to infiltrate water onsite as a low impact development strategy. Built Green, a local green building program of the Master Builders Association of King and Snohomish Counties, calls out compost use specifically in their certification checklists for both single and multifamily homes, requiring that projects "amend disturbed soil with compost to a depth of min. 10 inches to restore soil environmental functions" [7].

- **King County Wastewater Treatment Division** now works in partnership with Seattle Public Utilities on an ongoing basis to implement green stormwater infrastructure as called for by local and state requirements and environmental objectives. [8] The use of compost is highlighted as one key element of many GSI projects. As installation of GSI continues to increase (King County WTD and SPU have a joint goal of managing 700 million gallons of stormwater through GSI annually by 2025), the use of compost in these applications is expected to increase as well [8].
- Examples of **green stormwater infrastructure** that incorporate compost include [9]:
  - Stormwater greenstreets and bioswales, which are planted areas designed to collect stormwater and reduce runoff from streets and sidewalks. These include planter boxes, trees, and planted areas in the sidewalks (bioswales). These plantings use bioretention soil that includes a mix of compost (up to 40%).
  - Permeable surfaces, such as permeable pavers or porous concrete that allow water to seep through the material and be absorbed into the soil (ideally compost amended) underneath.
  - Rain gardens and wet detention basins, which include use of soil mixes that contain compost.
  - Green roofs, which use engineered soils or other growing media to support vegetation. Some of the available blends include compost.

HABITAT RESTORATION

Existing research on compost use shows that compost can conserve water where soils are damaged, support revegetation and growth of cover plants, and improve soil fertility [1]. Studies on compost use for land restoration uses have shown that it can have beneficial effects on plant survival rates, ground cover, plant size, and soil and water quality [10]. Highlighted compost uses for habitat restoration include support of revegetation and plant growth in wetlands, forest lands, campgrounds, and fire-damaged soils.

Benefits

Compost use has a number of soil benefits that are beneficial to habitat restoration [10]:

- Increases soil porosity, which increases the exchange of air and water through the soil and can mitigate soil compaction.
- Enhances the capacity of soil to hold water, which can buffer against harsh soil conditions (e.g., sandy soil).
- Supplies soil nutrients as compost breaks down to support plant growth.
- Binds or degrades pollutants, such as heavy metals, pesticides herbicides, and other contaminants.

- Aggregates soil (binds soil particles together), which improves the physical characteristics of the soil and is a factor that reduces sediment in runoff and erosion.

Examples of beneficial compost use relevant to activities by Parks departments and the forest service include the below.

- **Restoration of land after road removal** in parks or forest land. Road closures can support land conservation activities by reducing surface erosion and promoting growth of native plants. However, challenges to land restoration include poor quality soil, high compaction, lack of water holding capacity, and inadequate nutrients in the soil [10]. A U.S. Forest Service study in 1996 found that seedlings planted on compacted, eroded, and steep slopes grew taller and to wider diameters after 20 months when planted on test plots with compost compared to those planted with straw mulch [11]. Rates of herbaceous ground cover were also higher in compost-treated plots than in those that received mulch (80-95% ground cover vs. 50-60% mulch vs. 45% untreated) [12].
- **Restoration of wetland habitats.** In 1994, the Clean Washington Center and City of Everett (WA) partnered on a demonstration project to assess compost use for wetland restoration. On average, plots treated with compost had 20% more growth and 10-15% higher survival rates than those without. The study also found no reduction in quality of surrounding surface water following compost use [13].
- **Campsite restoration** after heavy recreation use, mitigating soil compaction and loss of vegetation which can cause soil erosion. A U.S. Forest Service study found that adding a soil amendment made from organic matter, compost, and native soil inoculum to closed campsites with disturbed soil raised the level of carbon and nitrogen in the soil and led to increased long-term vegetation cover compared to those that did not receive this treatment [10, 14]. Soil amendments also appeared to support seedling and transplant growth, which had larger shoots, root systems, and overall plant sizes in plots that received treatment than those that did not. In addition, total vegetation cover on treated plots was 1.3 to 1.6 times that of plots that did not receive soil amendments [14].
- **Restoring fire-damaged land.** Researchers at University of California Riverside studied the effects of a compost blanket on fire-damaged soils. Results showed that both compost blankets and incorporating compost into the soil reduced run-off by 1.6 to 23 times compared the control (no treatment). Compost use also reduced turbidity in the run-off by 1.3 to 45.4 times over the control [1].

