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EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) estimates that more food reaches landfills than any other material in municipal solid waste (MSW) in the United States, making up over 24 percent of MSW sent to landfills in 2018 (EPA, 2020b). Producing food and managing food waste uses significant resources. Wasted food contributes to a broad range of environmental impacts, including climate change, air pollutants, water scarcity, biodiversity loss, and soil and water quality degradation. In addition, communities with environmental justice concerns, by definition, bear the brunt of the adverse environmental, social, and economic consequences of waste management. By preventing food loss and waste where possible, and recycling the remainder, environmental impacts and impacts to underserved communities can be substantially reduced. To support food waste reduction strategies, identify current practices, and identify opportunities to prevent and reduce food waste, EPA publishes annual estimates of how much wasted food is generated and managed in the United States, which are detailed in this report.

Recognizing the importance of tackling food loss and waste, in 2015, EPA and USDA announced the first-ever national goal to reduce food loss and waste by 50% by the year 2030 (EPA, 2015). The same year, the United Nations announced the Sustainable Development Goal Target 12.3, which aims to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses by 2030 (UN, 2019).

The United States is not alone in its efforts to reduce wasted food. Roughly 30% of the food produced worldwide is lost or wasted each year: approximately 14 percent of the world’s food, valued at $400 billion, is lost on an annual basis between harvest and the retail market (FAO, 2019) and an estimated 17% of food is wasted at the retail and consumer levels (UNEP, 2021). Food loss and waste accounts for about 7% of global greenhouse gas emissions and nearly 30% of the world’s agricultural land is currently occupied to produce food that is ultimately never consumed (UN, 2022).

In 2017, the EPA set out to revise its food measurement methodology to more fully capture flows of wasted food (i.e., excess food and food waste)¹ through the food system, and to provide more granular annual estimates of generation and management of wasted food to the public and for purposes of tracking progress against domestic and international goals. EPA developed an enhanced methodology to calculate sector-specific estimates of wasted food generation, as well as estimates of how much wasted food was sent to each management pathway. EPA’s “Wasted Food Measurement Methodology Scoping Memo” (EPA, 2020a) describes the enhanced methodology that EPA developed between 2017 and 2019, the studies used, and how EPA plans to use the enhanced methodology to calculate its annual estimates for the “Advancing Sustainable Materials Management: Facts and Figures” report (hereafter referred to as the “Facts and Figures Report”).

EPA has collected and reported data on the generation and management of municipal solid waste (MSW), including wasted food, in the United States for more than 30 years. EPA historically published U.S. estimates of wasted food generation and management annually in its “Facts and Figures Report.” The 2018 “Facts and

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¹ The term “excess food” refers to food that is donated to feed people, while the term “food waste” refers to food and inedible parts not ultimately consumed by humans that are discarded or recycled, such as plate waste (i.e., food that has been served but not eaten), spoiled food, or peels and rinds considered inedible. The term “wasted food” is an overarching term that can be used to refer to both excess food and food waste. Section 9.1 contains a glossary of terms used throughout this report.
Figures Report” (EPA, 2020b) was the first such report that used the enhanced methodology to calculate wasted food estimates.\(^2\)

The “2019 Wasted Food Report” serves as an update to the “2018 Wasted Food Report” (EPA, 2020c) and provides detailed estimates, by sector and management pathway, of 2019 wasted food estimates.

EPA included the following generating sectors in the enhanced methodology:

- Food and beverage manufacturing and processing;
- Residential, which is comprised of single and multi-family units;
- Food retail, which includes supermarkets, supercenters, and food wholesalers;
- Food service, which includes several hospitality categories such as restaurants, hotels, and sports venues as well as other institutions that provide food service including hospitals, nursing homes, military installations, office buildings, correctional facilities, colleges and universities, and K-12 schools; and
- Food banks.

EPA’s enhanced methodology aims to capture the various methods in which wasted food is managed and to align with the “Food Loss and Waste Accounting and Reporting Standard” (or “FLW Standard”), which is a global standard that provides requirements and guidance for quantifying and reporting on the weight of food and/or associated inedible parts removed from the food supply chain (Food Loss and Waste Protocol, 2016). EPA’s enhanced methodology includes the following management pathways for wasted food. All are consistent with the FLW Standard, with the addition of food donation.

- Animal feed
- Bio-based materials/biochemical processing
- Codigestion/anaerobic digestion (shorthanded to “Anaerobic digestion” in this report)
- Composting/aerobic processes (shorthanded to “Composting” in this report)
- Controlled combustion
- Donation
- Land application
- Landfill
- Sewer/wastewater treatment

EPA estimates that in 2019, 66.2 million tons of wasted food was generated in the food retail, food service, and residential sectors. Of this, 40% was from households, 40% was from food service providers, and 20% was from food retail. Most of this waste (59.8%) was landfilled. An additional 40.1 million tons of wasted food was generated by the food manufacturing and processing sectors. The biggest proportion of this food manufacturing and processing waste (42.6%) was managed by anaerobic digestion.

EPA’s data for the food retail, food service, and residential sectors is used to inform progress toward the national goal to reduce food loss and waste by 50% by 2030 (EPA, 2015). For food waste, this goal aims to cut in half the amount of food from the retail, food service, and residential sectors that has been removed from the human food supply chain compared to a 2016 baseline of 328 pounds per person. In the three years between the baseline (2016) and the latest national data (2019), there was a slight increase of 6% (from 328 pounds to 349 pounds per person). More information on measurement for the 2030 goal can be found in Section 7.

EPA recognizes that there have been many efforts across the food system to reduce food waste, and by a variety of stakeholders, since 2019. For example, in 2021, 25 states introduced food waste-related legislation (Harvard Food Law and Policy Clinic, 2022), such as landfill bans or other mandates focused on reducing food waste going to landfills. Some of these laws have yet to be fully implemented, and therefore will continue to result in the reduction of wasted food, which is not taken into account in this report reflecting 2019 data. Private sector businesses have made strides in setting goals, measuring and reducing food waste, and communities are increasingly focused on education and awareness efforts aimed at helping their residents waste less food at home. EPA continues to support public and private sector efforts, facilitate peer learning, provide data and conduct research to help decision makers, and provide funding to support waste reduction efforts. Notably, in 2022, EPA established funding opportunities through the Solid Waste Infrastructure for Recycling Grant Program and Recycling Education and Outreach Grant Program for a total of $350 million (EPA, 2022).

Finally, there are some data limitations associated with EPA’s estimates. EPA relies on existing studies and data to develop generation factors, and for some sectors, there are few existing studies. In addition, as states and cities adopt landfill bans and recycling mandates, estimates that rely heavily on studies that pre-date those laws may result in overestimation of generation, especially as these laws become more common and continue to be implemented.

On the management pathway side, composting and anaerobic digestion tonnages may be underestimated, as EPA did not extrapolate to account for states and facilities for which no data was found. Food donation may be overestimated due to EPA’s approach to accounting for food being donated to food banks not in the Feeding America network. Data for food being sent down the drain to the sewer system is also lacking. Finally, while the estimates contained in this report reflect 2019 data, which is prior to the start of the COVID-19 pandemic, EPA is evaluating available information regarding the effects of the pandemic on wasted food generation and management. These findings will be incorporated into future estimates for 2020 and beyond. More detail on caveats and uncertainties can be found in Section 7.
1 BACKGROUND

Wasted food is a growing problem in our society—but also an untapped opportunity. EPA estimates that more food reaches landfills than any other material in our municipal solid waste (MSW), making up over 24 percent of MSW sent to landfills in 2018 (EPA, 2020b). Wasted food is generated by households, food service providers, food retailers, and food manufacturers and processors.

When food is wasted, it also wastes the resources—such as the land, water, energy and labor—that go into growing, storing, processing, distributing, and preparing that food. Each year, food loss and waste from farm to kitchen embodies an area of agricultural land the size of California and New York combined, enough energy to power 50 million U.S. homes for a year, and emissions (excluding landfill emissions) equal to the annual CO2 emissions of 42 coal-fired power plants (EPA, 2021). Through its Sustainable Management of Food efforts, EPA promotes ways to reduce wasted food and thereby limit its negative environmental consequences. The approach takes a life-cycle perspective, targeting waste generation at all points in the food supply chain, and promoting greater efficiency and more creative and beneficial management strategies. The benefits of such an approach are wide-ranging. Environmental benefits include resource conservation and reduction of greenhouse gas emissions. Socioeconomic benefits include improved efficiency in the food supply system, resulting in better distribution to feed people and financial savings. To support wasted food reduction strategies, identify current practices, and identify opportunities, EPA publishes annual estimates of how much wasted food is generated and managed nationally.

EPA, with support from Eastern Research Group (ERG) and Industrial Economics, Incorporated (IEc), updated its wasted food measurement methodology to build on and expand prior efforts. The enhanced methodology and resulting 2016 estimates are detailed in “Wasted Food Measurement Methodology Scoping Memo” (EPA, 2020a). The enhanced methodology was developed through a comprehensive assessment of the literature supporting the measurement of wasted food generation and management, coupled with a sector-specific data collection and characterization effort. EPA used this enhanced methodology to calculate its annual published estimates of wasted food generation and management for the first time in “Advancing Sustainable Materials Management: 2018 Fact Sheet” (EPA, 2020b) (“2018 Facts and Figures Report”). The “2018 Wasted Food Report” (EPA, 2020c) was developed to accompany the “2018 Facts and Figures Report”, and provides detailed estimates by sector and management pathway, along with other relevant information about the 2018 wasted food estimates. This report serves as an update to the “2018 Wasted Food Report” and provides detailed estimates, by sector and management pathway, of 2019 wasted food estimates.

2 SCOPE AND TERMINOLOGY

This report summarizes the 2019 wasted food estimates for the following sectors:

- Food and beverage manufacturing and processing;
- Residential, which is comprised of single and multi-family units;
- Food retail, which includes supermarkets, supercenters, and food wholesalers;
- Food service, which includes several hospitality categories such as restaurants, hotels, and sports venues as well as other institutions that provide food services including hospitals, nursing homes, military installations, office buildings, correctional facilities, colleges and universities, and K-12 schools; and
- Food banks.
This report also summarizes 2019 wasted food estimates for the following management pathways:

- Anaerobic digestion
- Animal feed
- Bio-based materials/biochemical processing
- Composting
- Controlled combustion
- Donation
- Land application
- Landfill
- Sewer/wastewater treatment

EPA’s scope for wasted food measurement has historically been on the food retail, food service, and residential sectors. That is also the scope of the food waste portions of the national 2030 Food Loss and Waste Reduction Goal (EPA, 2015), and Sustainable Development Goal Target 12.3. (United Nations, 2019), which both aim to reduce food loss and waste by 50% by 2030. However, the food manufacturing and processing sector is an important part of the U.S. food system, so estimates for that sector are also presented in this report. EPA’s methodology does not include food loss from the agricultural sector, such as unharvested crops.

