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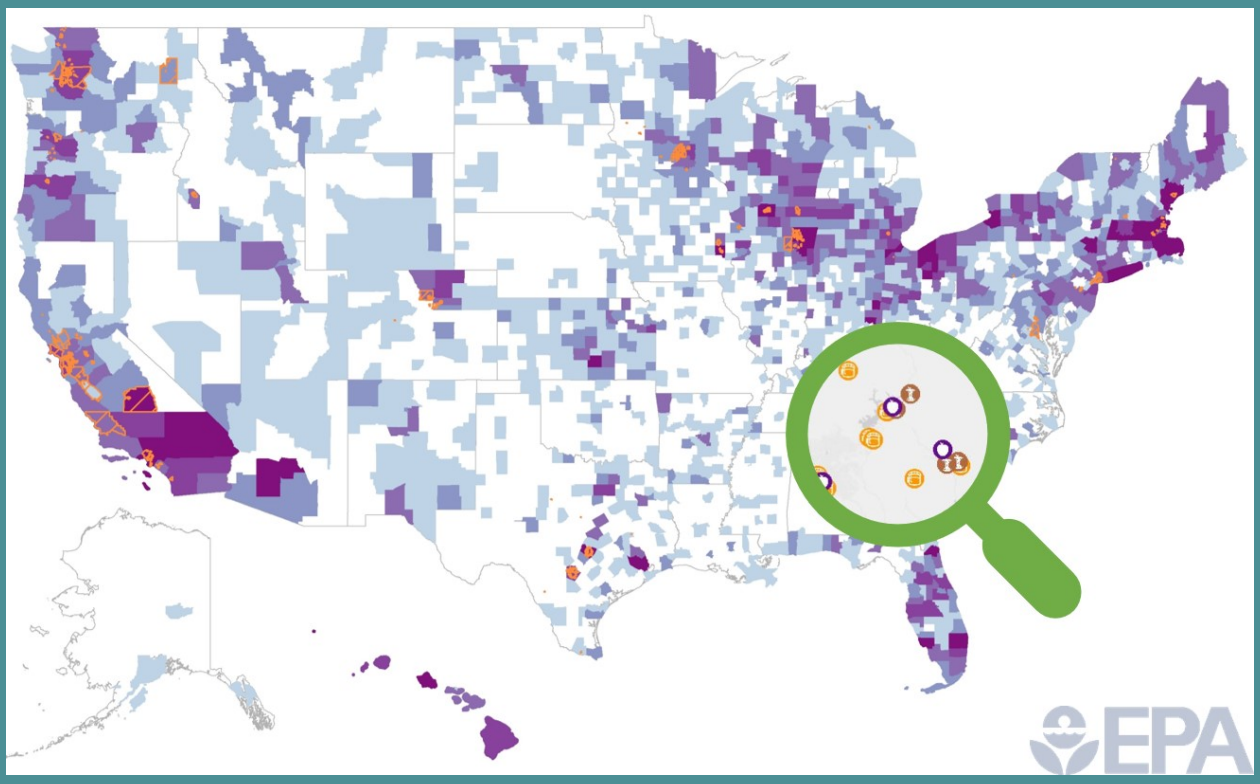
Excess Food Opportunities Map Version 2.1 – Technical Methodology



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Excess Food Opportunities Map
Version 2.1 – Technical Methodology

Office of Resource Conservation and Recovery
Office of Land and Emergency Management
Washington, DC

Abstract

This report presents the methodology behind the development of the EPA Excess Food Opportunities Map (Map) Version 2.1, which supports diversion of excess food from landfills. The information presented by the Map can be used to inform waste management and food recovery at the local level, and identify potential sources of organic feedstocks, infrastructure gaps, and disposal alternatives to landfill.

This report describes the identification of select industrial, commercial and institutional sources in the United States that potentially generate excess food at the establishment level, and identification of potential recipients of these materials. Based on the North American Industry Classification System (NAICS), 76 categories of industries and three school types representing nearly 1.2 million establishments in the US were identified as potential sources of excess food. These 76 industries and three school types were grouped into the following sectors: food manufacturers and processors (46), food wholesale and retail (17), educational institutions (3), the hospitality industry (3), correctional facilities (1), healthcare facilities (3), and restaurants and food services (6). Several publicly and commercially available datasets containing common business statistics for the selected industries were then compiled as a precursor to generating establishment-level excess food estimates. Methodologies developed by various states and non-profit organizations were reviewed to identify approaches to estimating excess food generation rates by industry. Combining select methodologies with establishment-level data resulted in a Dataset that supports the Map and includes nearly 1.2 million potential excess food generators. The map also identifies approximately 5,000 potential excess food recipients, including composting facilities, anaerobic digestion facilities, and food banks and over 200 communities with residential source separated organics programs.

The Version 2.0 update in 2019 included 1) an update of all generator sectors using 2018 data, 2) the addition of the restaurant and food services sector (e.g., restaurants, caterers, etc.), and 3) an update of the composting facilities. The Version 2.1 update in 2020 includes 1) an update of the anaerobic digestion facilities, 2) an update of the communities with residential source separated organics programs and 3) minor updates to the composting facilities.

Executive Summary

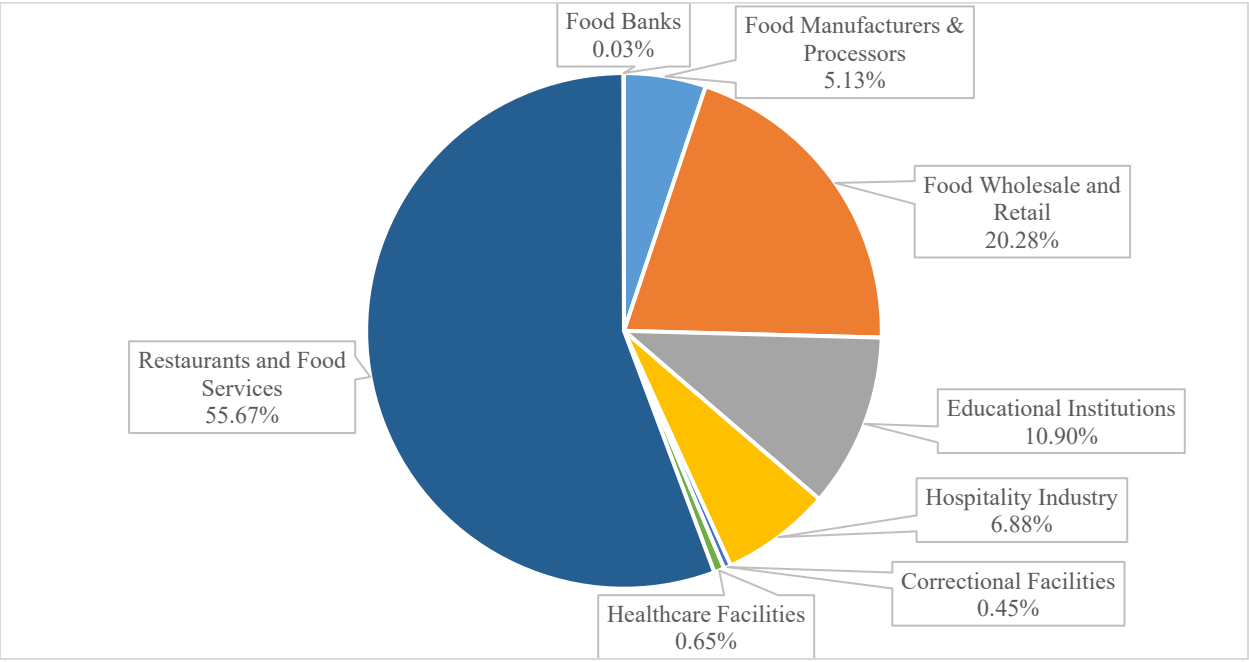
This report describes the methodologies used to create estimates for the EPA Excess Food Opportunities Map (Map) Version 2.1. This interactive map supports nationwide diversion of food from landfills through the display of nearly 1.2 million potential industrial, commercial, and institutional excess food generator locations, estimates of their excess food generation rates, and the display of approximately 5,000 potential recipient locations. This map can be used to:

- Inform waste management decisions at the local level;
- Identify potential sources of food for rescue and recovery;
- Connect potential feedstocks to compost, anaerobic digestion, or other excess food processors;
- Identify potential infrastructure gaps for managing excess food.

For the purposes of this report, "excess food" refers to food—whether processed, semi-processed, or raw—that is intended for human consumption but was removed from the supply chain and is managed in a variety of ways, such as donation to feed people, creation of animal feed, composting, anaerobic digestion, or sending to landfills or combustion facilities. Because EPA intends to maximize recovery and beneficial use of all discarded organics, inedible parts (e.g., pits, rinds, bones) were included in the excess food estimates, to the extent that they were included in the set of referenced studies. Further, this report does not include on-farm losses, including unharvested crops.

Based on the North American Industry Classification System (NAICS), 76 categories of industries and three school types representing nearly 1.2 million establishments in the US were identified as potential sources of excess food. These 76 industries and three school types were grouped into the following sectors: food manufacturers and processors (46), food wholesale and retail (17), educational institutions (3), the hospitality industry (3), correctional facilities (1), healthcare facilities (3), and restaurants and food services (6). Figure 1 shows that the restaurants and food services and food wholesale and retail sectors make up the majority of potential sources of excess food in terms of number of establishments. Commercially and publicly available data were compiled to create a Dataset of all identified establishments. The Dataset includes each establishment's name, location, a calculated estimated excess food generation rate, and additional information such as phone numbers and websites, where available. The Dataset also includes potential recipients of excess food, including establishment name, location, phone number and website, where available, for composting facilities, anaerobic digestion facilities, and food banks.

Figure 1. Non-Residential Excess Food Generating Sectors



Sector-specific methodologies for estimating excess food generation rates were adopted from existing studies conducted by state environmental agencies, published articles, and other sources, such as the Food Waste Reduction Alliance (FWRA). All adopted studies used methodologies based on commonly tracked business statistics to estimate excess food generation rates for several or all of the targeted sectors. These business statistics include number of employees, annual revenue, number of students (for educational institutions), number of inmates (for correctional facilities) and number of beds (for healthcare facilities).

Using establishment-specific statistics collected in the Dataset, the methodologies were used to estimate the amount of excess food from each establishment in each of the targeted sectors. More than one methodology was available for every sector, so a range of excess food estimates was calculated for each establishment, and the high and low estimates are displayed in the Map and Dataset.

The Map and methodologies are not intended to provide accurate nation-wide estimates of excess food generation, nor do they reflect establishment-specific recovery or recycling efforts. Rather, they are intended to show estimated generation amounts, potential sources and possible recipients of excess food. This information may be used to help the public and private sectors divert excess food from landfill and toward more preferred uses as reflected in EPA's Food Recovery Hierarchy (i.e., human consumption, animal feed, industrial use, anaerobic digestion, composting).

Acknowledgements

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Notice

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List of Abbreviations, Acronyms, and Initialisms

ABC	American Biogas Council
BJS	Bureau of Justice Statistics
BSR	Business for Social Responsibility
CCG	Cascadia Consulting Group
CTDEEP	Connecticut Department of Energy & Environmental Protection
DHS	Department of Homeland Security
EPA	Environmental Protection Agency
FWRA	Food Waste Reduction Alliance
ICI	Industrial, Commercial, and Institutional
lbs	Pounds
MassDEP	Massachusetts Department of Environmental Protection
MSW	Municipal Solid Waste
NAICS	North American Industry Classification System
NCDENR	North Carolina Department of Environment and Natural Resources
NCES	National Center for Education Statistics
NRDC	Natural Resources Defense Council
NSLP	National School Lunch Program
SCDOC	South Carolina Department of Commerce
ton	Short Ton
UNEP	United Nations Environment Program
US	United States
US EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
VTANR	Vermont Agency of Natural Resources

1. Introduction

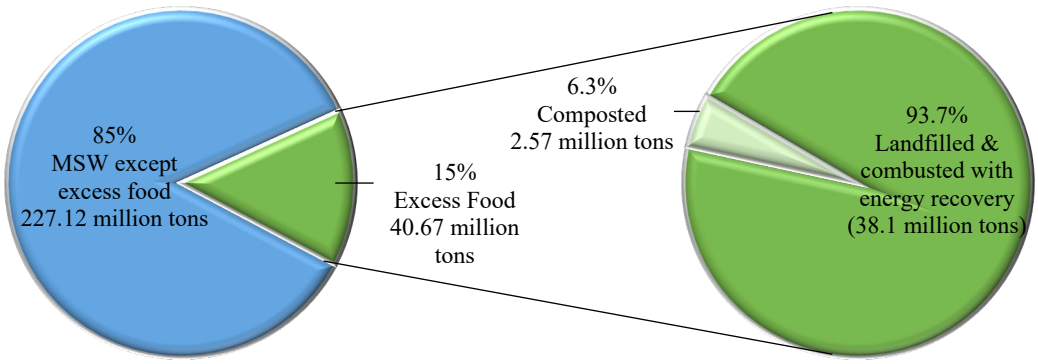
1.1. Background

On September 16, 2015, in alignment with Target 12.3 of the United Nations Sustainable Development Goals, the United States Department of Agriculture (USDA) and United States Environmental Protection Agency (EPA) announced the first ever domestic goal to reduce food loss and waste by half by the year 2030. The EPA Excess Food Opportunities Map (Map) is a tool intended to support achievement of this goal.