Examples of compost use in habitat restoration

- **California:** Lawmakers passed a state bill (AB 1981) in September 2018 that amended state organics recycling regulations to include a requirement that the Department of Forest and Fire Protection support the use of compost on working lands, including support of post-fire recovery efforts to reduce erosion and stabilize fire-damaged land through the application of compost [15]. Implementation of this bill has recently commenced, so no specific examples of its effects are available yet but the state's growing investment in fire recovery efforts indicates that this is likely to be a growing area of compost application in California.

SITE REMEDIATION AND RECLAMATION

The benefits of compost associated in the section above (Habitat Restoration) also make compost use effective for site remediation and reclamation. Compost has been used to clean up contaminated soil, treat brownfields, and restore land after industrial activity such as mining.

Benefits

As with habitat restoration, research describing compost use for site remediation and reclamation report benefits around restoration of soil nutrients, which in turn facilitate plant growth and revegetation. In 2012, researchers conducted a three-year study in partnership with the Metropolitan Water Reclamation District of Greater Chicago on the use biosolids and compost for remediation of coal strip mining sites in Illinois. Use of soil amendments increased soil quality, revegetation of the land, and increased earthworm populations (as an indicator of soil health) [16, 17]. Table 16 shows some of the measured impacts of use of soil amendments compared to plots that received no treatment at Year 3 of the study.

Table 16. Comparison of soil nutrients in untreated vs. treated brownfield plots (adapted from Basta et. al, 2015) [17]

	No treatment	Biosolids	Compost
Total Nitrogen (g/kg)	1.6	10.1	15.7
Total Phosphorous (g/kg)	0.5	18.7	2.8
Total Carbon (g/kg)	-	201	161

Articles on compost use also report that compost can bind pollutants such as heavy metals and reduce uptake of metals by plants [10], but Cascadia's review found limited research on this claim and mixed results. A summary of compost use studies in the U.K. described tests of plant growth with a mix of compost types in contaminated soils (from a former zinc smelter, a mine, and a firing range). The study measured both metal content in compost leachate and metal uptake of metals within the plants. No clear trends were observed in the effect of compost use on zinc and copper concentrations in leachate, though the researchers demonstrated reduced uptake of metals within plants after compost amendment in at least one plot [18].

Compost use may be able to mitigate other types of soil contamination, however. One study cited by WRAP on a former gasworks site found that application of a compost mulch reduced hydrocarbon contamination in the soil on 60-70% of the site to the target levels (from 150,000 mg/kg total petroleum hydrocarbons (TPH) and 40,000 polycyclic aromatic hydrocarbons (PAH) to <30,000 mg/kg TPH and <10,000 mg/kg PAH). The study also noted that treating the soil with compost was significantly cheaper than disposal, with an estimated savings of £50 per metric ton of contaminated soil [19].

Examples of compost use in site remediation and reclamation

This literature review did not identify regular programs or practices for compost use in site remediation and reclamation. The case studies and examples cited above for remediation of coal strip mining in Illinois and on select sites in the UK highlight potential benefits of the approach if adopted.

URBAN FORESTRY, PARK LANDSCAPING, AND TURF MAINTENANCE

Compost can provide multiple benefits across common land management activities undertaken by public agencies such as urban forestry, park landscaping, and turf maintenance.

Benefits

- **Tree health**. Compost application is beneficial for tree health; by improving soil structure, compost enhances root development and increases stress resistance. A study of urban forests in New York City found that compost application increased water-holding capacity and microbial biomass of soil immediately and increased tree growth, though this was not apparent until the third growing season after application [20]. Cornell Waste Management Institute recommends using up to 50 percent compost in tree planting to support tree health and increase survival rates of newly planted trees [21].
- **Water conservation**. Amending soil with compost increases the organic content of soil, which in turn enhances soil water-holding capacity and infiltration, and reduces water loss from evaporation, run-off, and erosion. Estimates vary on the level of potential water savings from compost use; guidelines on compost-amended soil for the City of Redmond indicate that amending a turf site with compost that has little slope and wind can reduce peak summer irrigation by 60 percent compared to unamended sites [22]. Another source estimates up to 30-50 percent water savings following use of compost as a mulch in orchards [23].
- **Faster turf establishment and enhanced turf health**. Cornell's Waste Management Institute notes that compost application on play fields can help turf establish more quickly and increase rooting, as well as improve its density and color [21]. The Sports Turf Managers Association (STMA) recommends applying and tilling 1-2 inches of compost into the upper 4-6 inches of soil and has recommended ranges for chemical and physical characteristics of compost [24].