EPA’s estimates do not distinguish between “food” and “inedible parts.” EPA’s goal is to make the best use of not only food that was intended for human consumption, but also the associated inedible parts. Throughout this document, EPA uses the term “food” as a shorthand to refer to both food and inedible parts. When referring to both “excess food” (food that is donated to feed people) and “food waste” (food that is intended for human consumption but is ultimately not consumed by humans), EPA uses the overarching term “wasted food”. Food waste can be managed in a variety of ways, including creation of animal feed, composting, anaerobic digestion, or sending to landfills or combustion facilities. Examples of wasted food include unsold food from retail stores; plate waste, uneaten prepared food, or kitchen trimmings from restaurants, cafeterias, and households; or by-products from food and beverage processing facilities. Section 9.1 contains a glossary of terms used throughout this report.

3 GENERATION OF WASTED FOOD

Generation estimates rely on studies conducted by state and municipal governments, industry groups, universities, and other groups that measure wasted food generated at facilities in various sectors. Estimates are correlated to facility-specific characteristics (e.g., revenue or the number of employees) to establish equations expressing generation factors (e.g., 4,080 lbs of wasted food generated/employee/year in supermarkets). There are multiple studies, and therefore multiple generation factors, available for most sectors. EPA scaled up these rates by applying national, sector-specific statistics (e.g., U.S. Census-reported store sales, number of employees in restaurants, number of patients in hospitals, number of inmates in correctional facilities), which resulted in multiple generation estimates per sector. An average annual

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3 These management pathways are consistent with the “FLW Standard” destinations (Food Loss and Waste Protocol), with the addition of food donation. For simplicity, the term anaerobic digestion is used in this report to cover both stand alone and co-digestion facilities and the term composting is used in this report to cover composting and other aerobic processing as composting is the predominant aerobic management pathway for food waste.

4 EPA uses the definition of “food” and “inedible parts” from the FLW Standard (Food Loss and Waste Protocol). Please see section 9.1 for a glossary of terms.
generation estimate was then calculated for each sector, and these values were summed to calculate overall estimates of excess food and food waste generated nationally.

To calculate national wasted food generation estimates for 2019, EPA started with a literature search update. The literature search sought to determine whether any new articles or studies had been published since 2017 (the most recent year for which a comprehensive literature search was conducted) that offer updated generation factors or data on generation for 2019 estimates. EPA’s literature search considered a variety of criteria when evaluating the usefulness and reliability of different information sources. These criteria included the following:

- the depth and level of detail provided by the data sources;
- the availability/accessibility of the data in terms of implicit and/or explicit acquisition costs;
- the reliability of the data in terms of the quality of the methods applied; and
- the scope of the data (e.g., whether the study considers wasted food generation at hospitals in one state or hospitals nationwide).

EPA did not find updated literature for 2019 estimates; all sectors retained the same generation factors as were used to calculate 2018 estimates in EPA’s “2018 Wasted Food Report” (EPA, 2020c). Table 1 summarizes the generation factors applied to each sector.
## Table 1. Average Wasted Food Generation Factors (2019)

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>CATEGORY</th>
<th>GENERATION FACTOR</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing/ Processing</td>
<td>N/A</td>
<td>0.095</td>
<td>Lbs/sales $/year</td>
</tr>
<tr>
<td>Residential</td>
<td>N/A</td>
<td>337.9</td>
<td>Lbs/household/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17.0</td>
<td>Percent food waste (of total household waste)</td>
</tr>
<tr>
<td>Food Retail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supermarkets</td>
<td></td>
<td>2.0</td>
<td>Tons/employee/year</td>
</tr>
<tr>
<td>Supercenters</td>
<td></td>
<td>0.38</td>
<td>Tons/employee/year</td>
</tr>
<tr>
<td>Supermarkets and Supercenters¹</td>
<td></td>
<td>104.9</td>
<td>Tons/ establishment/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.0</td>
<td>Lbs/thousand $ revenue/year</td>
</tr>
<tr>
<td>Food Wholesale²</td>
<td></td>
<td>120.7</td>
<td>Tons/facility/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.005</td>
<td>Tons/thousand $ revenue/year</td>
</tr>
<tr>
<td>Hotels</td>
<td></td>
<td>1,137.8</td>
<td>Lbs/employee/year</td>
</tr>
<tr>
<td>Restaurants (full service)</td>
<td></td>
<td>3,050.7</td>
<td>Lbs/employee/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39.1</td>
<td>Tons/facility/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33.0</td>
<td>Lbs/thousand $ revenue/year</td>
</tr>
<tr>
<td>Restaurants (limited service)</td>
<td></td>
<td>2,751.3</td>
<td>Lbs/employee/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40.9</td>
<td>Tons/facility/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33.0</td>
<td>Lbs/thousand $ revenue/year</td>
</tr>
<tr>
<td>Sports Venues</td>
<td></td>
<td>0.31</td>
<td>Lbs/visitor/year</td>
</tr>
<tr>
<td>Hospitals</td>
<td></td>
<td>653.1</td>
<td>Lbs/bed/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.47</td>
<td>Lbs/meal</td>
</tr>
<tr>
<td>Nursing Homes</td>
<td></td>
<td>657.0</td>
<td>Lbs/bed/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.55</td>
<td>Lbs/meal</td>
</tr>
<tr>
<td>Military Installations</td>
<td></td>
<td>105.3</td>
<td>Lbs/person/year</td>
</tr>
<tr>
<td>Office Buildings</td>
<td></td>
<td>169.9</td>
<td>Lbs/employee/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.22</td>
<td>Tons/1000 sq ft/year</td>
</tr>
<tr>
<td>Correctional Facilities</td>
<td></td>
<td>1.1</td>
<td>Lbs/inmate/day</td>
</tr>
<tr>
<td>Colleges and Universities</td>
<td></td>
<td>0.36</td>
<td>Lbs/student/meal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.44</td>
<td>Lbs/student/meal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td>Tons/student/year</td>
</tr>
<tr>
<td>K-12 Schools</td>
<td></td>
<td>26.3</td>
<td>Lbs/student/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.43</td>
<td>Lbs/meal</td>
</tr>
<tr>
<td>Food Banks</td>
<td>N/A</td>
<td>372.5</td>
<td>Tons/establishment/year</td>
</tr>
</tbody>
</table>

¹ The revenue total from supermarkets and supercenters includes in-person shopping from these traditional brick and mortar establishments as well as revenue from any secondary e-commerce business from these retailers.

² When a company has a large e-commerce segment, typically with separate warehousing facilities, the Annual Retail Trade survey considers this a separate industry from the company’s brick-and-mortar NAICS classifications, and this type of e-commerce is included in the wholesale category.

EPA then updated the extrapolation sector-specific statistics to reflect 2019 data.

Table 2 summarizes the 2019 extrapolation basis value for each generation sector and category and the associated data source.
## Table 2. Extrapolation Bases for Wasted Food Generation Estimates (2019)

<table>
<thead>
<tr>
<th>SECTOR/CATEGORY</th>
<th>GENERATION UNITS</th>
<th>EXTRAPOLATION BASIS VALUE</th>
<th>EXTRAPOLATION BASIS UNITS</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food Manufacturing and Processing</strong></td>
<td></td>
<td></td>
<td></td>
<td>(United States Census Bureau, 2021a)</td>
</tr>
<tr>
<td>Food Manufacturing and Processing</td>
<td>Lbs/sales $/year</td>
<td>845,096,721,000</td>
<td>Sales $</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>Lbs/household/year</td>
<td>128,579,000</td>
<td>Households</td>
<td>(United States Census Bureau, 2021)</td>
</tr>
<tr>
<td>Religious Institutions</td>
<td></td>
<td></td>
<td></td>
<td>(EPA, 2020b)</td>
</tr>
<tr>
<td>Percent food waste</td>
<td>149.2</td>
<td>Million Tons MSW</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Food Retail</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supermarkets and Supercenters</td>
<td>Tons/employee/year (supermarkets)</td>
<td>2,942,271</td>
<td>Employees</td>
<td>(United States Census Bureau, 2022d)</td>
</tr>
<tr>
<td>Supermarkets and Supercenters</td>
<td>Tons/employee/year (supercenters)</td>
<td>1,782,231</td>
<td>Employees</td>
<td>(United States Census Bureau, 2022e)</td>
</tr>
<tr>
<td>Supermarkets and Supercenters</td>
<td>Tons/establishment/year</td>
<td>123,833</td>
<td>Establishments</td>
<td>(United States Census Bureau, 2022f)</td>
</tr>
<tr>
<td>Downtown Superman</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lbs/thousand $ revenue/year</td>
<td>716,842,000,000</td>
<td>Revenue $</td>
<td>(United States Census Bureau, 2022)</td>
<td></td>
</tr>
<tr>
<td>Wholesalers</td>
<td>Tons/facility/year</td>
<td>35,112</td>
<td>Facilities</td>
<td>(United States Census Bureau, 2022a)</td>
</tr>
<tr>
<td>Wholesalers</td>
<td>Tons/thousand $ revenue/year</td>
<td>685,095,000,000</td>
<td>Revenue $</td>
<td>(United States Census Bureau, 2022b)</td>
</tr>
<tr>
<td>Wholesalers</td>
<td>Tons/thousand $ revenue/year (E-commerce)</td>
<td>1,368,000,000</td>
<td>E-commerce Revenue $</td>
<td>(United States Census Bureau, 2022c)</td>
</tr>
<tr>
<td><strong>Food Service</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotels</td>
<td>Lbs/employee/year</td>
<td>2,102,377</td>
<td>Employees</td>
<td>(United States Census Bureau, 2022e)</td>
</tr>
<tr>
<td>Restaurants/ (full service)</td>
<td>Lbs/employees/year</td>
<td>5,860,567</td>
<td>Employees</td>
<td>(United States Census Bureau, 2022f)</td>
</tr>
<tr>
<td>Restaurants/ (full service)</td>
<td>Tons/facility/year</td>
<td>272,689</td>
<td>Facilities</td>
<td>(United States Census Bureau, 2022f)</td>
</tr>
<tr>
<td>Restaurants/ (full service)</td>
<td>Lbs/thousand $ revenue/year</td>
<td>300,700,000,000</td>
<td>Revenue $</td>
<td>(United States Census Bureau, 2022f)</td>
</tr>
<tr>
<td>Restaurants/ (limited service)</td>
<td>Lbs/employees/year</td>
<td>5,418,681</td>
<td>Employees</td>
<td>(United States Census Bureau, 2022g)</td>
</tr>
<tr>
<td>Restaurants/ (limited service)</td>
<td>Tons/facility/year</td>
<td>330,296</td>
<td>Facilities</td>
<td>(United States Census Bureau, 2022g)</td>
</tr>
<tr>
<td>Restaurants/ (limited service)</td>
<td>Lbs/thousand $ revenue/year</td>
<td>290,400,000,000</td>
<td>Revenue $</td>
<td>(United States Census Bureau, 2022g)</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Lbs/bed/year</td>
<td>919,559</td>
<td>Beds</td>
<td>(American Hospital Association, 2021)</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Lbs/meal</td>
<td>1,260,760,907</td>
<td>Meals</td>
<td>(Statista, 2022)</td>
</tr>
<tr>
<td>Nursing Homes</td>
<td>Lbs/bed/year</td>
<td>1,660,400</td>
<td>Beds</td>
<td>(National Center for Health Statistics (U.S.), 2019)</td>
</tr>
<tr>
<td>Nursing Homes</td>
<td>Lbs/meal</td>
<td>1,280,931,000</td>
<td>Meals</td>
<td>(National Center for Health Statistics, 2021)</td>
</tr>
<tr>
<td>Military Installations</td>
<td>Lbs/person/year</td>
<td>1,189,842</td>
<td>Active-duty military in U.S.</td>
<td>(Defense Manpower Data Center, 2019)</td>
</tr>
<tr>
<td>SECTOR/CATEGORY</td>
<td>GENERATION FACTOR UNITS</td>
<td>EXTRAPOLATION BASIS VALUE</td>
<td>EXTRAPOLATION BASIS UNITS</td>
<td>SOURCE</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Tons/1000 sq ft/year</td>
<td>16,682,000</td>
<td>1,000 sq ft</td>
<td>(Energy Information Administration (EIA), 2019)</td>
</tr>
<tr>
<td>Correctional Facilities</td>
<td>Lbs/inmate/day</td>
<td>2,086,600</td>
<td>Inmates</td>
<td>(Minton et al., 2021)</td>
</tr>
<tr>
<td>Colleges and Universities</td>
<td>Lbs/student/meal</td>
<td>3,381,166,269</td>
<td>Meals</td>
<td>(National Center for Education Statistics, 2019b)</td>
</tr>
<tr>
<td></td>
<td>Tons/student/year</td>
<td>20,006,901</td>
<td>Students</td>
<td>(National Center for Education Statistics, 2019b)</td>
</tr>
<tr>
<td>K-12 Schools</td>
<td>Lbs/student/year</td>
<td>56,350,000</td>
<td>Students</td>
<td>(National Center for Education Statistics, 2019a)</td>
</tr>
<tr>
<td></td>
<td>Lbs/meal</td>
<td>9,278,062,379</td>
<td>Meals</td>
<td>(U.S. Department of Agriculture Food and Nutrition Service, 2021)</td>
</tr>
<tr>
<td>Food Banks</td>
<td>Tons/establishment/year</td>
<td>1,270</td>
<td>Establishments</td>
<td>(Hoovers, 2019)</td>
</tr>
</tbody>
</table>