The United Nations Environment Program (UNEP) estimates that approximately one third of food produced for human consumption is excess (UNEP, n.d.). The USDA estimated that in 2010, approximately 66.5 million tons of food (i.e., 31% of the 430 billion pounds produced) was lost at the retail and consumer level in the US (USDA, 2014). Production of this excess food requires significant water, land, and additional resources.

As reflected in Figure 2, the EPA estimated that excess food generated from the commercial, institutional, and residential sectors represents approximately 15% (i.e., 40.67 million tons) of all Municipal Solid Waste (MSW) generated in 2017 (US EPA (2019b)). Approximately 93.7% of food included in the municipal solid waste stream was either landfilled or combusted, and just 6.3% composted (US EPA (2019b)). Landfills are the third largest anthropogenic source of methane emissions in the United States (107.7 MMT CO2 Eq.), accounting for 16.4 percent of total methane emissions in 2017 (US EPA (2019c)). Therefore, diverting excess food from landfills where it might degrade before gas collection is implemented could significantly reduce the production of greenhouse gas emissions.

Figure 2. US EPA Estimation of U.S. Excess Food Disposition in 2017

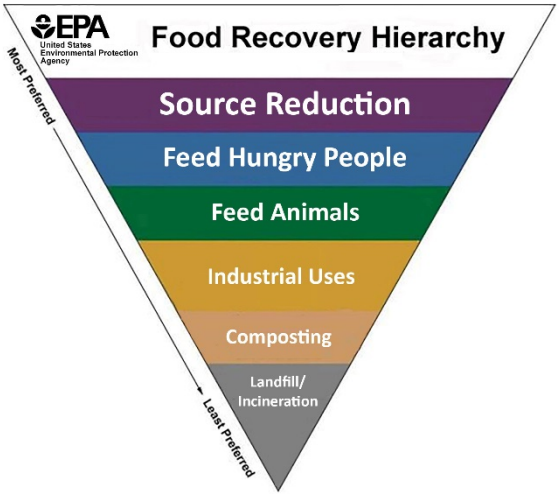


The definition of excess food varies across studies and among organizations, resulting in different estimates of excess food. For example, the USDA considers only the edible fraction in its accounting of food losses as its focus is on improving human nutrition (USDA (2014)). For the purposes of this report, "excess food" refers to food—whether processed, semi-processed, or raw—that is intended for human consumption but was removed from the supply chain and is managed in a variety of ways, such as donation to feed people, creation of animal feed, composting, anaerobic digestion, or sending to landfills or combustion facilities. EPA's goal is to maximize recovery and beneficial use of all discarded organics, so some organic materials are included in this definition that are not intended for human consumption, such as inedible parts (e.g., pits, rinds, bones) discarded in kitchens or during processing, and yard waste collected by municipal services (i.e., communities with residential source separated organics that collect yard waste and excess food).The Map does not include unharvested crops or on-farm processing excess food, or excess food or other organic material disposed of by the residential sector.

To prioritize efforts to divert excess food, EPA created the Food Recovery Hierarchy (Figure 3) (US EPA (2015)). Source reduction is the most preferred option as it not only mitigates the environmental impacts associated with management of excess food, but also minimizes the impacts associated with food production, processing, and delivery to the end-user. Any other management option chosen in a particular situation is dependent on the characteristics and the source of the excess food, as well as the available recipients in the area. For example, some food preparation residuals and/or post-consumer food discards may not be suitable for human consumption, so the next most preferred use is for animal feed. Feeding people and landfill/incineration are the most and least preferred options, respectively, for managing the recoverable fraction of excess food.

Several states have already passed legislation requiring diversion of excess food and other organics from landfills, supporting the domestic goal of reducing excess food by 50% by 2030. These include Massachusetts (310 CMR 19.000), California (AB 1826), Connecticut (CGS Sec. 22a-226e), and Vermont (Vermont Act 148), all of which set limits on the quantity of food certain generators can send to landfill. Furthermore, several of these states (e.g., Connecticut, Massachusetts, and Vermont) have developed interactive tools for mapping state-specific excess food sources, sometimes including potential excess food recipients, such as composting facilities, in their tools (CTDEEP (n.d.), MassDEP (2017), VTANR (2019)). Beyond these regulatory efforts, there are also several voluntary regional-scale excess food generation and disposal efforts (USDA (2014); BSR (2014)).

Figure 3. Food Recovery Hierarchy



At the national level, EPA has developed tools and resources for measuring, tracking, and reducing excess food, as well as assessed the cost and environmental impact of excess food management (US EPA (2014); US EPA (2016a)). The Agency also estimates a nation-wide excess food generation rate from residential, institutional and commercial sources on an annual basis (US EPA (2019b)). The EPA

recognizes the need for tools to support a broader understanding of potential excess food generation, and to foster collaboration and partnership among stakeholders interested in promoting and achieving sustainable management of food.

1.2. Objectives and Approach

The primary objective of this report is to present the methodology used to develop and update the Dataset and Map, including establishment-specific estimates of excess food generation. This national-scale, interactive map is intended to help inform waste management and food recovery decisions at the local level, and identify potential sources of organic feedstocks, infrastructure gaps, and disposal alternatives to landfill. The approach taken is as follows:

- Using the North American Industry Classification System (NAICS), 76 categories of industries and three school types representing nearly 1.2 million establishments in the US were identified as potential sources of excess food. These 76 industries and three school types were grouped into the following sectors: food manufacturers and processors (46), food wholesale and retail (17), educational institutions (3), the hospitality industry (3), correctional facilities (1), healthcare facilities (3), and restaurants and food services (6). A full list of industry NAICS codes and descriptions is provided in Appendix A. Agricultural sources of excess food were not included in this study.
- An extensive literature review informed development of methodologies used to estimate excess food generation factors for each sector (further details are provided in Section 2).
- Publicly and commercially available data sources were mined for supplementary data to estimate establishment-level excess food generation rates using the identified methodologies. The resulting Dataset was used to support the online Map.
- Information about potential recipients of excess food was also collected and mapped, and includes food banks, composting facilities, and anaerobic digestion facilities.
- Information about communities with source separated organics programs was also collected and mapped.

The resulting Map provides establishment-level information such as name, geographic location, and physical address, and where possible, estimates of excess food generation. The Map also includes similar establishment-level information about potential recipients of excess food that also comes from publicly and commercially available datasets, as well as state websites.

1.3. Report Organization

This report is organized as follows:

Chapter 1: Introduction

Chapter 2: Sector-specific data sources and excess food estimation methodologies for generators

Chapter 3: Macro analysis of sector-specific excess food generation rates

Chapter 4: Data sources for recipients

Chapter 5: Data sources for communities with residential source separated organics programs

2. Sector-Specific Data Sources and Excess Food Estimation Methodologies for Generators

2.1. Overview

This chapter describes the methods and data sources used to estimate the excess food generation rates for individual establishments in the 76 identified ICI industries and three school types. For the purposes of this report, "excess food" refers broadly to post-harvest food that is produced for human consumption but removed from the supply chain to be recovered, recycled, or disposed (refer to Appendix B for full definition). The definition does not include unharvested crops or on-farm processing excess and excess food or other organic material disposed of by the residential sector.

These 76 industrial, commercial and institutional (ICI) industries and three school types were grouped into the following sectors: food manufacturers and processors (46), food wholesale and retail (17), educational institutions (3), the hospitality industry (3), correctional facilities (1), healthcare facilities (3), and restaurants and food services (6). The full list of industries, and associated excess food characteristics, is provided in Appendix A.

Establishment-level data for most industries came from Hoover's, Inc. and included contact information, location details (geo-coordinates and physical addresses), establishment type (headquarters, branch, or single location), revenue ($USD), and number of employees. Similar establishment-level data for educational institutions was obtained from the National Center for Education Statistics (NCES 2018a, 2018b, 2018c), and data for healthcare facilities was obtained from the U.S. Department of Homeland Security (DHS (2017)).

In general, sector-specific methodologies for estimating excess food generation rates were adopted from existing studies conducted by state environmental agencies, published articles, and other sources, such as the Food Waste Reduction Alliance (FWRA). All adopted studies used methodologies based on commonly tracked business statistics to estimate excess food generation rates for several or all the targeted sectors. These business statistics include number of employees, annual revenue, number of students (for educational institutions), number of inmates (for correctional facilities) and number of beds (for healthcare facilities).

Using establishment-specific statistics collected in the Dataset, the methodologies were used to estimate the amount of excess food from each establishment in each of the targeted sectors. More than one methodology was available for every sector, so a range of excess food estimates was calculated for each establishment, and the high and low estimates are displayed in the Map and Dataset. The excess food estimate includes edible as well as inedible food to the extent accounted for by the studies. EPA did not attempt to estimate the portions of excess food generation rates that are potentially recoverable for human consumption. If data were not available to generate an excess food estimate, the establishment was still mapped, but no estimate was provided. Data were available to calculate estimates for 97.8% of establishments in Version 2.0 of the Map, and no changes were made to the generator sectors in Version 2.1 of the Map.

2.2. Food Manufacturers and Processors

Forty-six industries are included as food manufacturers and processors (Table 1).

Table 1. NAICS Codes for Food Manufacturers and Processors

No.	NAICS Code	NAICS Code Description
1	112930	Fur-Bearing Animal and Rabbit Production
2	311211	Flour Milling
3	311212	Rice Milling
4	311213	Malt Manufacturing
5	311221	Wet Corn Milling
6	311224	Soybean and Other Oilseed Processing
7	311225	Fats and Oils Refining and Blending
8	311230	Breakfast Cereal Manufacturing
9	311313	Beet Sugar Manufacturing
10	311314	Cane Sugar Manufacturing
11	311340	Non-chocolate Confectionery Manufacturing
12	311351	Chocolate and Confectionery Manufacturing from Cacao Beans
13	311352	Confectionery Manufacturing from Purchased Chocolate
14	311411	Frozen Fruit, Juice, and Vegetable Manufacturing
15	311412	Frozen Specialty Food Manufacturing
16	311421	Fruit and Vegetable Canning
17	311422	Specialty Canning
18	311423	Dried and Dehydrated Food Manufacturing
19	311511	Fluid Milk Manufacturing
20	311512	Creamery Butter Manufacturing
21	311513	Cheese Manufacturing

22	311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing
23	311520	Ice Cream and Frozen Dessert Manufacturing
24	311611	Animal (except Poultry) Slaughtering
25	311612	Meat Processed from Carcasses
26	311613	Rendering and Meat Byproduct Processing
27	311615	Poultry Processing
28	311710	Seafood Product Preparation and Packaging
29	311811	Retail Bakeries
30	311812	Commercial Bakeries
31	311813	Frozen Cakes, Pies, and Other Pastries Manufacturing
32	311821	Cookie and Cracker Manufacturing
33	311824	Dry Pasta, Dough, and Flour Mixes Manufacturing from Purchased Flour
34	311830	Tortilla Manufacturing
35	311911	Roasted Nuts and Peanut Butter Manufacturing
36	311919	Other Snack Food Manufacturing
37	311920	Coffee and Tea Manufacturing
38	311930	Flavoring Syrup and Concentrate Manufacturing
39	311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing
40	311942	Spice and Extract Manufacturing
41	311991	Perishable Prepared Food Manufacturing
42	311999	All Other Miscellaneous Food Manufacturing
43	312111	Soft Drink Manufacturing
44	312120	Breweries
45	312130	Wineries
46	312140	Distilleries

The literature search identified a total of 55 studies examining excess food generation at the food manufacturing and processing level. Many of these studies, however, are not directly useful to methods development as some lack quantitative information on generation rates, while others apply generation rates from earlier studies. EPA chose three studies that involved original research (e.g., surveying food manufacturers/directly measuring excess food generated from a sample of food manufacturers) (Table 2). These three studies were used to estimate excess food generated, resulting in a range of values for each facility.