  A study of manure-based compost applied to athletic fields in New York state found that it improved soil organic matter, increased pH of acidic soils, and decreased soil density in the short term, and also improved grass quality and cover and reduced weeds in the long term. The study found that fields with heavy use were not significantly improved despite compost application, and resulted in excess phosphorus concentrations, though this could be mitigated with lower phosphorus composts [25]. Compost can also be used as part of athletic field maintenance to increase soil porosity, improve water infiltration capacity, and reduce compaction. Topdressing fields with compost can enhance playability and safety since fields can get compacted from heavy user and vehicle traffic [21]. STMA recommends applying 0.25-0.5 inches of compost as a topdressing after core cultivation and in the spring and fall [24].

Examples of compost use in Urban Forestry, Park Landscaping, and Turf Maintenance

- In **New York City**, residents can volunteer to be Street Tree Stewards and gain tools and educations to help them care for local trees [26]. Existing guidelines for street tree stewardship in New York City include mixing in a thin layer of compost every year. Street Tree Stewards can get free compost every year through the NYC Compost Project [27].
- The **New York City Parks Department** also leads on compost use in parks and community gardens. In one of many examples, the Hudson River Park Community Composting Program allows for neighborhood residents to drop off food scraps for onsite composting that is used in Hudson River Park plant beds [28].
- The **City of Phoenix** is currently working with Arizona State University to study compost application on multiuse turf in nine parks over five years using compost made from local yard waste and food scraps [29].
- STMA notes that many sports facilities around the country are developing composting programs using materials such as manure, green waste, and food waste [24].

CARBON SEQUESTRATION

Emerging research is exploring the role compost use can play in supporting carbon sequestration and storage in soil.

Benefits

A recent study from California's Natural Resource Agency found that 0.25 inches of compost amendment applied to a variety of types of rangelands resulted in a significant net increase in soil carbon storage. Model results showed that net carbon sequestration benefits from one application would last approximately 85 years, with soil sequestration potential peaking after 15 years, though results depended on location and various emissions scenarios [30]. While promising, the study noted the need for research on other types of landscapes and climates to determine whether these benefits are more broadly applicable. Another consideration for compost as a carbon sequestration strategy is that compost must also be locally available so as not to cancel out sequestration benefits with transportation-associated emissions.

Research in 2018 from University of California Davis showed through modeling efforts that grasslands and rangelands in California can be more resilient carbon sinks than forests, given risks introduced by drought and wildfire. Forests store carbon in woody biomass and leaves, which is released back to the atmosphere if the trees are burned in a wildfire. In contrast, grasslands sequester most carbon underground. Researchers highlight that in more stable environmental conditions, trees outperform grass and rangelands in terms of carbon storage, but the research highlights how varied approaches can be taken to meet California's ambitious greenhouse gas emissions reduction goals, and that cap-and-trade and carbon offset programs should be diversifying portfolios beyond trees to mitigate potential future risks [31].

In early 2019, a consortium of researchers from the University of California, Davis, and the UC Working Lands Innovation Center received a $4.7 million grant to research how soil amendments such as compost, rock, and biochar can be used to store carbon in soil and how to scale up these methods. The study will include multiple test plots across California and include an assessment of co-benefits such as improved crop productivity and soil health. Consortium researchers note the significant potential of soil carbon-based approaches and report that use of compost soil amendments could sequester 28 million tons of carbon dioxide equivalents if used on 5 percent of California's rangelands. This carbon reduction would be equal to approximately 80 percent of California's current emissions from the agriculture and forestry sector [32].