1 Revenue includes sales from in-person shopping as well as e-commerce from these retailers whose primary business is brick-and-mortar stores. This revenue excludes alcohol sales.
2 Only the revenue for food and beverage sales from companies whose primary business is e-commerce (NAICS 4541) is used here. Food and beverage e-commerce sales do not breakout alcohol sales.

To arrive at generation estimates for each generation sector, EPA then multiplied generation factors by the corresponding updated extrapolation basis value and averaged annual generation for sectors with multiple generation estimates.

Table 3 summarizes annual wasted food generation estimates for each of the sectors, as well as contextual information on each sector. First, for each sector, the table identifies, where appropriate, the NAICS codes used to define the sector. Second, the table lists the number of unique empirical studies on which the generation estimate is based. Finally, the table provides estimated generation in tons per year, as well as the percent of all generation that the sector represents.

EPA estimates that in 2019, 66.2 million tons of wasted food was generated in the food retail, food service, and residential sectors. An additional 40.1 million tons of wasted food was generated in the food manufacturing and processing sector.

As shown in Table 3 and Figure 1, households account for about 40% of total generation. Restaurants and supermarkets and supercenters are also major generators, followed by office buildings, food wholesalers, K-12 schools, and hotels. Most of the remaining categories have annual generation below one million tons. Table 4 quantifies the wasted food generated by food manufacturers and processors.
Table 3. Estimated Annual Wasted Food Generation for the Food Retail, Food Service and Residential Sectors (2019)

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>CATEGORY</th>
<th>NAICS CODES</th>
<th>NUMBER OF STUDIES INFORMING GENERATION RATE</th>
<th>ESTIMATED ANNUAL GENERATION (TONS PER YEAR) (CATEGORY)</th>
<th>PERCENT OF TOTAL (CATEGORY)</th>
<th>ESTIMATED ANNUAL GENERATION (TONS PER YEAR) (SECTOR)</th>
<th>PERCENT OF TOTAL (SECTOR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>N/A</td>
<td>N/A</td>
<td>12</td>
<td>26,502,346</td>
<td>40.0%</td>
<td>26,502,346</td>
<td>40.0%</td>
</tr>
<tr>
<td>Food Retail</td>
<td>Supermarkets and Supercenters</td>
<td>445110, 445120, 445210, 445220, 445230, 445291, 445292, 445299, 452311</td>
<td>9</td>
<td>8,998,443</td>
<td>13.6%</td>
<td>12,971,959</td>
<td>19.6%</td>
</tr>
<tr>
<td></td>
<td>Food Wholesale</td>
<td>424410, 424420, 424430, 424440, 424450, 424460, 424470, 424480, 424490, 4541³</td>
<td>3</td>
<td>3,973,516</td>
<td>6.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Service</td>
<td>Hotels</td>
<td>7211</td>
<td>4</td>
<td>1,196,076</td>
<td>1.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Restaurants (full and limited</td>
<td>722511, 722520, 722514, 722513, 722330, 722515</td>
<td>8</td>
<td>18,337,784</td>
<td>27.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sports Venues</td>
<td>N/A</td>
<td>3</td>
<td>39,702</td>
<td>0.06%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hospitals</td>
<td>622³</td>
<td>6</td>
<td>298,576</td>
<td>0.45%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nursing Homes</td>
<td>6239, 6233, 6232, 6231¹</td>
<td>3</td>
<td>415,591</td>
<td>0.63%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Military Installations</td>
<td>N/A</td>
<td>2</td>
<td>62,627</td>
<td>0.09%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Office Buildings</td>
<td>N/A</td>
<td>3</td>
<td>4,093,447</td>
<td>6.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Correctional Facilities</td>
<td>922140, 561210¹</td>
<td>6</td>
<td>425,232</td>
<td>0.64%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colleges and Universities</td>
<td>N/A</td>
<td>10</td>
<td>624,371</td>
<td>0.94%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>K-12 Schools</td>
<td>N/A</td>
<td>6</td>
<td>1,248,532</td>
<td>1.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td>Food Banks</td>
<td>624210</td>
<td>1</td>
<td>473,027</td>
<td>N/A</td>
<td>473,027</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Total Generation: 66,216,242 (100%)  
66,216,242 (100%)

¹ In several instances (e.g., hospitals, nursing homes, correctional facilities), the sector has a NAICS code, but the extrapolation data are not strictly delineated by NAICS code as with Census data. For instance, nursing homes are aligned with several NAICS codes, but data on nursing home populations are compiled by CDC, not by the Census Bureau.
² Food waste from food banks is not added to total generation because it would represent “double counting,” i.e., it is already accounted for in Total Generation, because total generation includes excess food that was donated to food banks (and some food donated to food banks inevitably is wasted).
³ Note that in 2019, EPA added wasted food estimates from e-commerce sales (NAICS code 4541). When a company has a large e-commerce segment, typically with separate warehousing facilities, the Annual Retail Trade survey considers this a separate industry from the company’s brick-and-mortar NAICS classifications. E-commerce sales that occur at brick-and-mortar locations are included in the overall revenue for the supermarkets and supercenters.
Table 4. Estimated Annual Wasted Food Generation for the Food Manufacturing and Processing Sector (2019)

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>NAICS CODES</th>
<th>NUMBER OF STUDIES INFORMING GENERATION RATE</th>
<th>ESTIMATED ANNUAL GENERATION (TONS PER YEAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Manufacturing/</td>
<td>311 and 3121 (excluding 311111, 311119, 312112, and 312113)</td>
<td>3</td>
<td>40,050,707</td>
</tr>
<tr>
<td>Processing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 MANAGEMENT OF WASTED FOOD

The characterization of management pathways for wasted food involves two phases: (1) an initial characterization based on percentage distributions reported in the literature; and (2) a revised characterization based on actual tonnages for several key pathways.

EPA developed the initial management characterization for each sector as part of the generation analysis. The management pathways align with the “FLW Standard” destinations (Food Loss and Waste Protocol, 2016), with the addition of donation of excess food to food banks. EPA includes the following management pathways (please see Section 9.1 for a glossary):

- Anaerobic digestion,
- Animal feed,
- Bio-based materials/biochemical processing,
- Composting,
- Controlled combustion,
- Donation,
- Land application,
- Landfill, and
- Sewer/wastewater treatment.

The initial analysis drew on sector-specific literature that provided a percentage distribution across the management pathways (i.e., an estimate of the percent of wasted food destined for each major management pathway by generating sector). These same studies were used for the 2019 update with the exception of the anaerobic digestion pathway, which was based on reported tonnages by sector to EPA’s 2019 anaerobic digestion survey (EPA, 2023). The survey did not have breakdowns for food waste going to AD from nursing homes but did have reported tonnages for other sector categories included in this report (although reported tonnage for some were zero).

- **Food manufacturers, food retail, and restaurants**: Annual surveys performed by Business for Social Responsibility (BSR) in 2013 and 2014 (Business for Social Responsibility, 2013, 2014) and the Food Waste Reduction Alliance (FWRA) in 2016 (Food Waste Reduction Alliance, 2016) provided the management distribution. These three studies surveyed manufacturers, food retailers, and restaurants and provided detail on how those sectors manage their wasted food. After subtracting out the amount reported to be sent to anaerobic digesters based on the EPA’s 2019 anaerobic digestion survey (EPA, 2023), the remaining waste management pathways were distributed among the remaining percentage of waste generated from each sector category. EPA used the food manufacturing data for the manufacturing and processing sector, the food retail data for the food retail/wholesale sector, and the restaurant data for both full service and limited-service restaurants.

- **Residential**: EPA developed a distribution based on a variety of studies examining composting rates in different geographic locations, as well as studies on the use of household food waste disposers (e.g., in-sink disposals). EPA then assumed that the remaining food waste that was not sent to composting, sewer, or anaerobic digestion is either landfilled or combusted, with the proportion based on various literature sources.