Table 2. Generation Factors for Manufacturers and Processors

SOURCE	YEAR	GENERATION FACTOR	UNIT
FWRA	2016	0.17	lbs/revenue/year
BSR	2014	0.053	lbs/revenue/year
BSR	2013	0.062	lbs/revenue/year

These three studies establish generation factors based on pounds of excess food generated per dollar of annual sales revenue per year. The 2013 and 2014 studies were developed by BSR for the FWRA, while the 2016 study was published with FWRA as the author. These three studies are heavily cited in other studies (see NRDC (2017); Garcia-Garcia (2016); ReFED (2016)). The studies estimated generation rates by surveying food manufacturers and processors around the nation. Depending on the year of the survey, the surveyed manufacturers and processors represent anywhere between 6.2 percent to 17 percent of the national food manufacturing/processing industry, based on sales. The facilities included in the studies vary each year; because the samples change, the studies are independent, so all three studies were used. The three generation rates from the studies range from 0.053 to 0.17 pounds per dollar of annual industry sales revenue. It should be noted that these studies do not contain specific generation factors for each type of manufacturer or processor, and that excess food generation can vary depending on the type of industry (for example, cane sugar manufacturing and meat processors likely produce different amounts of excess food). Therefore, due to the absence of NAICS-code specific excess food generation factors, these generation factors were applied to all facilities across all 46 NAICS codes. The three generation factors were used in conjunction with annual revenue data obtained from Hoover's, Inc. to estimate the annual amount of excess food generated by food manufacturing and processing facilities. This is reflected in the following equation:

$$\text{Food Manufacturers and Processors Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Facility's Annual Revenue (\$)} \times X \frac{\text{lb}}{\text{Annual Revenue (\$)}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

Where X = 0.17, 0.053, or 0.062.

2.2.1 Changes in Version 2.0

In Version 1.0, EPA identified 54 industries as food manufacturers and processors. Ten of those were classified as "animal, milk, and egg producers" and were not mapped in Version 1.0. EPA took a closer look at the industries who manufacture and process food and beverages and added and deleted some industries in order to better ensure that the list of industries included in the Map for this sector are appropriate. Therefore, in Version 2.0 of the Map, EPA included five additional industries: flour milling (NAICS code 311211), rice milling (NAICS code 311212), malt manufacturing (NAICS code 311213), soft drink manufacturing (NAICS code 312111), and distilleries (NAICS code 312140), and removed three industries: dog and cat food manufacturing (NAICS code 311119) other animal food manufacturing (NAICS code 311119), and ethyl alcohol manufacturing (NAICS code 325193).

EPA also conducted a literature review to find the best available methodologies to calculate excess food for this sector, and three studies were chosen. In Version 1.0, EPA relied on one methodology (BSR (2014)), which is still used in Version 2.0, in addition to two other methodologies.

2.2.2 Changes in Version 2.1

No changes were made in Version 2.1.

2.3. Food Wholesale and Retail

2.3.1. Overview

Seventeen industries were classified as food wholesale and retail (Table 3). Establishments with NAICS codes starting with 424 were classified as food wholesale, and those with NAICS codes starting with 445 and 452 were classified as food retail (i.e., supermarkets, grocery stores, and supercenters). Establishment-level data for this sector was obtained from Hoover's, Inc.

Table 3. NAICS Codes for Food Wholesalers and Retailers

No.	NAICS Code	NAICS Code Description
1	424410	General Line Grocery Merchant Wholesalers
2	424420	Packaged Frozen Food Merchant Wholesalers
3	424430	Dairy Product (except Dried or Canned) Merchant Wholesalers
4	424440	Poultry and Poultry Product Merchant Wholesalers
5	424450	Confectionery Merchant Wholesalers
6	424460	Fish and Seafood Merchant Wholesalers
7	424470	Meat and Meat Product Merchant Wholesalers
8	424480	Fresh Fruit and Vegetable Merchant Wholesalers
9	424490	Other Grocery and Related Products Merchant Wholesalers
10	445110	Supermarkets and Other Grocery (except Convenience) Stores
11	445210	Meat Markets
12	445220	Fish and Seafood Markets
13	445230	Fruit and Vegetable Markets
14	445291	Baked Goods Stores
15	445292	Confectionery and Nut Stores
16	445299	All Other Specialty Food Stores
17	452311	Warehouse Clubs and Supercenters

2.3.2. Food Wholesale

For purposes of this Map, food wholesalers are those with NAICS codes 424410 through 424490. The literature search identified 22 studies examining excess food generation among food wholesalers. Many of these studies, however, are not directly useful for methods development. Some lack quantitative information on generation rates, while others apply generation rates from earlier studies. Two studies conducted by CCG defined the wholesale sector broadly, grouping food wholesalers with other non-durable wholesalers such as apparel and chemicals. Given that these other non-durables differ greatly from food in their waste generation patterns, EPA excluded the two CCG studies. EPA chose three studies that focused on food wholesale and involved original research (e.g., direct analysis of facilities' excess food) (Table 4). These three studies were used to estimate excess food generated, resulting in a range of values for each establishment.

Table 4. Generation Factors for Food Wholesale Facilities

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNIT
1	Okazaki et. al	2008	94.4	Tons/establishment/ year

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNIT
2	US EPA	2011	147	Tons/establishment/ year
3	BSR	2014	0.01	lbs/revenue/year

Okazaki et al (2008) and US EPA (2011) established generation factors of 94.4 and 147 tons of excess food per year per establishment, respectively. BSR (2014) collected industry generation data through a series of surveys and estimated 10 pounds of excess food per thousand dollars of company revenue. This is reflected in the following equation:

$$\text{Food Wholesalers Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Establishment's Annual Revenue } \$ \times 0.01 \frac{\text{lb}}{\text{Annual Revenue } (\$)} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

2.3.3. Food Retail (Supermarkets, Grocery Stores, and Supercenters)

For purposes of this Map, food retailers are those with NAICS codes 445110 through 445299 and 452311. The literature search identified 54 studies examining excess food generation among food retailers. Many of these studies, however, are not directly useful for methods development. Some lack quantitative information on generation rates, while others apply generation rates from earlier studies. EPA chose eight studies that involved original research (e.g., direct analysis of facilities' excess food) (Table 5). These eight studies were used to estimate excess food generated, resulting in a range of values for each establishment.

Table 5. Generation Factors for Food Retail (Supermarkets, Grocery Stores, and Supercenters)

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNIT	ESTABLISHMENT TYPE
1	CCG	2006	2.31	Tons/employee/year	Supermarket/Grocery Store
2	Kessler Consulting	2012	2.32	Tons/employee/year	Supermarket/Grocery Store
3	CCG	2015	2.02	Tons/employee/year	Supermarket/Grocery Store
4	Draper/Lennon	2001	1.5	Tons/employee/year	Supermarket/Grocery Store
5	CCG	2006	0.27	Tons/employee/year	Supercenter
6	ReFED	2016	0.5	Tons/employee/year	Supercenter
7	Okazaki et. al	2008	114.6	Tons/establishment/ year	Supermarket/Grocery Store
8	NCDENR	2012	117	Tons/establishment/ year	Supermarket/Grocery Store

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNIT	ESTABLISHMENT TYPE
9	BSR	2014	0.01	lbs/revenue/year	Supermarket/Grocery Store

In the relevant literature, several studies provide separate generation rates for supermarkets/grocery stores and supercenters. Supercenters are defined as large retail establishments that sell a complete line of grocery merchandise in addition to non-grocery goods. Supercenters include big-box stores, such as Wal-Mart and warehouse clubs such as BJs and Costco. Supermarkets/grocery stores and supercenters exhibit different characteristics regarding the sale of food. Most notably, supercenters often sell food items in bulk and at a lower unit price relative to supermarkets.

CCG (2006), CCG (2015), and the North Carolina Department of Environment and Natural Resources (NCDENR (2012)) (now known as North Carolina Department of Environmental Quality) conducted audits of food retail sector waste.[1] Draper/Lennon (2001), Kessler Consulting (2012), Okazaki et al. (2008), BSR (2014), and ReFED (2016) collected data through a series of surveys and interviews with store managers and other experts.

The five studies containing generation factors 1-6 estimated generation factors between 0.27 and 2.32 tons per employee per year. The low generation factor was reported by CCG (2006), which sampled waste at big-box retail stores. Another low generation factor, 0.5 tons per employee per year, was reported by ReFED (2016), who interviewed supercenters to estimate excess food per employee. Generation rates for supercenters are likely lower than those for supermarkets/grocery stores because they take into account all employees, not just the grocery department employees. The higher supermarket/grocery store estimates were provided by CCG (2006) and Kessler Consulting (2012), who conducted waste audits at supermarkets.

Studies 7 and 8 estimated the quantity of excess food generated per establishment per year in supermarkets/grocery stores and result in generation factors of 114.6 and 117 tons per establishment per year.

The 9th study quantifies excess food generated on a revenue basis. BSR (2014) collected industry generation data through a series of surveys and estimated 10 pounds of excess food per thousand dollars of company revenue (or 0.01 pounds per dollar revenue).

Generation factors 1, 2, 3, 4, 7, 8, and 9 were applied to establishments classified as supermarkets and grocery stores (i.e., those with NAICS codes starting with 445). Generation factors 5 and 6 were applied to establishments classified as supercenters (i.e., NAICS code 452311). These generation factors were used to calculate a range of excess food estimates for supermarkets, grocery stores, and supercenters.

Generation factors 1, 2, 3, 4, 5, and 6 were used in conjunction with employee data obtained from Hoovers, Inc. and use the following equation:

[1] North Carolina's state-specific estimate was provided by a North Carolina hauler who collected segregated food waste from a major grocery chain.

$$\text{Food Retailers Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) = \text{Number of employees} \times \frac{X\frac{\text{tons}}{\text{employee}}}{\text{year}}$$

Where X = 0.27 to 2.32

Generation factors 7 and 8 result in generation rates of 114.6 and 117 tons of excess food per year per establishment (no equation is needed).

Generation factor 9 was used in conjunction with revenue data obtained from Hoovers, Inc. and uses the following equation:

$$\text{Food Retailers Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Establishment's Annual Revenue } \$ \times 0.01 \frac{\text{lb}}{\text{Annual Revenue } (\$)} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

2.3.4. Changes in Version 2.0

In Version 2.0 of the Map, the name of this sector was changed from "Wholesalers and Distributors" to "Wholesale and Retail" to better reflect the industries included. EPA took a closer look at the industries included in this sector and added and deleted some industries to ensure that the list of industries included in the Map for this sector are appropriate. Therefore, in Version 2.0 of the Map, EPA removed six industries: Grain and Field Bean Merchant Wholesalers (NAICS code 424510), Livestock Merchant Wholesalers (NAICS code 424520), Beer and Ale Merchant Wholesalers (NAICS code 424810), Wine and Distilled Alcoholic Beverage Merchant Wholesalers (NAICS code 424820), Farm Supplies Merchant Wholesalers (NAICS code 424910), and Flower, Nursery Stock, and Florists' Supplies Merchant Wholesalers (NAICS code 424930). EPA added one industry, Warehouse Clubs and Supercenters (NAICS code 452311).

EPA also conducted a literature review to find the best available methodologies to calculate excess food for this sector. For food wholesale and retail establishments (except supermarkets, grocery stores, and supercenters), three studies were chosen for Version 2.0. In Version 1.0, EPA relied on one methodology (BSR (2014)), which is still used in Version 2.0, in addition to two other methodologies. For supermarkets, grocery stores, and supercenters, nine studies were chosen for Version 2.0. In Version 1.0, EPA relied on one methodology (Draper/Lennon (2001)), which is still used in Version 2.0, in addition to eight other methodologies. EPA is also no longer estimating the recoverable fraction of excess food for supermarkets and grocery stores, as the methodology that EPA relied on for Version 1.0 is outdated. EPA would include recoverable fraction estimates in future updates to the Map if appropriate methodologies are available.

2.3.5. Changes in Version 2.1

No changes were made in Version 2.1.

2.4. Educational Institutions

2.4.1. Overview

The educational institutions sector consists of three types of schools: postsecondary (i.e., colleges, universities, and professional schools), public elementary and secondary schools, and private elementary and secondary schools (Table 6). Data were obtained from the National Center for Education Statistics (NCES); NAICS codes are not used in NCES databases.