Examples of compost use in Carbon Sequestration

- The **California Department of Food and Agriculture** administers the **Healthy Soils Program**, a multi-agency collaboration to promote soil health on the state's farm and ranchlands. The program provides funding to projects that deploy land management practices that improve soil health while reducing greenhouse gas emissions [33].
- The **Marin Carbon Project** is a consortium of agricultural groups working to increase carbon sequestration in soils in Marin County through research, advocacy, and support of carbon farming demonstration projects. In 2014, the group developed a carbon accounting protocol for compost use on grazed grasslands that ranchers can use to independently verify carbon sequestration from compost use on their lands and generate carbon offset credits that can be traded in carbon markets. In one demonstration project, they worked with three ranches to apply 4,000 cubic yards of compost to nearly 100 acres of land. [34]

TRANSPORTATION

Compost has been used by several state Departments of Transportation (DOTs) to mitigate the impacts of highway construction, provide erosion control, support roadside planting, and manage stormwater runoff. The motivations that drive compost use in the transportation sector are closely tied to its applications in stormwater management (see discussion above). Compost in roadside uses can take the following forms [35]:

- To promote revegetation: Compost blankets, a layer of compost of varying depth (1 to 2-inch layers are often cited).
- To manage erosion and mitigate run-off: filter berms (sometimes called compost logs), which are ridges of piled compost, or compost filter socks, which are mesh tubes filled with compost. Both are placed or constructed perpendicular to a slope.

Benefits

Benefits to compost use cited by projects led by state transportation agencies include [1, 36]:

- Re-establishing vegetation after new construction.
- Mitigating run-off from slopes, such as by absorbing moisture to control erosion from slopes by reducing the rate of flow.
- Filtering sediment and other pollutants.
- Addressing compacted soil from construction efforts, which can also impede growth of new cover crops.

Revegetation efforts following construction activities can be particularly challenging since the construction damage to soil can speed up erosion and exacerbate run-off problems, and quickly establishing cover crop is a critical step to managing these challenges [1]. Compost use can also be beneficial over more traditional methods of establishing ground cover, such as seeding with fertilizers and sometimes also herbicides, for which the benefits can be short-lived and introduce potential for contamination in run-off [1]. In addition, studies suggest that compost use for slope stabilization and establishing vegetation can be more cost-effective than alternatives [36].

There is a large body of research and examples of compost use in the transportation sector by state agencies. This is not a comprehensive list, but several examples are introduced below.

- A two-year study on Louisiana highways evaluated the effect of compost use and different application methods on erosion control. Researchers found that plots treated with compost blankets had significantly lower levels of total suspended solids (TSS) and turbidity in samples of run-off than untreated plots. TSS levels in compost-treated plots were approximately 10 times lower than the untreated control, with greater reductions observed with thicker compost coverage [37].
- A three-year study in Iowa in partnership with the Iowa Department of Transportation tested different compost types (biosolids, yard waste compost, and compost derived from paper mill and grain processing waste) and different compost coarseness. This study found that all compost-treated plots had less than one-third weed growth by mass compared to untreated plots at the end of two growing seasons. Compost-treated plots also reduced run-off in the first 30 minutes of high-intensity rainfall compared to untreated plots (0.2 mm of runoff from treated plots vs. 15 mm of runoff). Because of the reduced run-off volumes, the study also observed less eroded material in compost-treated plots. This study found that both 2”

and 4" applications of compost led to beneficial results over no treatment or topsoil only. This study also cites a potential for cost savings over conventional methods by reducing transportation costs, which in Iowa are 6" covers of topsoil [38]. Based on the results, the researchers recommend use of compost in projects that require both short-term erosion and run-off control as well as a need provide extra support for growth of cover plants.

- Texas DOT (TxDOT) demonstrated how a mix of compost and wood chips (applied in a 3:1 ratio) could be used to revegetate bare and heavily eroded slopes in 1999. TxDOT applied a 3" layer of the compost and wood chip mixture to the bare soil before seeding native grasses. This layer successfully resisted erosion from rainfall during the application season, and a stand of grass was established on the slope within two months [39].