- **Remaining sectors (food services sectors other than restaurants as well as food banks)**: The initial management characterization for 2016 and 2018 estimates relied on the general wasted food management distribution estimated in “Advancing Sustainable Materials Management: 2017 Fact Sheet” (EPA, 2019). For the 2019 estimates, EPA made a change to the management characterization for food services sectors other than restaurants, as well as food banks. Based on similarities in operations, EPA applied the management distribution for restaurants, as derived from the BSR and FWRA surveys, to the remaining food services sectors for all management pathways except for anaerobic digestion. In addition, EPA applied the management distribution for retail, as derived from

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5 For more detailed explanation on the initial management percentage methodology and distributions, please refer to “Food Waste Measurement Methodology Scoping Memo” (EPA, 2020a).

6 The annual surveys performed by FWRA reports a minimal amount of food waste managed by an “other” category, however, the surveys do not define “other”. As a result, EPA zeroed out the “other” category and redistributed the management percentage to the other management pathways. In addition, the annual surveys report the amount of food waste managed by a combination of landfilling and controlled combustion (categorized as “disposed of”). The amount combusted on site was specified but the specific breakdown of total (on and off site) combustion and landfilling are not provided so EPA assumed a breakout of 80.4% to landfill and 19.6% to controlled combustion. This estimated breakout was derived from the Energy Recovery Council’s (ERC) Directory of Waste-to-Energy facilities (Energy Recovery Council (ERC), 2018).

7 The initial 2016 management characterization estimates are from the “Food Waste Measurement Methodology Scoping Memo” (EPA, 2020a).
the BSR and FWRA surveys, to food banks but modified the management distribution by zeroing out
the “food donation” and “anaerobic digestion” category and redistributing these management
percentages to the other management pathways. This change in management distribution sources
was implemented so that management distributions for 2019 would be based on more sector specific
information.

To develop a revised management profile, subsequent analyses incorporated more detailed data on three
management pathways, leading to revised estimates of the landfill and controlled combustion pathways:

- **Composting:** EPA developed estimates of food waste composted by summarizing state-specific data
  available from state environmental agency websites and published reports and comparing reported
  values with EPA’s State Data Measurement Sharing Program (SMP) (Re-TRAC, 2019)—these 2019
  composting estimates are provided in Table 12. EPA did not extrapolate these data to account for
  activity in the remaining states, tribes, and territories for which data were not available. MSW
  compost, which is compost of the organic fraction of MSW, was also included in the total compost
  estimate and reflected production from all known sources based on published literature. Data
  compiled suggest that about 3.3 million tons of food waste were managed through composting in
  2019. Note that these estimates do not include food waste composted from food manufacturers and
  processors. To estimate food waste composted by manufacturers and processors, EPA used the
  results of surveys conducted by BSR and the FWRA of food manufacturers around the nation as noted
  above.

- **Anaerobic digestion:** EPA arrived at estimates for food waste anaerobically digested using EPA’s
  2019 nationwide survey of anaerobic digestion facilities (EPA, 2023). In its latest “Anaerobic
  Digestion Facilities Processing Food Waste in the United States” report, EPA conducted a nationwide
  survey of anaerobic digestion facilities in the U.S. in 2021, the results of which reflect 2019 data. Of
  the 275 surveys distributed to anaerobic digestion facilities, 99 were returned by operational
  facilities, resulting in a survey response rate of 36 percent, which is a significantly lower participation
  rate than the survey including 2018 data of 67 percent. Of the 99 facilities who responded to the
  survey, 89 facilities provided information about the amount of food waste they processed. The 2023
  report (containing 2019 data) separates out food waste processed by anaerobic digesters by
  category. These category specific values are integrated into the 2019 wasted food estimates to
  provide more detail to category management profiles. Nursing homes were not included in the 2023
  anaerobic digestion report (containing 2019 data), and two categories had no reported tonnages
  (military installations and correctional facilities); as a result, no food waste is allocated to anaerobic
  digestion in these categories. The food manufacturing and processing sector included in this report
  comprises the “Industrial (other)”, “Manufacturing/Processing”, and “Other” categories detailed in
  the 2023 anaerobic digestion report (containing 2019 data). The anaerobic digestion amount for
  “Retail/wholesale” category included in the 2023 anaerobic digestion report (containing 2019 data)
  was equally divided between the food retail and food wholesale categories included in the 2019
  wasted food estimates. Livestock farms and food bank anaerobic digestion data are not included in
  the 2019 wasted food estimates as livestock farms are out of scope of this report and reported
  anaerobic digestion food waste from food banks was very small. Anaerobic digestion facilities
  reported a total of 17.60 million tons of food waste managed by anaerobic digestion annually in
  2019, 17.59 million tons of which is included in the 2019 wasted food estimates.

- **Donation:** EPA’s estimation method is primarily based on a 2019 annual report from Feeding America
  (Feeding America, 2019), the largest domestic hunger relief organization with a nationwide network
of more than 200 food banks. Feeding America secures food from corporate manufacturers, retailers, and produce suppliers nationwide; stores excess food temporarily in warehouses; and then distributes the excess food to families and individuals through food assistance agencies such as youth or senior centers, shelters, and food pantries. EPA calculated the total quantity of excess food received by Feeding America food banks (i.e., food that would have otherwise been thrown away by the establishments donating the food, but which was instead donated to Feeding America food banks), and then developed an estimate of excess food managed per Feeding America food bank. While Feeding America is the largest national network of food banks, there are hundreds more food bank establishments in the United States, so EPA multiplied excess food received per Feeding America food bank by the total number of food bank establishments nationwide to estimate total excess food managed through donation. The number of food banks in the United States is based on data available from Hoovers, a research company that provides information on companies and industries. Based on analysis and extrapolation of data from Feeding America, the food retail and food service sectors donated approximately 5.1 million tons of excess food in 2019. The food manufacturing and processing sector donated an additional estimated 2.2 million tons of excess food in 2019.

In order to integrate the composting and donation estimates into the overall analysis of management pathways and arrive at landfilling and controlled combustion figures, EPA associated the aggregate figures with specific generator categories (i.e., determined where the food waste and excess food originated). The analysis incorporated the following assumptions:

- **Composting**: The quantity of food waste allocated to composting is reduced when using the aggregate based on state data (3.9 million tons) in place of the initial estimate (5.1 million tons). The analysis retains the relative proportion of the generation sectors contributing to composting but transfers the net quantity (5.1 – 3.9 = 1.2 million tons) to landfilling and controlled combustion.

- **Donation**: Relative to the initial characterization, the revised characterization points to a larger quantity of excess food being recovered for donation. The newly estimated 7.8 million tons is assumed to originate from sectors identified in the Feeding America donation profile. These 7.8 million tons reflects the total amount of food donations but some of these donations cannot be used by the food banks and are re-routed to other management pathways. EPA assumes that 3.5% of donated excess food is from food service, 28.2% from food manufacturers and processors, and 68.3% from food retail. The 68.3% associated with food retail is split between supermarkets/supercenters and wholesale in proportion to their generation. The 3.5% in food service is split between each of the food service categories. In the food retail and food service sectors, the increase in excess food donation amounts is netted out of landfilling and controlled combustion because these are the two management pathways receiving the largest tonnages of food waste from those sectors. In the food manufacturing and processing sector, the increase is netted out of landfilling, controlled combustion, land application and animal feed because these all receive large amounts of wasted food from this sector.

For the food retail, food service and residential sectors together, EPA estimates that 59.8% of wasted food is sent to landfill, 14.6% is managed by sewer/wastewater treatment, 7.8% is managed by donation, 6.0% is managed by controlled combustion, and smaller amounts are managed by other management pathways. For food the food manufacturing and processing sector, EPA estimates that 42.3% of wasted food is managed by

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8 These percentages are based on a 2019 annual report from Feeding America (Feeding America, 2019).
anaerobic digestion, 34.2% is used to create animal feed, 12.9% goes to land application, and 5.5% is managed by food donation. Table 5 and Table 6 present the revised profile of wasted food management, and Figure 2 and Figure 3 depict the percentage distribution to each management pathway. It is important to note that the estimates for donation in Table 5 exclude the small share of excess food that is donated but which food banks cannot distribute (i.e., 473,027 tons) and therefore becomes food waste that is routed to other management pathways. This tonnage is included in the other management pathways where that food waste is sent.

Table 5. Quantity of Wasted Food Managed by the Food Retail, Food Service, and Residential Sectors Based on Revised Management Profile (2019)

<table>
<thead>
<tr>
<th>MANAGEMENT PATHWAY</th>
<th>QUANTITY MANAGED (TONS)</th>
<th>PERCENTAGE MANAGED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donation¹</td>
<td>5,135,293</td>
<td>7.76%</td>
</tr>
<tr>
<td>Animal Feed</td>
<td>1,516,771</td>
<td>2.29%</td>
</tr>
<tr>
<td>Bio-based Materials/Biochemical Processing</td>
<td>2,335,988</td>
<td>3.53%</td>
</tr>
<tr>
<td>Anaerobic digestion</td>
<td>538,539</td>
<td>0.81%</td>
</tr>
<tr>
<td>Composting</td>
<td>3,304,764</td>
<td>4.99%</td>
</tr>
<tr>
<td>Land Application</td>
<td>141,371</td>
<td>0.21%</td>
</tr>
<tr>
<td>Controlled Combustion</td>
<td>9,646,263</td>
<td>14.57%</td>
</tr>
<tr>
<td>Landfill</td>
<td>39,621,902</td>
<td>59.84%</td>
</tr>
<tr>
<td>Sewer/Wastewater Treatment</td>
<td>3,975,352</td>
<td>6.00%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>66,216,242</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

¹ This estimate excludes the small share of excess food (473,027 tons) that food banks cannot distribute and is therefore food waste that is routed to other management pathways.
### Table 6. Quantity of Wasted Food Managed by the Manufacturing and Processing Sector Based on Revised Management Profile (2019)

<table>
<thead>
<tr>
<th>MANAGEMENT PATHWAY</th>
<th>QUANTITY MANAGED (TONS)</th>
<th>PERCENTAGE MANAGED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donation</td>
<td>2,205,990</td>
<td>5.51%</td>
</tr>
<tr>
<td>Animal Feed</td>
<td>13,709,339</td>
<td>34.23%</td>
</tr>
<tr>
<td>Bio-based Materials/Biochemical Processing</td>
<td>64,737</td>
<td>0.16%</td>
</tr>
<tr>
<td>Anaerobic digestion</td>
<td>17,055,531</td>
<td>42.58%</td>
</tr>
<tr>
<td>Composting</td>
<td>583,305</td>
<td>1.46%</td>
</tr>
<tr>
<td>Land Application</td>
<td>5,183,851</td>
<td>12.94%</td>
</tr>
<tr>
<td>Controlled Combustion</td>
<td>330,326</td>
<td>0.82%</td>
</tr>
<tr>
<td>Landfill</td>
<td>917,630</td>
<td>2.29%</td>
</tr>
<tr>
<td>Sewer/Wastewater Treatment</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>40,050,707</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

1 These figures exclude the small share of excess food (473,027 tons) that food banks cannot distribute and is therefore food waste that is routed to other management pathways.