Table 6. Educational Institutions—School Types

No.	School Type
1	Postsecondary Schools
2	Public Elementary and Secondary Schools
3	Private Elementary and Secondary Schools

2.4.2. Postsecondary Schools

Data for postsecondary schools were collected from the Integrated Postsecondary Education Data System of the NCES for the 2016 school year (NCES (2018a)). This data includes the name, school type, address, geo-coordinates, phone number, website, and total enrollment of each institution.

The literature search identified a total of 44 studies addressing excess food generation in postsecondary school settings. Many of these studies, however, are not directly useful to methods development. Some lack quantitative information on generation factors, while others apply generation factors from earlier studies. Therefore, EPA chose ten studies that either involved original research (e.g., directly weighing plate waste at a college dining hall) or which present estimates widely cited in the literature (Table 7). These ten studies were used to estimate excess food generated, resulting in a range of values for each institution.

Table 7. Generation Factors for Postsecondary Schools

GENERATION FACTOR #	SOURCE	YEAR	UNITS	GENERATION FACTOR		
				PRE-CONSUMER[1]	POST-CONSUMER	TOTAL
1	Ebner et al.	2014	lbs/meal	0.07	0.15	0.22
2	Sarjahani et al.[2]	2009	lbs/meal	0.19	0.23	0.42
3	Vannet Group	2008	lbs/meal	0.16	0.31	0.47
4	Graunke and Wilke	2008	lbs/meal	0.16	0.19	0.35
5	Draper/Lennon	2001	lbs/meal	N/A	N/A	0.35
6	Thiagarajah and Getty	2012	lbs/meal	0.16	0.25	0.40
7	Whitehair et al.[3]	2013	lbs/meal	0.09	0.14	0.23
8	Kim and Morawski[2]	2012	lbs/meal	0.13	0.21	0.34
9	Caton et al.	2010	lbs/meal	0.31	0.49	0.79

10	CCG	2015	lbs/student/year	N/A	N/A	22.0

Notes:

1. Pre-consumer values are estimated for generation factors 6-9 using the average proportion of pre-consumer excess food from studies 1-5. On average, studies 1-5 showed post-consumer excess food to be 61.4 percent of all waste.
2. Sarjahani et al. (2009) and Kim and Morawski (2012) estimate excess food generation with and without trays. EPA uses the average of the two estimates.
3. Whitehair et al. (2013) studies the effect of a messaging campaign to reduce excess food. EPA uses the baseline data as the basis for this generation factor.

Generation factors 1-5 use direct estimates of excess food generation per meal, including pre-consumer food (i.e., excess food in the kitchen or from preparation) as well as post-consumer food (i.e., plate waste). The highest generation factor is from Vannet Group (2008), yielding an estimate of 0.47 pounds per meal. EPA includes this study because it weighed excess food at all stages of the dining process, including the kitchen prep area, food serving stations, and consumer stations. Ebner et al. (2014), Sarjahani et al. (2009), and Graunke and Wilke (2008) conducted original research on excess food generated from college/university dining halls. EPA also included one study that did not directly measure excess food generation, Draper/Lennon (2001), because it is widely cited in the literature.[2]

The literature search also identified four additional high-quality studies that analyze only post-consumer excess food (i.e., plate waste). Studies 6-9 have a larger range between the lowest estimate from Whitehair et al. (2013) of only 0.14 pounds per meal, and the highest estimate from Caton et al. (2010) of 0.49 pounds per meal. Because these studies only consider post-consumer excess food, EPA scaled the post-consumer excess food generation factors upward using the average proportion of the excess food generated from post-consumer excess food in studies 1-5 to estimate a total excess food generation factor. On average, studies 1-5 showed post-consumer excess food to be 61.4 percent of all excess food. Applying this figure to the post-consumer values in studies 6-9 yields an estimate of total excess food generation per meal. For instance, dividing the Whitehair et al. (2013) estimate of 0.14 pounds per meal by 0.614 provides a total excess food estimate (pre- and post-consumer) of 0.23 pounds per meal. The pre-consumer values in Table 7 are simply the total excess food generation factor minus the post-consumer factor.

Generation factor 10 frames generation in terms of pounds per student per year and is estimated from one source CCG (2015). While CCG (2015) does not differentiate between the K-12 and college/university sectors, EPA included the generation factor derived from "education sector" because the study is recent, and the estimates are derived through direct waste sampling. EPA also used the same generation factor for elementary and secondary schools.

The NCES database did not provide the number of meals served at each institution, so in order to use the generation factors (1 through 9) that are based on pounds per meal, EPA searched for

[2] See NRDC (2017), Hodge et al. (2016), Moriarty (2013), Wellesley College (2013), and US EPA (2011).

studies that contained data on how many meals, on average, each student consumes per year at postsecondary institutions.

- **Meals per Residential Student per Year** – Students living on campus consume more food on campus than non-residential students. Draper/Lennon (2001) applied two separate "meals per enrolled student per year" estimates for residential and non-residential institutions. Specifically, they assumed a total of 405 meals per residential student per year. Two additional studies provide data on the number of meals served per enrolled student per year at residential institutions.[3] The analysis calculates the average meals per enrolled student at residential institutions as the average of the three estimates, equal to 285 meals per enrolled student per year.
- **Meals per Non-Residential Student per Year –** Lacking additional data on meals served per enrolled student at non-residential institutions, EPA retained the Draper/Lennon (2001) value of 108 meals per enrolled student at non-residential institutions.
- **Weighted Average Meals per Student –** EPA estimated a national average of 169 meals served per enrolled student as the average meals served per enrolled student between residential and non-residential institutions, weighted by the percent of students attending residential institutions and non-residential institutions.[4]

Generation factors 1 through 9 use the following equation:

$$\text{Postsecondary Schools Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of students} \times \frac{169 \dfrac{\text{meals}}{\text{student}}}{\text{year}} \times \text{X} \frac{\text{lbs}}{\text{meal}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

Where X = 0.22 to 0.79

Generation factor 10 is based on pounds per student per year, and uses the following equation:

$$\text{Postsecondary Schools Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

[3] Ebner et al. (2014) reported two estimates: 180 and 270 meals per enrolled student per year according to two different methods. EPA used the average (225) as representative of Ebner et al (2014). Whitehair et al. (2013) reported 19,046 meals served at a dining hall serving 540 students over a six-week period. Assuming an academic calendar of 270 days following Draper/Lennon (2001), EPA estimated an average of 226 meals per student per year.

[4] EPA estimated that 34 percent of all enrolled students attend residential institutions. EPA calculated the percent of enrolled students attending residential institutions as sum of enrolled students at "primarily residential" and "highly residential" institutions divided by the total number of enrolled students. See the Classification Summary Tables, Carnegie Classification of Institutions of Higher Education, Center for Postsecondary Research, Indiana University School of Education, available at: http://carnegieclassifications.iu.edu/downloads.php.

$$\text{Number of students} \times 22 \frac{\text{lbs}}{\text{student}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

2.4.3. Elementary and Secondary Schools

Data for elementary and secondary schools were collected from the NCES for the 2015-2016 school year. Public school data were obtained from the NCES Public Elementary/Secondary School Universe Survey for the 2015-2016 school year (NCES (2018b)) and included institution name, address, phone number, website, geo-coordinates, school level (elementary, middle, high school, and others), and the total student enrollment for each institution. Private school data were obtained from the NCES Private School Universe Survey for the 2015-2016 school year (NCES (2018c)) and included institution name, address, phone number, geo-coordinates, and the total number of students enrolled for each institution. Excess food estimates were based on five different studies that establish generation factors of excess food based on pounds per meal or pounds per student per year, resulting in a range of values for each institution (Table 8).

The literature search identified a total of 32 studies addressing excess food generation in the K-12 school setting. Many of these studies, however, are not directly useful to methods development. Some lack quantitative information on generation factors, while others apply generation factors from earlier studies. Therefore, EPA chose five studies that either involved original research (e.g., waste audits at an elementary school) or that present estimates widely cited in the literature and applied them to both public and private elementary and secondary schools (Table 8).

Table 8. Generation Factors for Public and Private Elementary and Secondary Schools

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNITS
1	Wilkie et al.	2015	25.9	lbs/student/year
2	RecyclingWorks Massachusetts	2013	18.0	lbs/student/year
3	CCG	2015	22.0	lbs/student/year
4	Byker et al.	2014	0.52	lbs/meal
5	Draper/Lennon	2001	0.35	lbs/meal

Generation factors 1, 2, and 3 use pounds per student per year. Wilkie et al. (2015) estimate an average generation factor of 25.9 pounds per student per year based on sampling at three different Florida schools.[5] RecyclingWorks Massachusetts (2013) estimates an average generation factor of 18.0 pounds per student per year, based on waste audits conducted at seven public elementary, middle, and high schools. CCG (2015) estimates a generation factor of 22.0 pounds per student per year.[6]

[5] The three schools include one public elementary school, one public high school, and one private middle/high school.

[6] CCG (2015) reported a generation rate of 3.67 tons of *total* waste per year per 100 students in Table 39. This is converted to excess food using the estimated percentage of total waste that is food of 30.0 percent, from Table 40. As noted earlier, the

Generation factors 4 and 5 use pounds (per student) per meal. Byker et al. (2014) estimated an average generation factor of 0.52 pounds per meal at public pre-kindergarten and kindergarten classes. EPA also included one study that did not directly measure excess food generation at typical K-12 schools, Draper/Lennon (2001), because it is widely cited in the literature.[7] Draper/Lennon (2001) estimated an average of 0.35 pounds of excess food per meal.

The Wilkie et al. (2015) and Byker et al. (2014) studies differentiate between excess food and milk waste. The recommended methods incorporate both excess food and milk waste, implicitly assuming that students dispose of milk in the same trash receptacles as food.

Generation factors 1, 2, and 3 are based on pounds per student per year, and use the following equation:

$$\text{Elementary and Secondary Schools Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of students} \times \frac{\text{X}\,\frac{\text{lbs}}{\text{student}}}{\text{year}} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

Where X = 18.0, 22.0 or 25.9

The NCES database did not provide the number of meals served at each institution, so in order to use generation factors 4 and 5 that are based on pounds per meal, EPA used data released from the National School Lunch Program (NSLP), which reports the total number of students enrolled in the program and the number of meals served per year.[8] The result is an average of 163 meals per student per year. Generation factors 4 and 5 use the following equation:

$$\text{Elementary and Secondary Schools Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of students} \times \frac{163\,\frac{\text{meals}}{\text{student}}}{\text{year}} \times \text{X}\frac{\text{lbs}}{\text{meal}} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

Where X = 0.35 or 0.52

CalRecycle study pools all educational institutions, including colleges/universities and K-12 schools. EPA applied the same generation factor in both sectors.

[7] Draper/Lennon (2001) estimated excess food generation at colleges, universities, and independent preparatory schools. Cited in South Carolina Department of Commerce (2015), Mercer (2013), BSR (2012), and US EPA (2011).

[8] Data from the NSLP for FY2017 includes 30.0 million students, or approximately 60 percent of the total public school enrollment, accessed at: https://catalog.data.gov/dataset/national-school-lunch-assistance-program-participation-and-meals-served-data.

2.4.4. Changes in Version 2.0

For Version 2.0 of the Map, school type is included in the Dataset and Map instead of NAICS codes, because NCES data does not include NAICS codes. The NCES data also included phone numbers and websites for many of the institutions, which were included in the Dataset and the Map.

EPA also conducted a literature review to find the best available methodologies to calculate excess food for this sector. For postsecondary schools, ten studies were chosen for Version 2.0. In Version 1.0, EPA relied on two methodologies, one of which (Draper/Lennon (2001)) is still used in Version 2.0, in addition to nine other methodologies. In Version 1.0, EPA estimated plate waste for postsecondary schools, which is not explicitly done in Version 2.0; however, the studies in Table 7 do provide some generation factors that distinguish pre-consumer and post-consumer generation factors that could be used to estimate each type of excess food generation.

For elementary and secondary schools, five studies were chosen for Version 2.0. In Version 1.0, EPA relied on three methodologies, one of which (Draper/Lennon (2001)) is still used in Version 2.0, in addition to four other methodologies.

2.4.5. Changes in Version 2.1

No changes were made in Version 2.1.

2.5. Hospitality Industry

As listed in Table 9, establishments belonging to three NAICS codes were classified as the hospitality industry.

Table 9. NAICS Codes for the Hospitality Industry

No.	NAICS Code	NAICS Code Description
1	713210	Casinos (except Casino Hotels)
2	721110	Hotels and Motels
3	721120	Casino Hotels

The literature search identified 25 studies on excess food generation in the hospitality industry. EPA chose four studies that provide excess food generation factors based on empirical data collected directly from sampled hotels (Table 10).[9] These four studies were used to estimate excess food generated, resulting in a range of values for each establishment.