Examples of compost use in transportation applications

- A 2009 survey of state DOTs across the United States indicates that compost use by state transportation agencies is fairly common—of 20 state DOTs that participated in the survey, all but two (18 agencies) report using compost as a soil amendment (if not other uses as well) [35]. The scale of compost use within individual state transportation agencies is not known. An earlier EPA study from 2001 also found that 31 state DOTs have existing specifications for compost or related product, mostly for soil amendment but in more limited cases for erosion control as well [40].
- **WSDOT** is among the most active transportation agencies in compost use. An analysis of compost use among three DOTs published in BioCycle in 2016 found that, as of 2015, WSDOT used more compost—in terms of cubic yards/mile maintained—than TXDOT and CalTrans, the two other state transportation agencies that report very high use of compost [25]. WSDOT has two significant drivers in place for compost use: First, the agency's Standard Specifications includes 102 instances of reference to "compost" and includes specifications and guidance for the use of compost blankets and berms for erosion control, compost socks for flow control and sediment control, and compost as a soil amendment for planting and post-construction site rehabilitation. [41] Second, WSDOT's most recent update of its Highway Runoff Manual (HRM), which establishes minimum requirements and provides guidance to direct the planning and design of stormwater management infrastructure for existing and new Washington State highways and other facilities, includes extensive references to compost use as a soil amendment and in other applications as part of stormwater management BMPs [42].
- **TxDOT**—reported to be another one of the highest users of compost among state transportation agencies—uses several hundred cubic yards of compost and mulch each year to establish vegetation and control erosion on highway roadsides. TxDOT worked with the Texas Commission on Environmental Quality (TCEQ), the Texas Transportation Institute (TTI) and the compost industry to develop a specification for compost. This specification has

enabled TxDOT to enhance the environmental sensitivity of its transportation system while providing a much-needed market for organic materials.

While the case studies and the available literature primarily highlight project-driven compost uses such as to revegetate roadsides after construction, there are opportunities for more regular (e.g., annual) application of compost for regular maintenance activities. For example, DOTs can consider replacing conventional fertilizers in landscaping with compost or other recycled organics product.

AGRICULTURE

Compost has long been used in agricultural applications to increase soil organic matter, improve soil health and crop yields, and suppress plant diseases. Compost increases water infiltration capacity of soil and replaces nutrients that may have been lost over time that cannot be replaced with conventional fertilizer, improving plant health. Compost use is especially important in organic farming where synthetic pesticides and fertilizers are not used.

Benefits

Washington State University (WSU) Cooperative Extension in Snohomish County has worked with local compost producers, conservation districts, and counties to promote compost use from commercial food and yard waste on farms in King and Snohomish Counties through its Compost Outreach Program. Working with local farms to conduct on-farm demonstration trials in 2015, farmers reported that compost improved crop yields in 68 percent of trials, and 55 percent reported that compost increased water retention in their soils, though several participants reported that there was no observable difference on crops that received compost application [43].

Other reported benefits from studies on compost use in agriculture include the following:

- Amending soils with compost can reduce irrigation needs up to 50% in the summer; compost also has a higher water absorption and storage rate than other amendments such as commercial fertilizer, anhydrous ammonia, or raw manure [2].
- Amending soils with compost improves cation exchange capacity, allowing for slow release of nutrients like phosphorus, potassium, sulfur, etc. required for plants and reduces nutrient leaching [2]. This slow release of nutrients also reduces the need for inorganic fertilizers [44].

Examples of compost use in agricultural applications

While commercial compost is readily available in Western Washington, agricultural markets accounted for less than five percent of the total compost market in the state in 2016 [43]. As part the on-farm demonstration trials, WSU's Compost Outreach Program provided other compost support in the form of:

- Providing compost.

- Coordinating delivery of compost between producers and farmers.
- Providing technical assistance on compost use to help farmers set up trials correctly and answer questions.

As part of this work, the program also produced a compost use decision-making tool to estimate a breakeven price for the cost of compost (in tons per acre) for its anticipated benefits to crop yield [45]. The program has also since published a number of resources to help farmers in Washington use compost, including recommended best management practices, a list of equipment and techniques for spreading compost, and a map of farms that have compost equipment available to share [46].

One emerging agricultural area with potential for compost use is the cannabis market, where some producers will pay a premium for specialized soil mixes compared to producers of other crops [47]. Researchers at University of Washington, in partnership with TAGRO (City of Tacoma's biosolids-derived compost product), have been exploring the use of biosolids-containing soil blends on the growth of cherry tomatoes and hemp (as surrogate plants to cannabis), demonstrating that TAGRO soil blends outperform commercial brands of potting soil commonly used for cannabis production when it comes to plant weight and flower production [48, 49].

C.2 Potential Drawbacks & Barriers to Use

There are still areas of unknown and potential drawbacks associated with compost use across all areas mentioned in this study. In addition, there are barriers to use—real and perceived—that inhibit adoption of practices and policies promoting compost use (both food/yard waste-based and biosolids-based) across potential applications.