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**Figure 2. Percentage Distribution of Wasted Food Managed by the Food Retail, Food Service, and Residential Sectors (2019)**

![Pie chart showing the percentage distribution of wasted food managed by different sectors.](chart.png)
4.1 SECTOR-BY-SECTOR SUMMARY

4.1.1 Food Manufacturing and Processing Sector

Food and beverage manufacturers and processors generated an estimated 40.1 million tons of wasted food in 2019. The majority (42.6%) of this sector’s wasted food was managed by anaerobic digestion, 34.2% animal feed, 12.9% by land application, with smaller proportions managed by other methods. Food and beverage manufacturing/processing industries are unique from the other sectors EPA analyzed in the methods they use to manage their wasted food (i.e., a much higher percentage going to anaerobic digestion, animal feed and land application, and a lower percentage going to landfill, than the food retail, food service, and residential sectors). Figure 4 depicts the proportion of the food and beverage manufacturing and processing sector’s wasted food managed by each pathway.
4.1.2 Food Retail Sector

The food retail sector includes supermarkets, supercenters, and food wholesalers. The food retail sector was estimated to generate 13.0 million tons of wasted food (9.0 million tons from supermarkets and supercenters, and 4.0 million tons from food wholesale). About 41.1% of the food retail sector’s wasted food was donated, 20.9% was landfilled, 14.6% was sent to composting, 11.1% was sent to animal feed, 6.8% was combusted, and smaller proportions were managed by other methods. Figure 5 depicts the proportion of the food retail sector’s wasted food managed by each pathway.

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Food wholesale includes food waste resulting from e-commerce under NAICS code 4541. Online grocery shopping done through brick-and-mortar supermarkets or supercenters are included in the revenue from those stores under food retail.
4.1.3 Food Service Sector

The food service sector includes hospitality categories (restaurants, hotels, and sports venues) and various types of institutions serving food (hospitals, nursing homes, military institutions, office buildings, correctional facilities, colleges and universities, and K-12 schools). The food service sector was estimated to generate 26.7 million tons of wasted food, with the majority (over 73%) coming from the hospitality categories. Almost three quarters (72%) of the wasted food generated from the food service sector was landfilled, 17% was managed by controlled combustion, and 8% was composted, with smaller proportions managed by other methods. Figure 6 depicts the proportion of the food service sector’s wasted food managed by each pathway.
4.1.4 Residential Sector

The residential sector, which includes single family and multi-family dwellings, was estimated to generate 26.5 million tons of wasted food. The majority (66.2%) of residential wasted food was landfilled; 15.1% was combusted, and 15.0% was sent to sewer/wastewater treatment. Only 3.7% was composted. Figure 7 depicts the proportion of residential wasted food managed by each pathway.

Figure 7. Residential Sector Wasted Food Management Profile (2019)

4.1.5 Food Banks

Food banks are also a minor generator of food waste, because they receive a small amount (6.1%) of excess food that is unfit for distribution due to damage, spoilage, and other reasons. Food banks were estimated to generate 473,027 tons of food waste. Note that this tonnage is already accounted for in the estimates of wasted food generated in the food manufacturing and processing, food retail, food service, and residential sectors, because establishments in those sectors donate excess food to the food banks (i.e., 473,027 tons of the excess food that is donated from these sectors to food banks cannot be distributed and ends up becoming food waste). Approximately 42.4% of the food waste generated in food banks was landfilled, 17.1% was composted, 16.3% was combusted, 14.4% was managed by animal feed, and smaller proportions were managed by other methods. Figure 8 depicts the proportion of food banks’ food waste managed by each pathway.
4.2 PATHWAY-BY-PATHWAY SUMMARY

4.2.1 Food Donation

In 2019, 7.8%, or 5.1 million tons, of wasted food from food retail, food service, and residential sectors was managed by food donation. This percentage reflects the net amount donated after subtracting out the wasted food (473,027) that could not be used by food banks. Most of this excess food was donated by the supermarket and supercenter retailers and wholesalers. EPA does not have data on food managed by donation from the residential sector.

Figure 9 depicts the proportion of food donated by each of the categories in the food retail, food service, and residential sectors for which EPA had data. In addition, in 2019, 2.2 million tons of wasted food from the food manufacturing and processing sector was managed by food donation.
4.2.2 Animal Feed

In 2019, 2.3%, or 1.5 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by animal feed. Most of this wasted food managed by animal feed was generated by the supermarket and supercenter retailers and wholesalers. EPA does not have data on food sent to animal feed by the residential sector.

Figure 10 depicts the proportion of food sent to animal feed by each of the categories in the food retail, food service, residential, and food bank sectors for which EPA had data. In addition, 13.7 million tons of wasted food generated from the food manufacturing and processing sector was managed by animal feed.
4.2.3 Bio-based Materials/Biochemical Processing

In 2019, approximately 3.5%, or 2.3 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by bio-based materials/biochemical processing (i.e., converting material into industrial products). Most of this wasted food managed by bio-based materials/biochemical processing was from restaurants, other food service providers and supermarket and supercenter retailers. EPA does not have data on food managed by bio-based materials/biochemical processing by the residential sector.

Figure 11 depicts the proportion of food managed by bio-based materials/biochemical processing from each of the categories in the food retail, food service, residential, and food bank sectors for which EPA had data. In addition, approximately 64,737 tons of wasted food generated from the food manufacturing and processing sector was managed by bio-based materials/biochemical processing.
4.2.4 Anaerobic Digestion

In 2019, less than 1.0%, or approximately 538,539 tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by anaerobic digestion. Most of this wasted food managed by anaerobic digestion was from supermarket and supercenter retailers, restaurants, and wholesalers. The amount of food waste managed by anaerobic digestion by food banks was very small and has been excluded.

Figure 12 depicts the proportion of food managed by anaerobic digestion from each of the categories in the food retail, food service, residential and food bank sectors for which EPA had data. In addition, approximately 17.1 million tons of wasted food generated from the food manufacturing and processing sector was managed by anaerobic digestion.
4.2.5 Composting

In 2019, 5%, or 3.3 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was composted. Most of this wasted food managed by composting was from supermarket and supercenter retailers, households, and wholesalers.

Figure 13 depicts the proportion of food managed by composting from each of the categories in the food retail, food service, residential, and food bank sectors. In addition, approximately 583,305 tons of wasted food generated from the food manufacturing and processing sector was managed by composting.
4.2.6 Land Application

In 2019, 0.21%, or 141,371 tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by land application. All wasted food managed by land application was from supermarket and supercenter retailers, wholesalers, and food banks. EPA does not have data on food managed by land application by the food service or residential sectors.

Figure 14 depicts the proportion of food managed by land application from each of the categories in the food retail, food service, residential, and food bank sectors for which EPA had data. In addition, approximately 5.2 million tons of wasted food generated from the food manufacturing and processing sector was managed by land application.
4.2.7 Controlled Combustion

In 2019, 14.6%, or 9.6 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by controlled combustion. Most of this wasted food managed by controlled combustion was from households, restaurants, and other food service providers.

Figure 15 depicts the proportion of food managed by controlled combustion from each of the categories in the food retail, food service, residential, and food bank sectors. In addition, approximately 330,326 tons of wasted food generated from the food manufacturing and processing sectors was managed by controlled combustion.
4.2.8 Landfill

In 2019, 59.8%, or 39.6 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by landfilling. Most of this wasted food managed by landfilling was from households, restaurants, and other food service providers.

Figure 16 depicts the proportion of food managed by landfilling from each of the categories in the food retail, food service, residential, and food bank sectors. In addition, approximately 917,630 tons of wasted food generated from the food manufacturing and processing sector was managed by landfilling.

Figure 16. Landfilling Sources (Food Retail, Food Service, Residential, and Food Bank Sectors) (2019)
4.2.9 Sewer/Wastewater Treatment

In 2019, 14.6%, or 4.0 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by sewer/wastewater treatment. All this wasted food managed by sewer/wastewater treatment was from households. EPA does not have data on wasted food managed by sewer/wastewater treatment by any other sectors, including food retail, food service, food bank, and food manufacturing and processing.

4.3 OVERALL SUMMARY OF GENERATION AND MANAGEMENT OF WASTED FOOD

The generation and management characterizations can be combined in an overall diagram of the food system. The Sankey diagram in Figure 17 show the origination and ultimate destination of wasted food, depicting larger flows with broader connective arrows.

*Figure 17. Summary of Wasted Food Generation and Management Flows (Food Retail, Food Service, and Residential Sectors) (2019)*
5 PROGRESS TOWARD THE U.S. 2030 FOOD LOSS AND WASTE REDUCTION GOAL

In 2015, EPA and USDA announced the first-ever national goal to reduce food loss and waste by 50% by the year 2030. While the goal aims to reduce food loss, neither EPA nor USDA have baseline data for food loss, which includes food that goes uneaten in the agricultural sector, such as unharvested crops. The goal also aims to reduce food waste by 50% from the food retail, food service, and residential sectors. In 2021, EPA updated the baseline and goal for the food waste part of the national goal to align with the food waste scope for Sustainable Development Goal Target 12.3 (United Nations, 2019), which aims to cut in half the amount of food from the food retail, food service, and residential sectors that has been removed from the human food supply chain (i.e., food waste that is being sent to: anaerobic digestion; composting; land application; controlled combustion; landfill; sewer/wastewater; and litter, discards and refuse). Note that EPA does not have data on how much food waste is going to litter, discards and refuse. Using this updated interpretation, the baseline for the national goal for food waste is 328 pounds per person, because in 2016, 328 pounds of food waste per person was sent to anaerobic digestion, composting, land application, controlled combustion, landfill, and sewer/wastewater from the food retail, food service, and residential sectors. The 2030 goal aims to reduce this food waste by 50 percent to 164 pounds per person. In 2018, 335 lbs/person was sent to those six management pathways, and in 2019, 349 lbs/person was sent to those six pathways. In the three years between the baseline year (2016) and the latest estimates (2019), there was a 6% increase in per capita food leaving the human food supply chain from the food retail, food service, and residential sectors (i.e., food waste going to those six management pathways). The U.S. has a long way to go to meet this goal.