[9] Several studies report excess food generated per meal, or per guest or guest room. EPA excluded such studies from EPA's calculations due to the lack of data on annual number of hotel guests or occupied guest rooms per year in each establishment (Recycling Works Massachusetts (2013); Carvalho (2014); Coker (2009)).

Table 10. Generation Factors for the Hospitality Industry

SOURCE	YEAR	GENERATION FACTOR	UNIT
CCG	2006	1,983	lbs/employee/year
Okazaki et. al.	2008	375	lbs/employee/year
CCG	2015	1,197	lbs/employee/year
Tetra Tech	2015	997	lbs/employee/year

Most of the relevant studies reported pounds of excess food generated per hotel employee per year. In addition, a hotel excess food study from Hawaii (Okazaki et. al. (2008)) estimated excess food generated per hotel food service employee, unlike the other studies that consider excess food generated per general hotel employee. To apply data from Okazaki et al. (2008), the analysis divides the total amount of excess food generated in Hawaii hotels (as estimated by Okazaki et al. (2008)) by the total number of hotel employees under NAICS 7211 in Hawaii, to make the generation factor consistent with the other studies. These four generation factors range from 375 to 1,983 pounds per employee per year. The studies were published between 2006 and 2015 using data from three states (California, Hawaii, and New Jersey) and Vancouver, Canada.

These generation factors were used in conjunction with employee data obtained from Hoover's, Inc. using the following equation:

$$\text{Hospitality Industry Excess Food}\left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of employees} \times \frac{\text{X}\ \frac{\text{lb}}{\text{employee}}}{\text{year}} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

Where X = 375, 997, 1197, or 1983.

2.5.1. Changes in Version 2.0

EPA conducted a literature review to find the best available methodologies to calculate excess food for this sector, and four studies were chosen. In Version 1.0, EPA relied on two methodologies, one of which is still used in Version 2.0 (CCG (2006)), in addition to three other methodologies.

2.5.2. Changes in Version 2.1

No changes were made in Version 2.1.

2.6. Correctional Facilities

To estimate the amount of excess food generated by correctional facilities, facility-level data for NAICS code 922140 was collected from Hoover's, Inc.

The literature search identified 27 studies on excess food generation in correctional facilities. EPA chose six studies that provide excess food generation factors based on empirical data collected from various prisons (Table 11).[10] These six studies were used to estimate excess food generated, resulting in a range of values for each facility.

Table 11. Generation Factors for Correctional Facilities

GENERATION FACTOR #	STUDY	YEAR	GENERATION FACTOR	UNITS
1	Marion, J.	2000	1.00	lbs/inmate/ day
2	Draper/Lennon	2001	1.00	lbs/inmate/ day
3	Kessler Consulting	2004	1.20	lbs/inmate/ day
4	Mendrey, K.	2013	1.25	lbs/inmate/ day
5	Goldstein, N.	2015	1.40	lbs/inmate/ day
6	CalRecycle	2018	0.85	lbs/inmate/ day

Two of these studies (Marion (2000) and Draper/Lennon (2001)) rely on data collected by the New York State Department of Correctional Services (NYS DOCS) Food Discard Recovery Program between 1990 and 1997. Using data collected by the NYS DOCS program, Marion (2000) found that approximately one pound per day of food scraps was recoverable per inmate.[11] Draper/Lennon (2001) used Marion's findings, but also collected data from a prison food waste composting program in Connecticut; they also found that, on average, one prisoner generates one pound of excess food per day. Additionally, nine other sources published between 2002 and 2016 rely on the Marion (2000) one pound per inmate per day estimate in calculating excess food generated in correctional facilities in various states including New Jersey and South Carolina (Mercer (2013); SCDOC (2015)).

[10] Several studies report the role that excess food plays in the overall prison solid waste stream. In general, these studies find that excess food makes up about 30 percent of all waste generated (Marion (2000); Kessler Consulting (2004); Recycling Works Massachusetts (2013); Hodge et al (2016); CalRecycle (2018)).

[11] Marion's language is ambiguous as to whether the one pound/inmate/day estimate is the total excess food generated or the amount of excess food recovered. The analysis assumes that the recoverable portion of excess food is equivalent to excess food generation in correctional facilities.

These six excess food generation factors range from 0.85 to 1.4 pounds per inmate per day, from studies that conducted original research and collected data from correctional facilities. In instances where the study provided a range in the amount of excess food generated per inmate per day, EPA used the midpoint of the range. These studies were published between 2000 and 2018 using data from six states.[12] While the Marion (2000) and Draper/Lennon (2001) studies are older, they are frequently cited in other studies (see BSR (2012); Recycling Works Massachusetts (2013); Labuzetta et al (2016)); therefore, EPA retained them in this analysis.

Hoovers, Inc. does not provide data on the number of inmates at each correctional facility, but it does provide the number of employees at each facility. In order to use generation factors that are based on pounds per inmate, EPA estimated the average number of inmates per employee. The Bureau of Justice Statistics (BJS (2016), BJS (2005a), BJS (2005b)) publishes information on the number of inmates and employees for county and city jails and for state and federal prisons:

- County and city jails: 3.1 inmates/employee[13]
- State and federal prisons: 3.4 inmates/employee[14]

Using this data, the following equation was used to generate estimates of excess food for correctional facilities:

$$\text{Correctional Facilities Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of employees} \times \text{X } \frac{\text{inmates}}{\text{employee}} \times \frac{\text{Y } \frac{\text{lb}}{\text{inmate}}}{\text{day}} \times 365 \frac{\text{days}}{\text{year}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

Where X = 3.1 or 3.4 and Y = 0.85 to 1.4

2.6.1. Changes in Version 2.0

EPA conducted a literature review to find the best available methodologies to calculate excess food for this sector. Six studies were chosen for Version 2.0. In Version 1.0, EPA relied on one methodology (Draper/Lennon (2001)), which is still used in Version 2.0, in addition to five other methodologies. In addition, EPA relied solely on BJS statistics to estimate an average number of

[12] California, Connecticut, Florida, New York, Pennsylvania, and Washington.

[13] In 2016, 704,500 inmates were confined in city and county jails (BJS (2016), Table 7) and there were 226,300 total employees (BJS (2016), Table 8). 704,500 inmates/226,300 total employees = 3.1 inmates per employee in city and county jails.

[14] The total number of prisoners under the jurisdiction of Federal and State adult correctional authorities was 1,525,924 at year end 2005 (BJS (2005b), page 1). The total number of employees in correctional facilities under Federal and State authority at year end 2005 was 445,055 (BJS (2005a), Table 4). 1,525,924 prisoners/445,055 total employees = 3.4 prisoners per employee in federal or state prisons.

inmates per employee, which resulted in slightly different inmate to employee ratios than those estimated in Version 1.0.

2.6.2. Changes in Version 2.1

No changes were made in Version 2.1.

2.7. Healthcare Facilities

As listed in Table 12, establishments belonging to three NAICS codes were grouped as healthcare facilities. Establishment-level data for this sector was obtained from the Department of Homeland Security (DHS (2017)).

Table 12. NAICS Codes for Healthcare Facilities

No.	NAICS Code	NAICS Code Description
1	622110	General Medical and Surgical Hospitals
2	622210	Psychiatric and Substance Abuse Hospitals
3	622310	Specialty (except Psychiatric and Substance Abuse) Hospitals

The literature search identified a total of 46 studies addressing excess food generation in hospital settings. Many of these studies, however, are not directly useful to methods development. Some lack quantitative information on generation factors, while others apply generation factors from earlier studies. EPA chose four studies that either involved original research (e.g., sorting/analysis of hospital waste) or which present foundation estimates widely cited in the literature. These four studies were used to estimate excess food generated, resulting in a range of values for each facility (Table 13).

Table 13. Generation Factors for Healthcare Facilities

SOURCE	YEAR	GENERATION FACTOR	UNITS
Draper/Lennon	2001	1,248.3	lbs/bed/year
NCDENR	2012	468.2	lbs/bed/year
Walsh	1993	663.4	lbs/bed/year
CCG	2015	232.6	lbs/bed/year

The highest generation factor is from Draper/Lennon (2001) which is widely cited in other studies estimating excess food (see Recycling Works Massachusetts (2013); NRDC (2017); BSR (2012); among others). While widely applied, the generation factors in Draper/Lennon (2001) are built on original research developed in the 1990s, hence EPA supplemented this data point with other studies. Both the NCDENR (2012) study and the CCG (2015) study are more recent and use

original waste sampling. The Walsh (1993) study is older, but provides an additional data point for corroboration of the generation per bed figures.[15]

These four generation factors were used in conjunction with hospital bed data obtained from DHS to estimate a range of generation rates for healthcare facilities belonging to the three NAICS codes identified as healthcare facilities. This is reflected in the following equation:

$$\text{Healthcare Facilities Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{\# of Beds} \times \frac{\text{X } \frac{\text{lb}}{\text{bed}}}{\text{year}} \times \frac{\text{tons}}{\text{2,000 lb}}$$

Where X = 232.6, 468.2, 663.4, or 1248.3.

2.7.1. Changes in Version 2.0

For Version 2.0 of the Map, EPA used the Department of Homeland Security's Homeland Infrastructure Foundation-Level Data (DHS (2017)) instead of Hoover's, Inc., because the data was more comprehensive and included the number of beds per facility. The data also included phone numbers and websites for many of the facilities, which were included in the Dataset and the Map. Version 2.0 includes facilities in three NAICS codes, whereas Version 1.0 only included General Medical and Surgical Hospitals (NAICS code 622110). Finally, in Version 1.0, EPA relied on two methodologies, one of which is still used in Version 2.0 (Draper/Lennon (2001)), in addition to three other methodologies.

2.7.2. Changes in Version 2.1

No changes were made in Version 2.1.

2.8. Restaurants and Food Services

Six industries were classified as restaurants and food services (Table 14). Establishment-level data for this sector was obtained from Hoover's, Inc.

[15] The analysis of hospitals in the NCDENR report draws on a study of Orange County, North Carolina. The only hospital in the county is the University of North Carolina Medical Center, which has 803 beds (see https://www.uncmedicalcenter.org/uncmc/about/). EPA's analysis uses that figure to calculate pounds of excess food per bed. Both the CCG (2015) and Walsh (1993) studies report total solid waste generation per hospital bed. CCG (2015) provides a detailed composition analysis indicating that 20.4 percent of the hospital solid waste is food, allowing calculation of excess food per bed. EPA's analysis applies the same composition assumption (20.4 percent) to the Walsh (1993) solid waste per bed figure to estimate excess food per bed.

Table 14. NAICS Codes for the Restaurants and Food Services Sector

No.	NAICS Code	NAICS Code Description
1	722320	Caterers
2	722330	Mobile Food Services
3	722511	Full-Service Restaurants
4	722513	Limited-Service Restaurants
5	722514	Cafeterias, Grill Buffets, and Buffets
6	722515	Snack and Nonalcoholic Beverage Bars

Industries were classified as full-service or limited-service according to their six-digit NAICS codes. Full-service establishments include Caterers (NAICS code 722320), Full-Service Restaurants (NAICS codes 722511) and Cafeterias, Grill Buffets, and Buffets (NAICS code 722514). Limited-service establishments include Mobile Food Services (NAICS code 722330), Limited-service Restaurants (NAICS codes 722513), and Snack and Nonalcoholic Beverage Bars (NAICS code 722515).

The literature search identified a total of 49 studies that address excess food generation in restaurant and food service settings. Many of these studies, however, do not provide directly useful generation data. Some lack quantitative information on generation factors, while others apply generation factors derived from earlier studies. EPA chose five studies that either involved original research (e.g., sorting/analysis of facility waste) or which present generation factors that are widely cited in the broader literature (Table 15). These five studies were used to estimate excess food generated, resulting in a range of values for each establishment.

Table 15. Generation Factors for Restaurants and Food Services

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNITS	ESTABLISHMENT TYPE
1	CCG	2006	3,392 for full-service	lbs/employee/year	Full-service and limited service estimated separately
2			2,494 for limited-service		
3	Draper/ Lennon	2002	3,000	lbs/employee/year	Unspecified
4	CCG	2015	2,760	lbs/employee/year	Full-service and limited-service estimated together
5	BSR	2014	0.033	lbs/revenue/year	Unspecified

The three studies used to establish generation factors 1-4 established factors based on pounds per employee per year. The Draper/Lennon (2002) study, developed for the Massachusetts Department of Environmental Protection and updated by EPA Region 1 in 2011, was widely cited (see

Recycling Works Massachusetts (2013); Mercer (2013); SCDOC (2015); among others). While widely applied, the generation factors in Draper/Lennon (2002) are built on original research developed in the 1990s. Both the CCG (2006) and CCG (2015) studies are more recent and use waste sampling techniques to estimate of excess food generation.