POTENTIAL DRAWBACKS OF COMPOST USE

If improperly applied, the studies note that **compost use may result in runoff of nutrients, salts, and trace elements that impact water quality** [1, 50]. To mitigate the concerns, researchers note that compost use should be appropriately buffered from waterways, compost should not be applied on "excessively" steep slopes (where referenced, defined as over 50% slope), and should be applied using appropriate application rate calculations [3].

- Bioretention systems amended with compost for stormwater management can leach excess nutrients such as nitrogen and phosphorus, which can contribute to groundwater contamination, and copper, which can be harmful to aquatic life [51]. In one study, nitrate and phosphorus amounts were increased by up to three orders of magnitude after simulated storm events, with concentrations in leachate decreasing over time [51].
- In the studies on fire-damaged plots by UC-Riverside, compost-treated soil had higher salinity measurements than soil without [1].
- In the study on remediating brownfields in Chicago, researchers observed elevated biosolids in surface water run-off in Year 1, but this decreased after vegetation was established on the test plots [17].

In the context of habitat restoration and site remediation, some report concerns that **pollutants bound up in compost after its application will be released back into the environment** in the long-term [18], as well as the possibility of introducing physical contaminants (e.g., trace plastic pollutants) into the environment from trace contamination in finished product. Cascadia did not find studies designed to address these concerns in this review.

Barriers to Compost Use

Across applications, some report that **quality of the compost** is a barrier to its use. Texas DOT reported that proper inspection of compost is needed to ensure quality of the material used, and that material not adequately meeting their composting specification can contribute to water quality issues [35], and farmers in the Snohomish County Compost Outreach Program cited concerns about potential plastic contamination [43]. Texas DOT and other transportation agencies have also reported challenges getting **adequate supply** of compost that meets quality standards set out in their specifications [35, 52].

Some studies indicate that compost use has high potential cost-savings over other methods for restoring habitat, maintaining water quality, re-establishing vegetation, and other uses included in Cascadia's review. However, specific cost data and cost-benefit analyses from these studies are limited. **Other studies also report concerns about potential cost**, particularly for **transportation and application of the material** [53]**.** The BioCycle summary of compost use by DOTs reports that compost use is still considered an expensive part of projects, so its application on projects is frequently designed to maximize its efficiency (e.g., applying no more than is needed to meet the minimum set targets) [52].

Finally, existing work cites a need for **increased awareness and education around potential compost uses and how to put them into practice** [1, 54]. This need is also noted in the survey of farmer's conducted both in Snohomish County and by researchers in Belgium, citing lack of information and lack of experience using compost [43, 55]. In the transportation sector, both Texas and Washington DOTs also cite a need for increased cross-stakeholder engagement, particularly with inspectors, designers, and engineers, to support compost use [35].

C.3 State and Local Policies and Incentives to Increase Compost Use

To understand how both King County, Washington state, and jurisdictions in North America are promoting compost uses, Cascadia looked for examples of policies and incentive mechanisms already in place. In general, these mechanisms include:

- Rebate programs and other financial assistance to end users.
- Preferred procurement practices for compost.
- Mandates or requirements for compost use in specific projects or product specifications.
- Monitoring and reporting, independent of specific requirements for use.

In addition to policies and incentives, many jurisdictions actively promote compost use in outreach and educational materials for the public. Examples of these activities were not included in this literature review but are nonetheless a critical element of efforts to promote and increase compost use.

In considering what policy, incentive, and/or education approach may work best, each mechanism has its advantages and drawbacks. For example, **rebates and financial incentives** can motivate private sector action but require substantial public investment and depend on a continual source of funding to be maintained. **Preferential procurement** can increase the use of compost by public agencies and help to more fully realize the environmental benefits of compost use in public projects but may result in higher up-front costs compared to alternatives. **Mandates or specific requirements** need investment in monitoring and enforcement mechanisms to be most effective. **Monitoring and reporting** policies on their own do not guarantee additional compost use but experiences from other products and jurisdictions has indicated that requiring monitoring and reporting use of a product or attribute can lead to increased use, even when not linked to a mandate or specification for use. However, this approach still requires investment to be effective and may not deliver benefits as large as other strategies.

REBATE PROGRAMS AND OTHER FINANCIAL INCENTIVES

Examples from Washington State

- **King County and City of Seattle**: In partnership with Seattle Public Utilities, The King County Wastewater Treatment Division provides funding for rebates or incentives to residents for installation of rain gardens and other green stormwater infrastructure (GSI) and other projects that improve water quality in the service area for King County's regional wastewater system through the RainWise program and WaterWorks grants. The use of compost is highlighted as a key element of many GSI projects although funding is not specifically tied to compost use [8].