Table 7. Progress Toward the 2030 Goal Compared to 2016 Baseline

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Generation (tons)</strong></td>
<td>62,231,998</td>
<td>63,132,123</td>
<td>66,216,242</td>
</tr>
<tr>
<td><strong>Total Food Waste to Food Management Pathways of Interest¹ (tons)</strong></td>
<td>52,946,283</td>
<td>54,688,348</td>
<td>57,228,191</td>
</tr>
<tr>
<td><strong>Per Capita Food Waste to Food Management Pathways of Interest² (lbs/capita)</strong></td>
<td>328</td>
<td>335</td>
<td>349</td>
</tr>
<tr>
<td><strong>% Change since 2016 baseline per capita food waste managed in pathways of interest</strong></td>
<td>n/a</td>
<td>2%</td>
<td>6%</td>
</tr>
</tbody>
</table>

¹Management Pathways of Interest include landfill, controlled combustion, sewer/wastewater treatment, anaerobic digestion, composting, and land application from the food retail, food service, and residential sectors.

²Cutting the 2016 baseline of 328 lbs/person by 50% would be 164 lbs/person. (EPA, 2015)

6 COMPARISON WITH 2018 METHODOLOGY AND ESTIMATES

There were several methodological changes between the 2018 and 2019 analyses that impacted the estimates.

For wasted food generation estimates in 2019, EPA included estimates from e-commerce sales classified under NAICS 4541 which represent establishments whose primary business segment is e-commerce. Since these companies are typically fulfilling orders with separate warehousing facilities this waste food generation was included with the wholesale category. Previously, only estimates of e-commerce sales from traditional
brick-and-mortar retail establishments were included as part of the retail sector’s total revenue. EPA also included Target and Walmart supercenters to more fully capture wasted food generated in food retail.

For wasted food management estimates in 2019, EPA changed the management pathway characterization for several sectors. EPA applied the management distribution for restaurants, as derived from the BSR and FWRA surveys, to all other food services sectors for all management distributions except for anaerobic digestion. This was done because the latest anaerobic digester survey provided a breakdown for each sector sending wasted food to digesters (EPA, 2023) that was used as the basis for each sector-specific management estimate. This survey did not include nursing homes; zero tonnage was reported from military installations and correctional facilities; and only a very small tonnage was reported from food banks (less than 10 tons), so no anaerobic digestion management was assumed for these sectors. In addition, EPA applied the management distribution for retail/wholesale, as derived from the BSR and FWRA surveys, to food banks but modified the management distribution by zeroing out the “food donation” and “anaerobic digestion” categories and redistributing the management percentage to the other management pathways.

For food donation, EPA changed the assumption of which sectors donated food to redistribute the estimated food donations based on the Feeding America extrapolations. In 2018, the donations were assumed to equal one-third of distributions from food manufacturing and processing, food retail, and food service. In 2019, EPA used the distribution of donated meals reported to Feeding America to assign the food donation tonnages to these three sectors. This resulted in 28.2% coming from food manufacturing and processing, 68.3% coming from food retail, and 3.5% coming from food service, where Feeding America’s “emerging retail” category was used as a proxy for the food service category as it included restaurants and hotels as well convenience stores (Feeding America, 2019). In addition, in 2019 food donations from the food service sector were assumed to come from various categories of the food service sector, proportional to each category’s generation, while in 2018 the food donations from the food service sector were limited to the restaurant category of the food service sector.

EPA compared the 2019 excess food and food waste generation estimates with those of 2018. As shown in Table 8, total generation increased slightly (4.9%) between 2018 and 2019; restaurants, households, sports venues, and supermarkets and supercenters experienced the greatest increases in generation. Supermarkets and supercenters likely experienced an increase in generation due to methodological reasons – between 2018 and 2019 EPA added food waste generated from large supercenters, such as Target and Walmart, as noted above. Food wholesale generation also experienced a slight increase as a result of adding e-commerce food waste generation into this sector.

EPA also compared the 2019 management pathway estimates with those of 2018. As shown in Table 9, the quantity of food waste managed from the food retail, food service, residential, and food bank sectors through landfill and controlled combustion was 15% higher in 2019 than 2018. Per-capita landfill and controlled combustion quantity was 14.5% higher in 2019 than in 2018, likely driven by the decrease in wasted food managed through the anaerobic digestion, land application, and animal feed pathways. However, these differences do not likely reflect actual changes in how these sectors managed their food waste between 2018 and 2019; rather, they are a result of methodological changes related to the 2019 anaerobic digestion survey. As shown in Table 10, the quantity of wasted food managed by anaerobic digestion increased by 68% for the

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10 Note that food banks experienced a 11% increase in food waste generated but were not included in the analysis as food waste from food banks is not added to total generation because it would represent “double counting,” i.e., it is already accounted for in Total Generation.
food manufacturing and processing sector and decreased by 89.8% for the food retail, food service, and residential sectors. This change is the result of the 2019 anaerobic digestion survey including data about which sector categories the food waste was coming from, which previous surveys did not do. In the 2019 survey, the vast majority of food waste going to anaerobic digestion is reported to be from food manufacturers and processors, but in 2018, EPA did not have that breakdown, and had to make assumptions regarding how much food waste each sector category was sending to anaerobic digestors that allocated more food waste going to anaerobic digestion from sectors other than manufacturing and processing.

Finally, EPA changed the terminology for the sector categories between the 2018 and 2019 reports. In the “2018 Wasted Food Report” (EPA, 2020c), the sector categories were industrial, commercial, institutional and residential. In this report, we elected to use terminology that is more commonly used and understood among stakeholders, so the sector categories are now: manufacturing/processing, food retail, food service, and residential. These are defined in more detail in Sections 2 and 3.


<table>
<thead>
<tr>
<th>SECTOR</th>
<th>2018</th>
<th>2019</th>
<th>PERCENTAGE CHANGE IN ESTIMATED ANNUAL GENERATION BETWEEN 2018 AND 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ESTIMATED ANNUAL GENERATION (TONS PER YEAR)</td>
<td>PERCENT OF TOTAL</td>
<td>ESTIMATED ANNUAL GENERATION (TONS PER YEAR)</td>
</tr>
<tr>
<td>Residential</td>
<td>24,954,863</td>
<td>39.53%</td>
<td>26,502,346</td>
</tr>
<tr>
<td>Supermarkets and Supercenters</td>
<td>8,683,093</td>
<td>13.75%</td>
<td>8,998,443</td>
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<tr>
<td>Food Wholesale</td>
<td>3,968,229</td>
<td>6.29%</td>
<td>3,973,516</td>
</tr>
<tr>
<td>Hotels</td>
<td>1,219,595</td>
<td>1.93%</td>
<td>1,196,076</td>
</tr>
<tr>
<td>Restaurants (full and limited service)</td>
<td>17,090,835</td>
<td>27.07%</td>
<td>18,337,784</td>
</tr>
<tr>
<td>Sports Venues</td>
<td>38,154</td>
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<td>39,702</td>
</tr>
<tr>
<td>Hospitals</td>
<td>301,576</td>
<td>0.48%</td>
<td>298,576</td>
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<tr>
<td>Nursing Homes</td>
<td>451,124</td>
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<td>415,591</td>
</tr>
<tr>
<td>Military Installations</td>
<td>61,373</td>
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<td>62,627</td>
</tr>
<tr>
<td>Office Buildings</td>
<td>4,065,145</td>
<td>6.44%</td>
<td>4,093,447</td>
</tr>
<tr>
<td>Correctional Facilities</td>
<td>440,679</td>
<td>0.70%</td>
<td>425,232</td>
</tr>
<tr>
<td>Colleges and Universities</td>
<td>613,106</td>
<td>0.97%</td>
<td>624,371</td>
</tr>
<tr>
<td>K-12 Schools</td>
<td>1,244,353</td>
<td>1.97%</td>
<td>1,248,532</td>
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<tr>
<td>Food Banks¹</td>
<td>426,057</td>
<td>N/A</td>
<td>473,027</td>
</tr>
<tr>
<td>TOTAL GENERATION (Food Retail, Food Service, Residential)</td>
<td>63,132,123</td>
<td>N/A</td>
<td>66,216,242</td>
</tr>
<tr>
<td>Manufacturing/Processing</td>
<td>39,821,247</td>
<td>38.68%</td>
<td>40,050,707</td>
</tr>
</tbody>
</table>

¹ Food waste from food banks is not added to total generation because it would represent “double counting,” i.e., it is already accounted for in Total Generation.
Table 9. Comparison of 2018 and 2019 Wasted Food Management Estimates for the Food Retail, Food Service, Residential, and Food Bank Sectors

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Donation¹</td>
<td>4,787,378</td>
<td>7.60%</td>
<td>5,135,293</td>
<td>7.76%</td>
<td>7.27%</td>
</tr>
<tr>
<td>Animal Feed</td>
<td>1,814,984</td>
<td>2.90%</td>
<td>1,516,771</td>
<td>2.29%</td>
<td>-16.43%</td>
</tr>
<tr>
<td>Bio-based Materials/ Biochemical Processing</td>
<td>1,841,411</td>
<td>2.90%</td>
<td>2,335,988</td>
<td>3.53%</td>
<td>-21.17%</td>
</tr>
<tr>
<td>Anaerobic Digestion</td>
<td>5,262,857</td>
<td>8.30%</td>
<td>538,539</td>
<td>0.81%</td>
<td>-89.77%</td>
</tr>
<tr>
<td>Composting</td>
<td>2,592,566</td>
<td>4.10%</td>
<td>3,304,764</td>
<td>4.99%</td>
<td>27.47%</td>
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<tr>
<td>Land Application</td>
<td>259,448</td>
<td>0.40%</td>
<td>141,371</td>
<td>0.21%</td>
<td>-45.51%</td>
</tr>
<tr>
<td>Controlled Combustion</td>
<td>7,552,705</td>
<td>12.00%</td>
<td>9,646,263</td>
<td>14.57%</td>
<td>27.72%</td>
</tr>
<tr>
<td>Landfill</td>
<td>35,277,543</td>
<td>55.90%</td>
<td>39,621,902</td>
<td>59.84%</td>
<td>12.31%</td>
</tr>
<tr>
<td>Sewer/ Wastewater Treatment</td>
<td>3,743,229</td>
<td>5.90%</td>
<td>3,975,352</td>
<td>6.00%</td>
<td>6.20%</td>
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<tr>
<td>TOTAL</td>
<td>63,132,123</td>
<td>100%</td>
<td>66,216,242</td>
<td>100%</td>
<td>4.89%</td>
</tr>
</tbody>
</table>

¹ Excludes portion of donations (473,027 tons) that could not be used and were re-routed to the other management pathways.
Table 10. Comparison of 2018 and 2019 Wasted Food Management Estimates for the Food Manufacturing and Processing Sector