BSR (2014) collected industry generation data through a series of surveys and estimated 33 pounds of excess food generated per thousand dollars of company revenue.

Generation factors 1, 3, 4, and 5 were used to estimate excess food generation for the establishments in the three NAICS codes classified as full-service establishments. Generation factors 2, 3, 4, and 5 were used to estimate excess food generation rates for the establishments in the three NAICS codes classified as limited-service establishments.

Generation factors 1-4 use the following equation:

$$\text{Restaurants and Food Services Sector Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of employees} \times \frac{\text{X}\dfrac{\text{lb}}{\text{employee}}}{\text{year}} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

Where X = 2494 to 3,392

Generation factor 5 uses the following equation:

$$\text{Restaurants and Food Services Sector Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Establishment's Annual Revenue \$} \times 0.033 \frac{\text{lb}}{\text{Annual Revenue (\$)}} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

2.8.1. Changes in Version 2.0

For Version 1.0 of the Map, EPA was not able to obtain establishment-level data for this sector due to resource constraints, and therefore it was not included in the Dataset or Map. While Version 1.0 of this report discussed available methodologies to calculate excess food generation, EPA sought out the newest and most appropriate methodologies to calculate excess food generation rates for Version 2.0.

2.8.2. Changes in Version 2.1

No changes were made in Version 2.1.

2.9. Food Banks

Food banks (NAICS code 624210) are considered potential generators as well as potential recipients of excess food. This is because some of the food they receive as donations may be expired, degrading, or otherwise deemed unfit for human consumption. In 2015, food bank data was provided by Feeding America, a nationwide network of food banks, food pantries, and meal programs. Feeding America is the nation's leading domestic hunger-relief organization and serves virtually every community in all 50 states, Washington D.C., and Puerto Rico. Specifically, Feeding America provided data on generation of excess food as reported by individual food banks in its network, where available.

2.9.1. Changes in Version 2.0

No changes were made to this sector in Version 2.0. EPA is seeking to expand the number of food banks and food rescue organizations included in the Dataset and Map for the next update.

2.9.2. Changes in Version 2.1

No changes were made in Version 2.1.

2.10. Data Analysis

Nearly 1.2 million establishments that potentially generate excess food were included in the Dataset and Map from ICI sectors based on 76 NAICS codes and three school types. The Dataset provides establishment-level information including name and geographic location, and includes common business statistics such as revenue, number of employees, or number of students which was used to estimate excess food generation using sector-specific equations, as detailed in sections 2.2 to 2.9. Excess food generation rates were estimated for 97.8% of establishments. Establishments for which generation rates could not be estimated were still mapped. There were several equations available to calculate excess food estimates for each sector, resulting in a range of values for each establishment; a high and low excess food estimate was included for each establishment.

The data was reviewed and filtered in the following ways:

- Establishments identified as "Headquarters" were excluded from the Dataset because these establishments typically serve an administrative function and do not generate excess food.
- Duplicates were defined as establishments with identical names and physical addresses. If an establishment had multiple observations, it was assigned the minimum for number of employees and revenue among all its observations.
- Observations that were identified as having unrealistically high or low quantities for revenue and/or employees were assumed to be input errors and removed from the Dataset based on statistical cutoffs. This step helped to avoid extreme overestimates or underestimates. For example, correctional facilities that were listed as only having one employee were removed.

3. Macro Analysis of Sector-Specific Excess Food Generation Rates

The Dataset provides establishment-level estimates of excess food in each identified sector. Data for the 1,166,790 establishments was obtained primarily from Hoover's, Inc., as well as the NCES databases and DHS. Excess food generation rates were estimated for 97.8% of all establishments, an increase from 86% in Version 1.0. Estimation was not possible if generation factor data were missing, in which case no excess food estimate was reflected in the Dataset, though the establishment was still mapped.

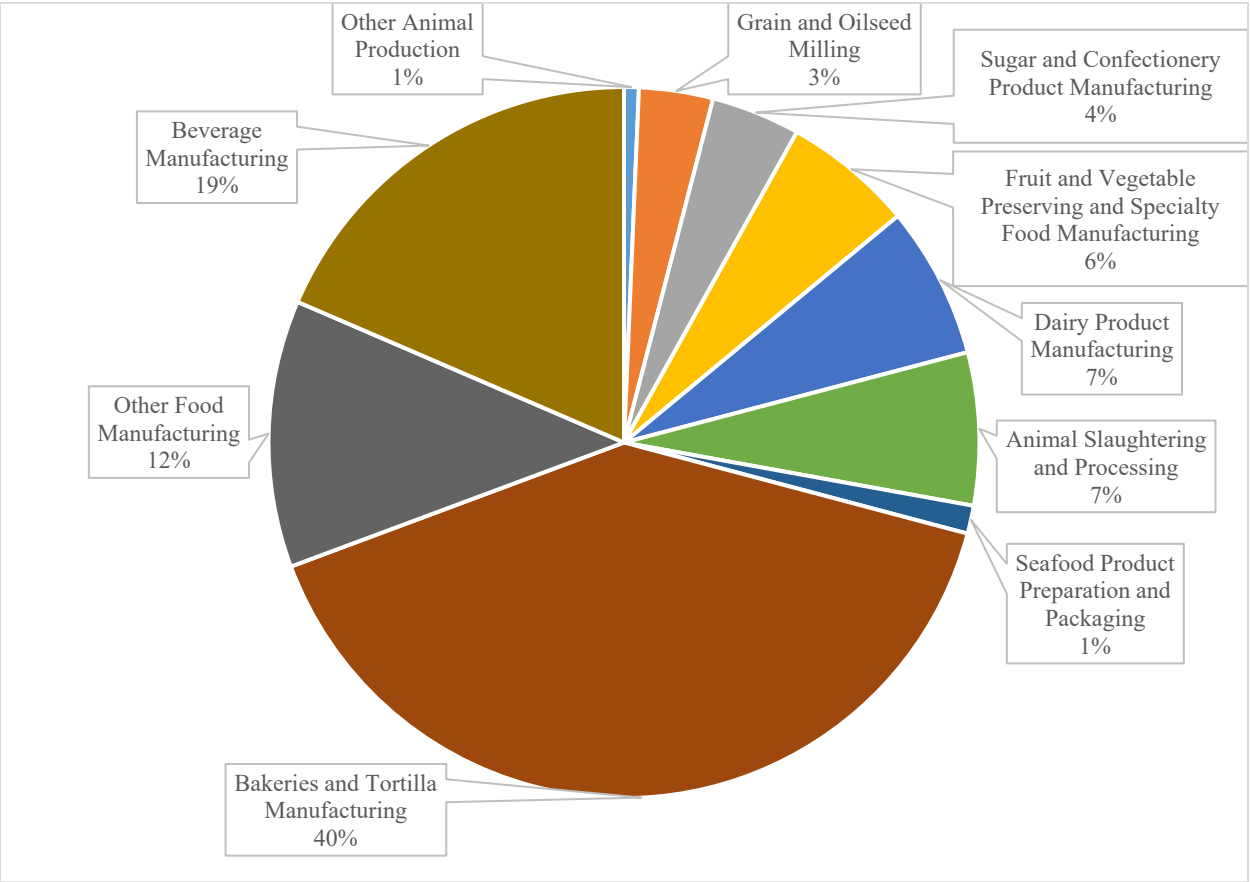
Table 16. Establishments Included in the Dataset by Sector

Sector	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
Food Manufacturers & Processors	59,914	53,265	88.9%
Food Wholesale & Retail	236,666	236,599	100.0%
Educational Institutions	127,203	124,365	97.8%
Hospitality Industry	80,312	80,232	99.9%
Correctional Facilities	5,269	5,268	100.0%
Healthcare Facilities	7569	6919	91.4%
Restaurants and Food Services	649,541	633,849	97.6%
Food Banks	316	154	48.7%
Total	1,166,790	1,140,651	97.8%

3.1. Food Manufacturers and Processors

The food manufacturers and processors sector, as described in Section 2.2, includes 46 NAICS codes. Data were obtained for 59,914 establishments, and excess food estimates were generated for 88.9% of the establishments. Figure 4 shows the proportion of food manufacturers and processors by industry type.

Figure 4. Proportion of Food Manufacturers and Processors by Industry Type



3.2. Food Wholesale and Retail

The food wholesale and retail sector, as described in Section 2.3, encompasses 17 NAICS codes. Data were obtained for 236,666 establishments associated with these codes, and excess food estimates were generated for 100.0% of establishments.

Figure 5 shows the proportion of food wholesalers and retailers by industry type; 75% of which are food retailers (supermarkets, grocery stores, and supercenters) and 25% are food wholesalers. Table 17 shows more granular data about data availability across this sector.

Figure 5. Proportion of Food Wholesale and Retail Establishments by Industry Type

Table 17. Number of Food Wholesale and Retail Establishments Included in the Dataset

Industry	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
Food Wholesalers	58, 386	58,386	100.0%
Food Retailers (Supermarkets, Grocery Stores, and Supercenters)	178,279	178,213	100.0%
Total	236,666	236,599	100.0%

3.3. Educational Institutions

The educational institutions sector, as described in Section 2.4, encompasses three school types. These are postsecondary schools, public elementary and secondary schools, and private elementary and secondary schools. Figure 6 shows the proportion of educational institutions by type, and Table 18 shows more granular information about data availability across the sector.

Figure 6. Proportion of Educational Institutions by School Type

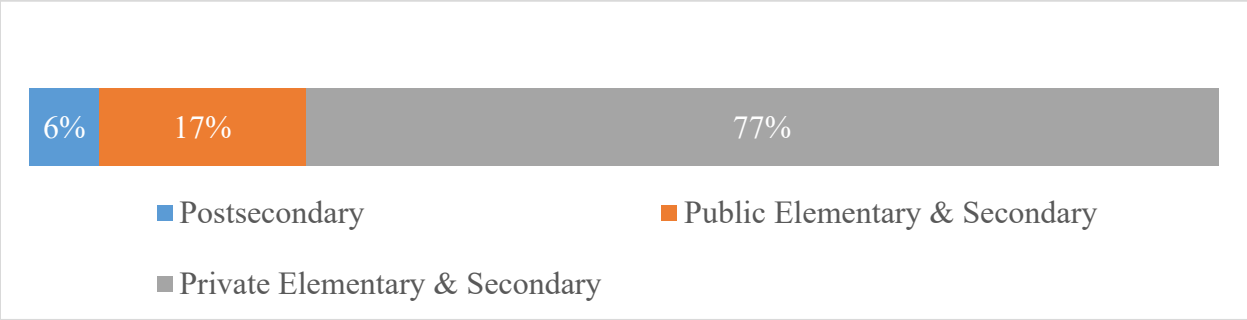


Table 18. Number of Educational Institutions Included in the Dataset

School Type	Institutions in the Dataset	Institutions with Excess Food Estimate	% Institutions with Excess Food Estimate
Postsecondary Schools	7,516	6,815	90.7%
Public Elementary and Secondary Schools	22,061	22,061	100.0%
Private Elementary and Secondary Schools	97,626	95,488	97.8%
Total	127,203	124,364	97.8%

3.4. Hospitality Industry

The hospitality industry, as described in Section 2.5, encompasses three NAICS codes. Data were obtained for 80,312 establishments associated with these codes, and excess food estimates were generated for 99.9% of the sample.

Figure 7 shows the proportion of hospitality establishments by industry type, for which hotels and motels represent the vast majority at 97.6% of the total. Table 19 shows more granular information about data availability across the sector.