In addition to rebates, City of Seattle partners with Cedar Grove to offer compost giveaways to residents both as a way of promoting the benefits of compost and the reinforcing the value of composting food scraps and yard debris. [56] Through a partnership with King Conservation District, King County provides select community gardens within King County's regional wastewater system service area free biosolids-derived GroCo compost [57].

Examples from other jurisdictions / Private Sector

- **City of Tacoma TAGRO**: The City of Tacoma's TAGRO brand of biosolids-derived products is seen as a leading national example of success in market development for compost. The City initiative began in the early 1990s and the program established market demand in its first decade in large part through product giveaways. In 2002, the program shifted to a "cost plus" model and giveaways were greatly reduced. By then, the product had an established brand and a strong customer base, and TAGRO was able to grow sales by offering high-quality products with a strong market demand [58]. The case study notes that a particular element that has contributed to TAGRO's success has been a commitment to making a product to specifications for sale from the start (a "market-back" focus), not simply to prepare a waste for disposal.
- **California**: As noted under the Carbon Sequestration section, proceeds from California's Cap-and-Trade Program are used to further the State's climate goals through comprehensive and coordinated investments throughout California. Compost use is a feature of investments made within Natural Resources & Waste Diversion – one of the State's three priority areas – primarily as part of the CA Healthy Soils Program (HSP), a collaboration of state agencies and departments to promote the development of healthy soils on California's farmlands and ranchlands. Now in its third year, the HSP Incentives Program has provided over $20 million dollars to farmers and ranchers to support projects that promote soil health, including compost application [59].
- **Carbon markets:** Despite the enormous potential for carbon sequestration through soils and land management, carbon markets have largely ignored opportunities for investment in projects related to increasing soil carbon on agricultural lands. Now, however, there is growing interest and exploration of linking soil carbon sequestration to market mechanisms. A new report from The Nature Conservancy suggests that global carbon markets may be starting to provide economic incentives for projects that enhance soil carbon [60]. In March 2019, the Australian government recognized the first project ever granted carbon credits for soil carbon eligible to count towards emissions reduction goals under The Paris Agreement [61].

  In the U.S., the 2018 Farm Bill passed by Congress includes a pilot program to incentivize and reward carbon performance on farms, such as cover crops, crop rotation, and other practices that enhance carbon storage in soils [62].

- **New York City**: The New York Department of Sanitation (DSNY) hosts multiple compost giveback events throughout the city each year, where residents can receive up to 40 lbs. of bagged compost produced by the city's organics collection program. Local organizations and elected officials are also invited to host compost giveback events and compost from the NYC Compost Project (a public-private partnership) is provided to local greening initiatives to help rebuild NYC soils [63].
- **Albuquerque, NM**: The Albuquerque Water Utility Authority offers a number of incentives for landscape water conservation, including a rebate for 25 percent of the cost of compost (up to $100) for participants in programs to replace turf with xeriscaping (landscaping with plants specifically chosen for efficient/low water use) [64].
- **Texas**: As part of a larger initiative to address issues related to manure management, the Texas Commission on Environmental Quality promoted the use of compost made with manure by offering a $5 rebate for every cubic yard of eligible compost purchased by Texas state agencies, local governments, and other eligible users between 2000 and 2005, and at a reduced rate of $4 per cubic yard until August 31, 2006. The program also funded a major education and marketing campaign by the Texas Cooperative Extension. At the end of the six-year initiative, TCEQ reported that the initiative funded activities that helped assure the continued composting of manure beyond the end of the project [65].

PREFERRED PROCUREMENT PRACTICES

Examples from Washington State

- **King County**: King County Code and the County's Sustainable Purchasing Executive Policy currently state that biosolids-derived products should be used as a soil amendment in landscaping projects funded by King County. [66] These procurement policies and other initiatives by King County have provided reliable market support for GroCo compost made with Loop for nearly twenty years. [67]

Examples from other jurisdictions / Private Sector

- **California:** The current draft rules for implementation of SB 1383 in California include a procurement requirement for "recovered organic waste products," defined as product made from California-generated organic waste diverted from landfill and processed by a permitted or otherwise authorized facility. [68] Under the current draft regulations, each jurisdiction will have an annual procurement target for recovered organic waste that is proportional to the amount of organic waste it generates. Eligible products that can be used to meet the procurement target are compost or renewable transportation fuel (from diverted organic waste, processed through a digester). The procurement requirements will come into effect in January 2022. [69]