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Donation</td>
<td>3,411,578</td>
<td>8.57%</td>
<td>2,205,990</td>
<td>5.51%</td>
<td>-35.34%</td>
</tr>
<tr>
<td>Animal Feed</td>
<td>19,579,841</td>
<td>49.17%</td>
<td>13,709,339</td>
<td>34.23%</td>
<td>-29.98%</td>
</tr>
<tr>
<td>Bio-based Materials/Biochemical Processing</td>
<td>345,461</td>
<td>0.87%</td>
<td>64,737</td>
<td>0.16%</td>
<td>-433.64%</td>
</tr>
<tr>
<td>Anaerobic Digestion</td>
<td>5,508,940</td>
<td>13.83%</td>
<td>17,055,531</td>
<td>42.58%</td>
<td>67.70%</td>
</tr>
<tr>
<td>Composting</td>
<td>862,707</td>
<td>2.17%</td>
<td>583,305</td>
<td>1.46%</td>
<td>-47.90%</td>
</tr>
<tr>
<td>Land Application</td>
<td>8,627,526</td>
<td>21.67%</td>
<td>5,183,851</td>
<td>12.94%</td>
<td>-66.43%</td>
</tr>
<tr>
<td>Controlled Combustion</td>
<td>189,101</td>
<td>0.47%</td>
<td>330,326</td>
<td>0.82%</td>
<td>42.75%</td>
</tr>
<tr>
<td>Landfill</td>
<td>1,296,094</td>
<td>3.25%</td>
<td>917,630</td>
<td>2.29%</td>
<td>-41.24%</td>
</tr>
<tr>
<td>Sewer/ Wastewater Treatment</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>39,821,247</strong></td>
<td><strong>100%</strong></td>
<td><strong>40,050,707</strong></td>
<td><strong>100%</strong></td>
<td><strong>0.57%</strong></td>
</tr>
</tbody>
</table>
CAVEATS AND UNCERTAINTIES

There are caveats and uncertainties associated with the estimates provided in this report, which include the following:\(^{11}\)

- **Lack of empirical data in some sectors.** EPA sought to incorporate original, empirical studies of generation factors. In several sectors, however, the research highlights a shortage of literature providing such generation factors. Instead, many generation studies rely upon a relatively small set of widely cited empirical studies. Relative to their role in overall generation, key sectors with a lack of empirical data include food manufacturing and processing, supercenters (distinct from supermarkets), food wholesalers, and office buildings.

- **Current generation may be overestimated.** In recent years, states and municipalities have introduced rules banning landfilling of organics (including food) or mandating that organic wastes be recycled. At the time of this report drafting, bans or mandate related laws had been enacted in California, Connecticut, Maryland, Massachusetts, New Jersey, New York, Rhode Island, Vermont, Washington, the District of Columbia and the cities of Austin, Boulder, Honolulu, Minneapolis, New York City, San Francisco, and Seattle. Many of the generation studies applied in the methodology precede some of these bans. Therefore, as bans continue to take effect and be implemented through increased source reduction, the methodology may overstate current generation, and may become increasingly biased over time.

- **Generation studies do not exist for all sectors.** EPA’s methodology is limited to sectors for which original generation rate studies exist, and those sectors likely account for the majority of wasted food in the U.S. However, it is possible that non-negligible quantities of wasted food originate in sectors not included, including theme parks, fairs, and exposition centers.

- **Uncertainty regarding revenue from e-commerce.** There is some uncertainty associated with the new estimated food and beverage revenue from businesses whose primary function is e-commerce (NAICS 4541) in the wholesale category of the food retail sector. The Annual Retail Trade Survey e-Commerce supplemental document provides a breakdown of e-commerce, with one line being food and beverage sales. However, there is some uncertainty with sector delineations of NAICS 4541 at the 3-digit level due to the survey’s amount of sampling error and non-sampling error. Additionally, for NAICS 4541 alcohol sales are not separated out from other food and beverage sales, and so this revenue could be overestimating wasted food.

- **Composting and anaerobic digestion may be underestimated.** Composting and anaerobic digestion represent growing alternatives to food waste disposal in landfills and combustion facilities. Although new survey data allow improved characterization of composting and anaerobic digestion quantities, uncertainties remain. EPA did not extrapolate to account for states that do not publicly provide food waste composting estimates, nor do the estimates account for backyard and community composting, so the national composting estimate is likely an underestimate. Anaerobic digestion quantities may also be understated given that only 99 of the 275 anaerobic digestion facilities nationwide responded to EPA’s survey (EPA, 2023), only 89 of the 275 responded regarding the amount food waste they processed, and EPA did not extrapolate to account for the additional facilities. It is notable that the

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\(^{11}\) For detailed caveats and limitations associated with each sector, please refer to “Wasted Food Measurement Methodology Scoping Memo” (EPA, 2020a).
survey collecting 2019 data had a much lower participation rate of 36 percent, as compared to the previous survey collecting 2018 and 2017 data that had a 67 percent participation rate.

- **Food donation may be overestimated.** There is some uncertainty in the specific amounts of excess food being donated which could lead to overestimation of this value. Feeding America reports donated meals by sector and these meals are then translated to a weight per meal metric. These meal donations could include food that would otherwise be wasted as well as other donations from the food manufacturing and processing, food retail, and food service sectors. The Feeding America network includes 200 food banks, which are larger warehouses, some of which donate to smaller food pantries or soup kitchens. The tonnage received per Feeding America facility was extrapolated to the total number of food banks nationally (1,270, based on data available from Hoovers, 2019), which resulted in an estimate of 7.8 million tons. However, it is likely that the food banks in Feeding America’s network operate on a larger scale than many food banks that are not in the Feeding America network, which could potentially lead to an overestimate nationally. The final estimate of 7.8 million tons for all sectors is significantly higher than the initial estimate of approximately 2.8 million tons that was based on management distributions based on percent of generated wasted food that is donated (Food Waste Reduction Alliance, 2016).

- **Lack of data on food waste sent to sewer/wastewater.** The amount of food waste being sent to sewer/wastewater treatment facilities remains poorly characterized. Few studies provide information on the prevalence of in-sink disposals in households and restaurants, or on in-sink disposal usage behavior. In addition, biosolids generated at treatment plants are often subsequently managed through land application or anaerobic digestion, suggesting that the sewer/wastewater treatment plants may be best viewed as temporary collection points rather than a true management destination for food waste. Given the lack of specific data on the routing of food waste from the sewer/wastewater pathway to other management sectors, EPA did not revise the amount of food waste initially estimated to go to sewer/wastewater treatment facilities.

While the estimates contained in this report reflect 2019 data, which is prior to the start of the covid-19 pandemic, EPA is evaluating available information regarding the effects of the pandemic on wasted food generation and management. These findings will be incorporated into future estimates for 2020 and beyond.

### 8 REFERENCES


9 APPENDIX

9.1 GLOSSARY

**Animal Feed**: Diverting material from the food supply chain (directly or after processing) to animals (excludes crops intentionally grown for bioenergy, animal feed, seed, or industrial use). (Food Loss and Waste Protocol, 2016)

**Bio-based Materials/Biochemical Processing**: Converting material into industrial products. Examples include creating fibers for packaging material, creating bioplastics (e.g., polylactic acid), making “traditional” materials such as leather or feathers (e.g., for pillows), and rendering fat, oil, or grease into a raw material to make products such as soaps, biodiesel, or cosmetics. “Biochemical processing” does not refer to anaerobic digestion or production of bioethanol through fermentation. (Food Loss and Waste Protocol, 2016)

**Codigestion/anaerobic digestion**[^12]: Breaking down material via bacteria in the absence of oxygen. This process generates biogas and nutrient-rich matter. Codigestion refers to the simultaneous anaerobic digestion of food loss and waste and other organic material in one digester. This destination includes fermentation (converting carbohydrates—such as glucose, fructose, and sucrose—via microbes into alcohols in the absence of oxygen to create products such as biofuels). (Food Loss and Waste Protocol, 2016) Often referred to as “anaerobic digestion” or “AD”.

**Composting/aerobic processes**: Breaking down material via bacteria in oxygen-rich environments. Composting refers to the production of organic material (via aerobic processes) that can be used as a soil amendment. (Food Loss and Waste Protocol, 2016) Often referred to as simply “composting”.

**Controlled combustion**: Sending material to a facility that is specifically designed for combustion in a controlled manner, which may include some form of energy recovery (this may also be referred to as incineration). (Food Loss and Waste Protocol, 2016)

**Excess food**: Food that is donated to feed people.

**Food**: Any substance—whether processed, semi-processed, or raw—that is intended for human consumption. “Food” includes drink, and any substance that has been used in the manufacture, preparation, or treatment of food. “Food” also includes material that has spoiled and is therefore no longer fit for human consumption. It does not include cosmetics, tobacco, or substances used only as drugs. It does not include processing agents used along the food supply chain, for example, water to clean or cook raw materials in factories or at home. (Food Loss and Waste Protocol, 2016). Throughout this document, EPA uses the term “food” as a shorthand to refer to both “food” and “inedible parts”.

**Food donation**: Collection and redistribution of unspoiled excess food to feed people through food pantries, food banks and other food rescue programs.

**Food loss**: This term often refers to unused product from the agricultural sector, such as unharvested crops. For purposes of Sustainable Development Goal Target 12.3, food loss occurs from production up to (and not including) the retail level (FAO, 2023).

**Food waste**: Food and inedible parts not ultimately consumed by humans that are discarded or recycled, such as plate waste (i.e., food that has been served but not eaten), spoiled food, or peels and rinds considered

[^12]: Anaerobic digestion may occur in a standalone facility dedicated for food waste or it may occur when food waste is added to an existing digester that accepts other types of organic material.
inedible. For purposes of Sustainable Development Goal Target 12.3, food waste occurs at the retail and consumer-facing levels and is managed by landfill; controlled combustion; sewer; litter, discards and refuse; co/anaerobic digestion; compost/aerobic digestion; and land application (FAO, 2023; UNEP, 2021).

**Inedible parts**: Components associated with a food that, in a particular food supply chain, are not intended to be consumed by humans. Examples of inedible parts associated with food could include bones, rinds, and pits/stones. “Inedible parts” do not include packaging. What is considered inedible varies among users (e.g., chicken feet are consumed in some food supply chains but not others), changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography. (Food Loss and Waste Protocol, 2016)

**Land Application**: Spreading, spraying, injecting, or incorporating organic material onto or below the surface of the land to enhance soil quality. (Food Loss and Waste Protocol, 2016)

**Landfill**: Sending material to an area of land or an excavated site that is specifically designed and built to receive wastes. (Food Loss and Waste Protocol, 2016)

**Sewer/wastewater treatment**: Sending material down the sewer (with or without prior treatment), including that which may go to a facility designed to treat wastewater. (Food Loss and Waste Protocol, 2016)

**Wasted food**: Food that was not used for its intended purpose and is managed in a variety of ways, such as donation to feed people, creation of animal feed, composting, anaerobic digestion, or disposal in landfills or combustion facilities. Examples include unsold food from retail stores; plate waste, uneaten prepared food, or kitchen trimmings from restaurants, cafeterias, and households; or by-products from food and beverage processing facilities. The term wasted food can be used to refer to both excess food and food waste.
9.2 SECTOR-SPECIFIC REFERENCES

The following is a list of references used for each sector. For more information on generation factors and studies used to estimate generation, please refer to “Wasted Food Measurement Methodology” (U.S. EPA, 2020b), Section 6.2.