Figure 7. Proportion of Hospitality Industry Establishments by Type

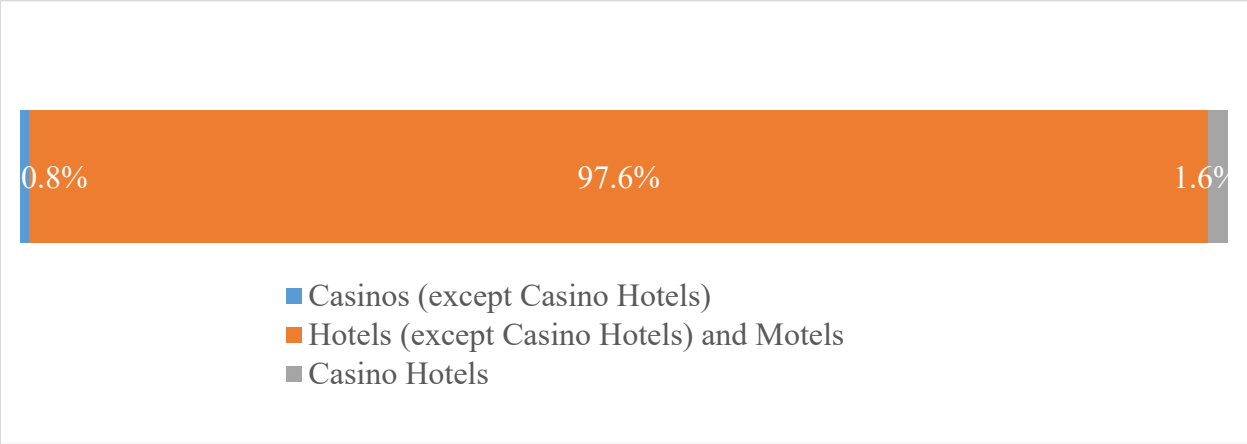


Table 19. Number of Hospitality Establishments Included in the Dataset

Industry	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
Hotels and Motels	78,398	78,319	99.9%
Casino Hotels	1,303	1,302	99.9%
Casinos (except Casino Hotels)	611	611	100.0%
Total	80,312	80,232	99.9%

3.5. Correctional Facilities

The correctional facilities sector, as described in Section 2.6, encompasses one NAICS code. Data were obtained for 5,269 facilities associated with this code, and excess food estimates were generated for 100.0% of the sample.

3.6. Healthcare Facilities

The healthcare facilities sector, as described in Section 2.7, encompasses three NAICS codes. Data were obtained for 7,569 establishments associated with these NAICS codes, and excess food estimates were generated for 91.4% of the sample.

Figure 8 shows the proportion of healthcare facilities by industry type for which general medical and surgical hospitals represent the majority at 80% of the total. Table 20 shows more granular information about data availability across the sector.

Figure 8. Proportion of Healthcare Facilities by Industry Type

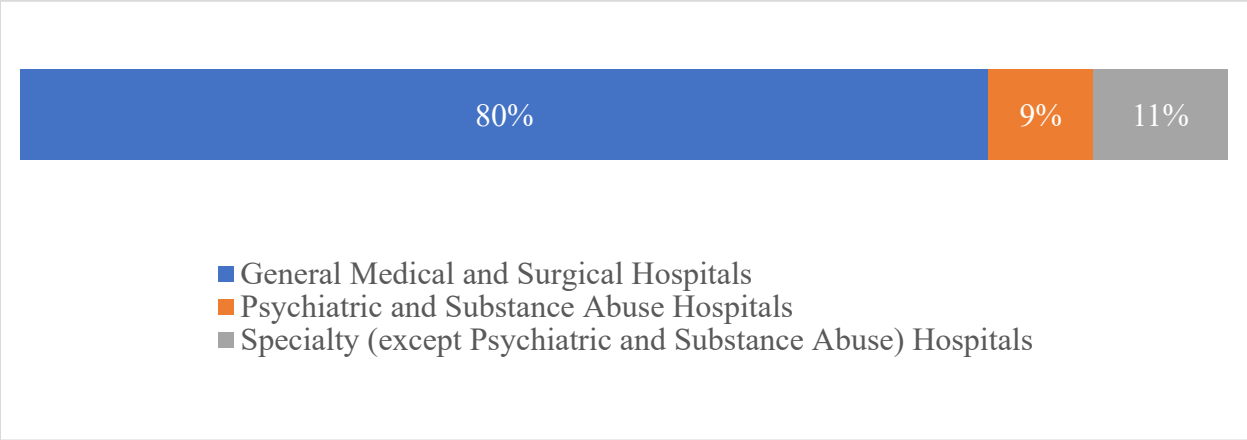


Table 20. Number of Healthcare Facilities Included in the Dataset

Industry	Facilities in the Dataset	Facilities with Excess Food Estimate	% Facilities with Excess Food Estimate
General Medical and Surgical Hospitals	6,071	5,598	92.2%
Psychiatric and Substance Abuse Hospitals	653	549	84.1%
Specialty (except Psychiatric and Substance Abuse) Hospitals	845	772	91.4%
Total	7,569	6,919	91.4%

3.7. Restaurants and Food Services

The restaurants and food services sector, as described in Section 2.8, encompasses six NAICS codes. Data were obtained for 649,541 establishments associated with these NAICS codes, and excess food estimates were generated for 97.6% of the sample.

Figure 9 shows the proportion of restaurants and food services establishments by industry type, for which full-service restaurants represent the majority at 53.8% of the total. Table 21 shows more granular information about data availability across the sector.

Figure 9. Proportion of Restaurant and Food Services Establishments by Industry Type

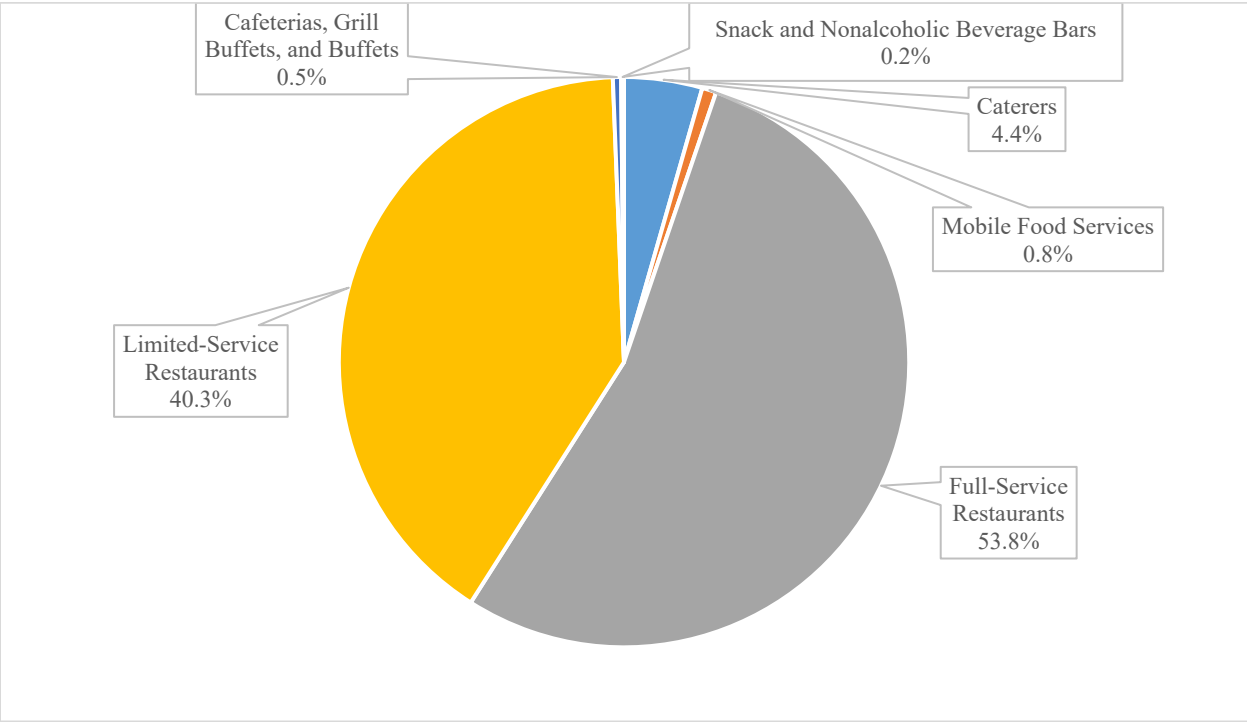


Table 21. Number of Restaurant and Food Services Establishments Included in the Dataset

Industry	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
Caterers	28,786	27,944	97.1%
Mobile Food Services	5,238	5,216	99.6%
Full-Service Restaurants	349,412	339,608	97.2%
Limited-Service Restaurants	262,036	257,146	98.1%
Cafeterias, Grill Buffets, and Buffets	3028	2933	96.9%
Snack and Nonalcoholic Beverage Bars	1041	1002	96.3%
Total	649,541	633,849	97.6%

3.8. Food Banks

Food banks, as described in Section 2.9, encompass one NAICS code. Data were obtained for 316 establishments associated with this code, and excess food generation data exist for 49% of the sample.

4. Data Sources for Recipients

4.1. Overview

The Map displays facility-specific information for four categories of potential recipients of excess food, the data sources for which are described below. Recipients make use of excess food in different ways, depending on the state of the resource (i.e., pre-consumer, post-consumer), as well as its macro-nutrients (i.e., lipid, carbohydrate, protein) and other biological characteristics. Appendix A summarizes common excess food characteristics by NAICS industry.

4.2. Food Banks

Food banks (NAICS code 624210) are considered potential recipients (because they receive donated food that would otherwise have gone to landfill, composting, etc.) as well as generators of excess food (because some of the food they receive as donations may be deemed unfit for human consumption and cannot be given to humans). Food bank data were provided by Feeding America, a nationwide network of food banks, food pantries, and meal programs. Feeding America is the nation's leading domestic hunger-relief organization and serves virtually every community in all 50 states, Washington D.C., and Puerto Rico. The data provided in 2015 includes 316 food banks for which Feeding America provided data on how much food is received and how much excess food is generated each year. No changes were made in Version 2.0 or 2.1 of the Map to the food bank sector.

4.3. Composting Facilities

Data for composting facilities was compiled through EPA review of state government websites, usually state departments of natural resources or environmental protection, and communication with state government employees. Version 1.0 of the Map contained 2,499 composting facilities in 39 states. Version 2.0 of the Map contained 3021 composting facilities in 49 states and one territory, and facilities were point mapped (they were only mapped by zip code or county in Version 1.0). Minor corrections were made to the Dataset in Version 2.1 for South Dakota and Illinois, resulting in eight facilities being removed, leaving 3013 composting facilities in the Dataset for 49 states and one territory. Associated websites and type of feedstock accepted are listed in the Dataset and in the Map, where information was available.

4.4. Anaerobic Digestion Facilities

Data for anaerobic digestion facilities for Version 1.0 of the Map was compiled using Agency and non-Agency sources (US EPA (2016b); ABC (2017)), resulting in a Dataset of 1,381 facilities. The main data sources include facilities that had been listed in the EPA Waste to Biogas Mapping Tool, supplemented by a list of facilities maintained by the EPA AgSTAR program, as well as other facilities tracked by or known to EPA through other collaborative program work. No changes were made in Version 2.0 of the Map to anaerobic digestion facilities. EPA updated the anaerobic digestion facilities Dataset in Version 2.1 of the Map, resulting in a Dataset containing 1607 facilities. The updated Version 2.1 Dataset was compiled from (1) a list of facilities on farms maintained by AgSTAR (US EPA (2019a)); (2) a list of stand-alone food waste digesters, on-farm digesters that co-digest food waste, and digesters that co-digest food waste at water resource recovery facilities (WRRFs) who responded to EPA's AD Data Collection Survey in 2018 (US EPA (2018)); and (3) the list of facilities at WRRFs maintained by the Water Environment Federation (WEF (2019)). In Version 2.1, anaerobic digestion facilities were point mapped (they

were only mapped by zip code or county previously). Where available, feedstock data was added to the Dataset to indicate what kind of feedstocks (e.g., types of food waste, types of animal manure) are accepted by the facility.

5. Data Sources for Communities with Residential Source Separated Organics Programs

Data for communities with residential source separated organics programs that collect excess food for Version 1.0 of the Map were identified from two sources (a 2011 survey published by BioCycle (Yepsen (2012)) and Layzer (2014)). Of the 156 communities identified, data was available to map 131 communities. No changes were made in Version 2.0 of the Map. In Version 2.1 of the Map, 221 communities with residential curbside food waste collection were identified from a 2017 survey published by BioCycle (Platt and Streeter (2017)) supplemented with data provided by states in 2020. All 221 communities were mapped. Some communities are counties that have programs that serve multiple cities or areas, while some communities are single towns or cities with their own programs. In Version 2.1, data were not available for the participation rate or amount collected for each program, so those fields were removed from the Dataset. However, where available, data were included for the number of households with access, the processing facility or hauler name, and material preference (i.e., types of feedstock accepted, such as types of food and yard waste). This Dataset includes communities with residential source separated organics programs that collect excess food, and does not include those communities that only collect yard waste.

6. Limitations and Opportunities for Improvement

This section summarizes limitations associated with the methodology as well as recommendations for future improvements.