- **Colorado:** In Colorado, the state environmental purchasing policy specifies that all landscape, including new construction, renovations, operations, and maintenance by state agencies and institutions—including contractors—will use sustainable landscape management techniques. Use of mulch and compost that give preference to those produced by Colorado-generated plant debris and/or food and agricultural waste preferences is explicitly stated as an example of a sustainable maintenance practice. [70]
- **Maryland:** In 2011, Maryland passed a law directing the Maryland Department of the Environment to study and develop recommendations on how to promote composting in the state, including compost use and procurement by public agencies. The subsequent report issued recommendations (now underway) including:
  - Studying the use of compost to increase the percentage of landscaping area fertilized with compost each year.
  - Collaboration cross-agency to increase purchase of compost for State projects. aryland state code currently includes a provision to give consideration and preference to compost, to the extent possible, for any land maintenance activity paid for with public funds (Md. Code §14-409).
  - Develop specifications for a Statewide procurement contract, with a potential price preference for compost produced in Maryland. [71]

MANDATES AND SPECIFICATION REQUIREMENTS

Examples from Washington State

- **Washington State**: State code for water quality standards specify a set of minimum requirements for all new development and redevelopment projects in Western Washington, documented in the Stormwater Management Manual for Western Washington. Recommended practices are meant to reduce pollutant load and concentration and to reduce discharge volumes. One of the minimum requirements for all projects is on-site stormwater management—within which one practices is post-construction soil amendment to a specified soil quality standard and depth. Recommended practices for erosion control also include the use of compost. [6]
- **King County**: The implementation of Ecology's Stormwater Management requirement for soil amendment in King County is included in King County's Clearing and Grading Regulations (King County Code 16.82), which require that soil amendments be added to any new or significantly redesigned landscaping areas, as well as to any landscaping areas disturbed or compacted during construction. For covered applications, the King County Department of Local Services, Permitting Division guidelines state that topsoil should be amended to a minimum of eight inches thick and with organic matter content between five and ten percent dry weight (tilling 1.75 inches of compost to existing soil for turf areas or 3 inches of compost to existing soil for planting beds into the first 8 inches of soil) or, if

conditions prevent amending soil in place (e.g., too compacted or rocky), the project developer can important topsoil mix with minimum soil organic matter content.

The Permitting Division requires that permit holders submit a soil management plan that identifies compost and/or topsoils to be applied and calculates associated volumes to be used. Soil management plans have fields to record the soil amendment product name, product type (topsoil, compost, or mulch), and the quantity in cubic yards. Permitting compliance staff then conduct onsite inspections to verify the depth of material and to check documentation of material purchase. [72]

Examples from other jurisdictions / Private Sector

- **California**: While the driver for compost use policies and incentives in Western Washington has been primarily stormwater pollution prevention, water conservation has been a major driver in California, where compost is featured as an important element in water efficient landscaping. Under California's Model Water Efficient Landscape Ordinance (MWELO), which must be adopted or exceeded by all jurisdictions within the state, landscape project applicants covered by the ordinance must submit a soil management report, which includes soil analysis and addition of soil amendments, if needed. Regular application of compost and other mulches are specified for beneficial purposes of reducing evaporation, suppressing weeds, moderating soil temperature, and preventing soil erosion. [73]
- **Denver, CO**: Under new operating rules adopted in 2017, all owners of newly constructed properties within Denver Water's service area must amend their soil with compost before the premise may be landscaped, so the soil more efficiently retains water. [74]
- **Green Business Certification Institute** (GBCI): The GBCI, which oversees credentialing of the Leadership in Energy and Environmental Design (LEED) certification program, also oversees the Sustainable Sites Initiative (SITES), a certification program for sustainable landscapes. Both certification programs include specifications for compost use in support of healthy soils as part of certification prerequisites and credits for varying levels of certification. [75]

USAGE MONITORING AND REPORTING

Examples from other jurisdictions / Private Sector

- **Maryland**: The Maryland State Highway Administration is required to report annual on the volume of compost it used in highway construction, the status of compost and compost-based products in projects, and recommendations to maximize the use of compost in Maryland State highway construction projects (Md. Code §8-609.3(d)).

Appendix D. References

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