### 9.2.1 Food Manufacturing and Processing Sector

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<td>King County Solid Waste Division: Organics Study</td>
<td>King County Department of Natural Resources and Parks (Cascadia Consulting Group)</td>
<td>King County Department of Natural Resources and Parks</td>
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<td><a href="https://kingcounty.gov/~/media/depts/dnrp/solid-waste/garbage-recycling/documents/Organics-Study-2009-final-report.ashx?la=en">https://kingcounty.gov/~/media/depts/dnrp/solid-waste/garbage-recycling/documents/Organics-Study-2009-final-report.ashx?la=en</a></td>
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<td>Urban food waste generation: Challenges and opportunities</td>
<td>Adhikari, B.K., Barrington, S.F., Martinez, J.M.</td>
<td>International Journal of Environment and Waste Management</td>
<td>2009</td>
<td><a href="https://hal.archives-ouvertes.fr/hal-00615443/document">https://hal.archives-ouvertes.fr/hal-00615443/document</a></td>
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<td>The food waste disposer as a municipal tool for waste diversion: An evaluation in five cities</td>
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<td>Mecklenburg County Food Waste Diversion Study</td>
<td>Mecklenburg County Solid Waste (Kessler Consulting, Inc.)</td>
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<td>Walsh, P. Pferdehirt, W., &amp; O'Leary, P.</td>
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<td>Marion, J.</td>
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<td>Composting feasibility study for the Randolph-Macon College Dining Facility</td>
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<td><a href="http://www.mdpi.com/2071-1050/7/2/1370">http://www.mdpi.com/2071-1050/7/2/1370</a></td>
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<td>Impact on Plate Waste of Switching from a Tray to a Trayless Delivery System in a University Dining Hall and Employee Response to the Switch</td>
<td>Thiagarajah, K., Getty, V.M.</td>
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### 9.3 Detailed Generation and Management Estimates of Wasted Food

Table 11 contains estimates of the amount of wasted food generated by each sector and category, and the amount managed by each management pathway, per sector and category.

**Table 11. Generation and Management Estimates of Wasted Food by Sector and Category (2019)**

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<td>TOTAL MANAGED BY EACH PATHWAY</td>
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| MANUFACTURING/PROCESSING | MANUFACTURING/PROCESSING |
| RESIDENTAL | 999,165 | 999,165 |
| SUPERMARKETS AND SUPERCENTERS | 441,209 | 441,209 |
| WHOLESALE | 361 | 361 |
| PROPERTIES | 361 | 361 |
| HOSPITALS | 12 | 12 |
| NURSING HOMES | 90 | 90 |
| MILITARY INSTALLATIONS | 125 | 125 |
| OFFICE BUILDINGS | 19 | 19 |
| CORRECTIONAL FACILITIES | 1,234 | 1,234 |
| COLLEGES & UNIVERSITIES | 188 | 188 |
| K-12 SCHOOLS | 376 | 376 |
| FOOD BANKS | 68,332 | 68,332 |
| INTERMEDIATE AMOUNT MANAGED | 2,374,717 | 2,374,717 |
| TOTAL MANAGED BY EACH PATHWAY | 2,400,725 | 2,400,725 |

| MANUFACTURING/PROCESSING | MANUFACTURING/PROCESSING |
| RESIDENTAL | - | - |
| SUPERMARKETS AND SUPERCENTERS | 194,019 | 194,019 |
| WHOLESALE | 85,674 | 85,674 |
| PROPERTIES | 90,808 | 90,808 |
| HOSPITALS | 1,392,231 | 1,392,231 |
| NURSING HOMES | 3,014 | 3,014 |
| MILITARY INSTALLATIONS | 4,755 | 4,755 |
| OFFICE BUILDINGS | 310,780 | 310,780 |
| CORRECTIONAL FACILITIES | 32,284 | 32,284 |
| COLLEGES & UNIVERSITIES | 47,403 | 47,403 |
| K-12 SCHOOLS | 94,790 | 94,790 |
| FOOD BANKS | 26,008 | 26,008 |
| INTERMEDIATE AMOUNT MANAGED | 2,374,717 | 2,374,717 |
| TOTAL MANAGED BY EACH PATHWAY | 2,400,725 | 2,400,725 |

| MANUFACTURING/PROCESSING | MANUFACTURING/PROCESSING |
| RESIDENTAL | - | - |
| SUPERMARKETS AND SUPERCENTERS | 582,043 | 582,043 |
| WHOLESALE | 15,462 | 15,462 |
| PROPERTIES | 237,050 | 237,050 |
| HOSPITALS | 513 | 513 |
| NURSING HOMES | 3,860 | 3,860 |
| MILITARY INSTALLATIONS | 5,372 | 5,372 |
| OFFICE BUILDINGS | 810 | 810 |
| CORRECTIONAL FACILITIES | 52,916 | 52,916 |
| COLLEGES & UNIVERSITIES | 8,071 | 8,071 |
| K-12 SCHOOLS | 16,140 | 16,140 |
| FOOD BANKS | 80,957 | 80,957 |
| INTERMEDIATE AMOUNT MANAGED | 3,807,112 | 3,807,112 |
| TOTAL MANAGED BY EACH PATHWAY | 3,888,068 | 3,888,068 |

| MANUFACTURING/PROCESSING | MANUFACTURING/PROCESSING |
| RESIDENTAL | - | - |
| SUPERMARKETS AND SUPERCENTERS | 37,109 | 37,109 |
| WHOLESALE | - | - |
| PROPERTIES | - | - |
| HOSPITALS | - | - |
| NURSING HOMES | - | - |
| MILITARY INSTALLATIONS | - | - |
| OFFICE BUILDINGS | - | - |
| CORRECTIONAL FACILITIES | - | - |
| COLLEGES & UNIVERSITIES | - | - |
| K-12 SCHOOLS | - | - |
| FOOD BANKS | 20,226 | 20,226 |
| INTERMEDIATE AMOUNT MANAGED | 5,304,996 | 5,304,996 |
| TOTAL MANAGED BY EACH PATHWAY | 5,325,222 | 5,325,222 |

| MANUFACTURING/PROCESSING | MANUFACTURING/PROCESSING |
| RESIDENTAL | 1,881,325 | 1,881,325 |
| SUPERMARKETS AND SUPERCENTERS | 830,752 | 830,752 |
| WHOLESALE | 857,724 | 857,724 |
| PROPERTIES | 13,150,297 | 13,150,297 |
| HOSPITALS | 28,471 | 28,471 |
| NURSING HOMES | 214,113 | 214,113 |
| MILITARY INSTALLATIONS | 298,027 | 298,027 |
| OFFICE BUILDINGS | 44,911 | 44,911 |
| CORRECTIONAL FACILITIES | 447,746 | 447,746 |
| COLLEGES & UNIVERSITIES | 200,453 | 200,453 |
| K-12 SCHOOLS | 40,339,079 | 40,339,079 |
| FOOD BANKS | 40,539,532 | 40,539,532 |

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### Wasted Food Managed by Sector and Category (Tons)

<table>
<thead>
<tr>
<th>Management Pathway</th>
<th>Food Retail</th>
<th>Food Service</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewer/Wastewater</td>
<td>- 3,975,352</td>
<td>- 3,975,352</td>
</tr>
<tr>
<td>Treatment</td>
<td>- 3,975,352</td>
<td>- 3,975,352</td>
</tr>
<tr>
<td>Total Food Waste &amp; Excess Food</td>
<td>40,050,707</td>
<td>26,502,346</td>
</tr>
<tr>
<td></td>
<td>8,998,443</td>
<td>3,973,516</td>
</tr>
<tr>
<td></td>
<td>18,337,784</td>
<td>1,196,076</td>
</tr>
<tr>
<td></td>
<td>39,702</td>
<td>3,973,516</td>
</tr>
<tr>
<td></td>
<td>298,576</td>
<td>415,591</td>
</tr>
<tr>
<td></td>
<td>62,627</td>
<td>425,232</td>
</tr>
<tr>
<td></td>
<td>1,248,532</td>
<td>473,027</td>
</tr>
<tr>
<td></td>
<td>473,027</td>
<td>106,266,950</td>
</tr>
<tr>
<td></td>
<td>106,266,950</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

1. Although an estimated 7,814,310 tons of excess food are donated to food banks, food banks are not able to distribute all the food that is donated to them due to spoilage, expiration, or other reasons. Therefore, approximately 473,027 tons of the 7,814,310 tons ends up being managed as food waste via all other management pathways, excluding sewer/wastewater treatment. In the Intermediate Amount Managed column, the estimates of food waste do not yet distribute the 473,027 tons to those other pathways.

2. Although an estimated 7,814,310 tons of excess food are donated to food banks, food banks are not able to distribute all the food that is donated to them due to spoilage, expiration, or other reasons. Therefore, approximately 473,027 tons of the 7,814,310 tons ends up being managed as food waste via all other management pathways, excluding sewer/wastewater treatment. In the Total Managed by Each Pathway column, the estimates of food waste generated by food banks are included in the management pathway estimates for each pathway.
# 9.4 State Composting Estimates

Table 12. State Composting Estimates (2019)

<table>
<thead>
<tr>
<th>STATE¹</th>
<th>REPORTED QUANTITY (TONS)</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maryland</td>
<td>87,078</td>
<td>EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022</td>
</tr>
<tr>
<td>Nebraska</td>
<td>695</td>
<td>City of Lincoln, Nebraska. 2019 Solid Waste Grant Awarded- Nebraska. City of Lincoln, Nebraska. <a href="https://lincoln.ne.gov/city/ltu/solid-waste/grant/awarded.htm">https://lincoln.ne.gov/city/ltu/solid-waste/grant/awarded.htm</a></td>
</tr>
<tr>
<td>STATE¹</td>
<td>REPORTED QUANTITY (TONS)</td>
<td>SOURCE</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>Mixed MSW Composting²</strong></td>
<td><strong>306,019</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>3,304,764</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Food Waste Composted by Food Manufacturers/Processors</strong></td>
<td><strong>583,305</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,888,068</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

¹ Not all states are included in these composting estimates due to a lack of state composting data found.

² Includes a small portion of non-food waste.