Map and methodology limitations and opportunities for improvement include the following:

1. **Generation factors**. Generation factors in the methodologies adopted for this study are based on limited measured data. Although the methodologies adopted for the Map provide a simple approach to estimate excess food generation from an ICI establishment, on-site measurement is always preferred.

2. **Recoverable fraction of excess food**. The recoverable fraction of excess food could be used to feed people, which represents the most preferred use of excess food. A reliable estimate of the recoverable fraction of excess food is critical data needed to pursue its best use. The recoverable fraction of excess food was not estimated for any of the sectors in Version 2.0 of the Map. If methodologies become available to estimate the recoverable fraction of excess food available by sector, EPA could include these estimates in a future version of the Map.

3. **On-farm loss**. This methodology and Map do not address on-farm loss, including unharvested crops or unmarketable crops. Some reports estimate that as much as 10 million pounds of excess food per year are produced on farms (ReFED (2016)).

4. **Food banks and other food rescue organizations.** The data for food rescue organizations is limited. While data for food banks were provided by Feeding America and covers their regional and partner distribution organizations, there are thousands of other organizations, such as food pantries and soup kitchens, that accept donations and distribute food to people in need. EPA is working to compile information on food rescue organizations to be included in a future version of the Map.

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APPENDICES

Appendix A: Excess Food Characteristics

Recipients of excess food make use of the food in different ways, depending on the state of the resource (i.e., pre-consumer, post-consumer), as well as its macro-nutrients. In general, excess food composition depends on the characteristics of its primary products. Table 22 lists excess food characteristic categories and commonly associated industries.

Table 22. Dominant Excess Food Characteristics and Associated Industry Examples

No	Excess Food Characteristics	Examples of Type of Industries
1	Lipids	Fats and oils refining and blending, fast food
2	Simple Carbohydrates	Bakeries, breweries, confectionaries and soda producers
3	Complex Carbohydrates	Fruits and vegetables processing, supermarkets and grocery stores
4	Proteins	Meat, poultry, and dairy processing
5	Mixed Materials	Food services
6	Glycerin	Biofuel manufacturing

The types of excess food components generated by each industry based on NAICS code are listed in Table 23. For the food manufacturing and processing and food wholesale and retail sectors, excess food characteristics were based on the type of industry. Jacob (1993) reported that supermarkets and grocery stores generate more than 90% of their waste, primarily complex carbohydrates, from the produce department. Draper/Lennon (2001) reported that excess food generated by sectors such as educational institutions, healthcare facilities, correctional facilities, and the hospitality industry consists primarily of complex carbohydrates, mostly from fruit and vegetable residuals, with the balance divided between meat and bakery products, with dairy contributing just a small fraction. Excess food generated by the food services sector is generally comprised of mixed components. Table 23 summarizes characteristics of excess food from the 76 industries plus school types selected for the Map. Note that along with proteins, simple and complex carbohydrates, and lipids, some excess food characteristics are reflected as a mix of these characteristics ("mixed"), or are denoted as "other" for certain sectors where these characterization categories are not a good fit (e.g., spice and extract manufacturing).

Table 23. Characteristics of Excess Food Associated with Industries in the Excess Food Opportunities Map

NAICS Code	NAICS Code Description	Excess Food Characteristics
Food Manufacturers and Processors		
112930	Fur-Bearing Animal and Rabbit Production	Proteins
311211	Flour Milling	Complex Carbohydrates
311212	Rice Milling	Complex Carbohydrates
311213	Malt Manufacturing	Complex Carbohydrates
311221	Wet Corn Milling	Complex Carbohydrates
311224	Soybean and Other Oilseed Processing	Lipids
311225	Fats and Oils Refining and Blending	Lipids
311230	Breakfast Cereal Manufacturing	Simple and Complex Carbohydrates
311313	Beet Sugar Manufacturing	Complex Carbohydrates
311314	Cane Sugar Manufacturing	Complex Carbohydrates
311340	Nonchocolate Confectionery Manufacturing	Simple Carbohydrates
311351	Chocolate and Confectionery Manufacturing from Cacao Beans	Simple Carbohydrates
311352	Confectionery Manufacturing from Purchased Chocolate	Simple Carbohydrates
311411	Frozen Fruit, Juice, and Vegetable Manufacturing	Simple Carbohydrates
311412	Frozen Specialty Food Manufacturing	Simple and Complex Carbohydrates
311421	Fruit and Vegetable Canning	Complex Carbohydrates
311422	Specialty Canning	Complex Carbohydrates
311423	Dried and Dehydrated Food Manufacturing	Proteins
311511	Fluid Milk Manufacturing	Proteins
311512	Creamery Butter Manufacturing	Proteins
311513	Cheese Manufacturing	Proteins
311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing	Proteins
311520	Ice Cream and Frozen Dessert Manufacturing	Proteins
311611	Animal (except Poultry) Slaughtering	Proteins
311612	Meat Processed from Carcasses	Proteins
311613	Rendering and Meat Byproduct Processing	Proteins
311615	Poultry Processing	Proteins
311710	Seafood Product Preparation and Packaging	Proteins
311811	Retail Bakeries	Simple Carbohydrates
311812	Commercial Bakeries	Simple Carbohydrates
311813	Frozen Cakes, Pies, and Other Pastries Manufacturing	Simple Carbohydrates
311821	Cookie and Cracker Manufacturing	Simple Carbohydrates
311824	Dry Pasta, Dough, and Flour Mixes	Simple and Complex

	Manufacturing from Purchased Flour	Carbohydrates
311830	Tortilla Manufacturing	Simple and Complex Carbohydrates
311911	Roasted Nuts and Peanut Butter Manufacturing	Simple Carbohydrates
311919	Other Snack Food Manufacturing	Simple Carbohydrates
311920	Coffee and Tea Manufacturing	Complex Carbohydrates
311930	Flavoring Syrup and Concentrate Manufacturing	Simple Carbohydrates
311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing	Complex Carbohydrates
311942	Spice and Extract Manufacturing	Others
311991	Perishable Prepared Food Manufacturing	Simple Carbohydrates
311999	All Other Miscellaneous Food Manufacturing	Others
312111	Soft Drink Manufacturing	Simple Carbohydrates
312120	Breweries	Simple Carbohydrates
312130	Wineries	Simple Carbohydrates
312140	Distilleries	Simple Carbohydrates
Food Wholesale and Retail		
424410	General Line Grocery Merchant Wholesalers	Mixed
424420	Packaged Frozen Food Merchant Wholesalers	Mixed
424430	Dairy Product (except Dried or Canned) Merchant Wholesalers	Proteins
424440	Poultry and Poultry Product Merchant Wholesalers	Proteins
424450	Confectionery Merchant Wholesalers	Simple Carbohydrates
424460	Fish and Seafood Merchant Wholesalers	Proteins
424470	Meat and Meat Product Merchant Wholesalers	Proteins
424480	Fresh Fruit and Vegetable Merchant Wholesalers	Complex Carbohydrates
424490	Other Grocery and Related Products Merchant Wholesalers	Mixed
445110	Supermarkets and Other Grocery (except Convenience) Stores	Complex Carbohydrates
445210	Meat Markets	Proteins
445220	Fish and Seafood Markets	Proteins
445230	Fruit and Vegetable Markets	Complex Carbohydrates
445291	Baked Goods Stores	Simple Carbohydrates
445292	Confectionery and Nut Stores	Simple Carbohydrates
445299	All Other Specialty Food Stores	Simple Carbohydrates
452311	Warehouse Clubs and Supercenters	Complex Carbohydrates
Educational Institutions		
n/a	Public Elementary and Secondary Schools	Complex Carbohydrates, Proteins
n/a	Private Elementary and Secondary Schools	Complex Carbohydrates, Proteins

n/a	Postsecondary Schools	Complex Carbohydrates, Proteins
Hospitality Industry		
713210	Casinos (except Casino Hotels)	Complex Carbohydrates
721110	Hotels and Motels	Complex Carbohydrates, Proteins
721120	Casino Hotels	Complex Carbohydrates, Proteins
Correctional Facilities		
922140	Correctional Institutions	Complex Carbohydrates, Proteins
Healthcare Facilities		
622110	General Medical and Surgical Hospitals	Complex Carbohydrates, Proteins
622210	Psychiatric and Substance Abuse Hospitals	Complex Carbohydrates, Proteins
622310	Specialty (except Psychiatric and Substance Abuse) Hospitals	Complex Carbohydrates, Proteins
Restaurants and Food Services		
722320	Caterers	Complex Carbohydrates, Proteins
722330	Mobile Food Services	Complex Carbohydrates, Proteins
722511	Full-Service Restaurants	Complex Carbohydrates, Proteins
722513	Limited-Service Restaurants	Complex Carbohydrates, Proteins
722514	Cafeterias, Grill Buffets, and Buffets	Complex Carbohydrates, Proteins
722515	Snack and Nonalcoholic Beverage Bars	Complex Carbohydrates, Proteins

Appendix B: Glossary

The definitions below are specifically tailored to the scope and aims of this paper.

AgSTAR: An EPA effort that promotes the use of biogas recovery systems to reduce methane emissions from livestock waste. AgSTAR assists those who enable, purchase or implement anaerobic digesters by identifying project benefits, risks, options and opportunities. AgSTAR also provides the Livestock Anaerobic Digester Database that offers basic information about anaerobic digesters on livestock farms in the United States.

ANAEROBIC DIGESTION: The biochemical decomposition of organic matter into methane gas and carbon dioxide by microorganisms in the absence of air.

ANTHROPOGENIC METHANE EMISSIONS: Methane (CH4), a potent greenhouse gas, emitted due to human activities.

COMPOST: An organic (derived from living matter) material that can be added to soil to help plants grow by enriching the soil, retaining moisture, suppressing plant diseases and pests, reducing the need for chemical fertilizers and encouraging the production of beneficial bacteria and fungi.

COMPOSTING: A process of combining organic wastes such as excess food, yard trimmings, and manures, in the right ratios into piles, rows, or vessels and adding bulking agents such as wood chips to create a soil amendment.

EXCESS FOOD: For purposes of this project, the phrase "excess food" generally refers to food—whether processed, semi-processed, or raw—that is intended for human consumption but was removed from the supply chain and is managed in a variety of ways, such as donation to feed people, creation of animal feed, composting, anaerobic digestion, or sending to 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. EPA often refers to this as "wasted food".

Because EPA's goal is to maximize recovery and beneficial use of all discarded organics, some organic materials were included in this project that are not intended for human consumption, such as inedible parts (e.g., pits, rinds, bones) and yard waste collected by municipal services (i.e., communities with residential source separated organics that collect yard waste and excess food). Furthermore, the residential and agricultural sectors, which can also generate excess food, were excluded from the map.

"Wasted food", "food waste", "surplus food", or "excess food" are terms commonly used to describe food that is not eaten as originally intended. The terms "surplus food" or "excess food" are often used to describe wholesome, nutritious food when discussing food recovery for donation to feed people while the term "food waste" is commonly used to describe food unfit for human consumption that cannot be donated and is managed in other ways, such as creation of animal feed, composting, anaerobic digestion, or sending to landfills or combustion facilities.

EXCESS FOOD GENERATION FACTORS: The values used to estimate excess food generation rates. Sector-specific surveys and/or literature-reported values were used to extract theses values which are consistent across a sector for each establishment. Examples of excess food generation factors are amount of excess food per employee per year, or amount of excess food per student per year.

FOOD LOSS: As defined by the USDA, the edible amount of food, postharvest, that is available for human consumption but is not consumed for any reason. It includes cooking loss and natural shrinkage (for example, moisture loss); loss from mold, pests, or inadequate climate control; and food waste.

FOOD RECOVERY: The action of collecting excess food to feed people.

INEDIBLE PARTS: As defined by the FLW Protocol, these are 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.

MUNICIPAL SOLID WASTE (MSW): Garbage or refuse generated by households, commercial establishments or institutional facilities.

ORGANIC RESIDUALS: Materials such as biosolids, compost, excess food, and yard trimmings.

ORGANIC WASTE: Any discarded material that can decompose.

ORGANICS: Materials such as excess food, yard waste, food, plant-based materials, animal feed, animal waste, wood, paper, and cardboard.

PLATE WASTE: Post-consumer leftover food, or food that has been served and not eaten. Also known as “front of house” excess food.

RECOVERABLE EXCESS FOOD: Food suitable for human consumption at or near the time of disposal, and suitable for donation or sale to secondary markets.

VARIABLES: The parameter used for excess food estimation, which varies for each establishment across the sector. For example, number of students or number of employees.