NYC Commercial Food Waste

Addressing a Sustainability Challenge Through Spatial Analysis

CAPSTONE THESIS FOR MASTER OF SCIENCE IN SUSTAINABILITY MANAGEMENT

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This report includes analysis and recommendations that have been authored by the group members of the Columbia Capstone Workshop and are not endorsed by the Department of Sanitation or the Business Integrity Commission.

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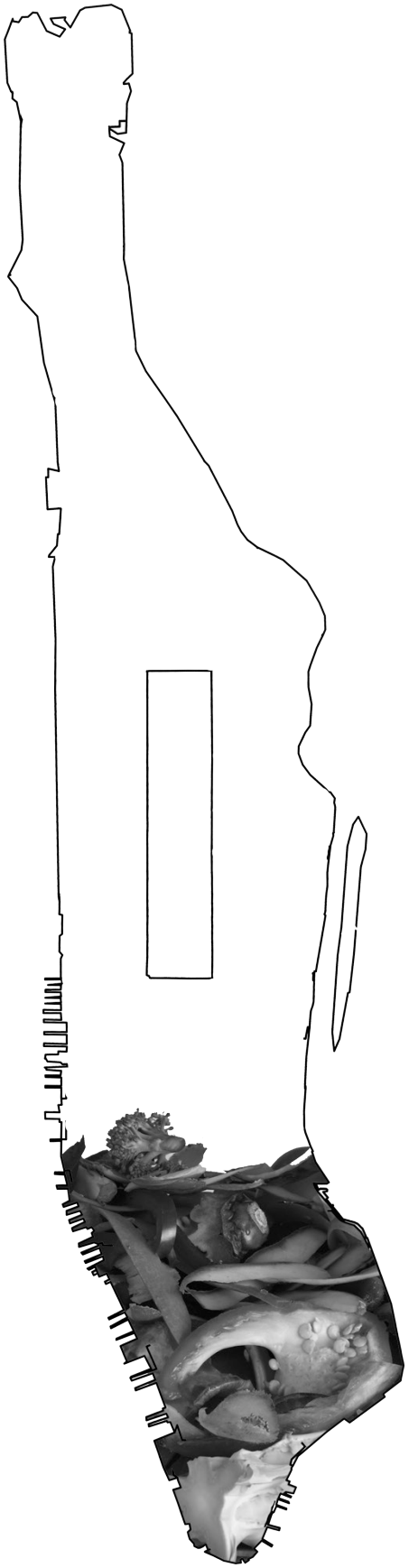

1 Source: Henningson, Durham & Richardson 2-4
2 Source: New York Transportation
3 Source: EPA Greenhouse Gas Equivalences Calculator
4 Source: EPA Greenhouse Gas Equivalences Calculator

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Executive Summary

New York City's commercial waste stream is a sustainability challenge. Commercial food waste accounts for approximately 25 percent of the nearly 3.9 million tons of total commercial solid waste produced in New York City annually (Henningson, Durham & Richardson 2-4). Currently, almost all of the commercial food waste is exported from New York City to other cities and states to be landfilled with the general waste stream of the City.

The existing disposal process depends on a long distance based truck transportation scheme to export the waste to landfills outside of New York City, with 98 percent being sent to Ohio, Pennsylvania, South Carolina and Virginia ("Taxes In, Garbage Out" 4). This system causes road degradation, congestion, gridlocks, and the release of greenhouse gas emission into the atmosphere. The system costs commercial waste generators $816 million each year with each ton of waste costing $127 to $208 per ton, which is the current rate cap, set by the Business Integrity Commission (Henningson, Durham & Richardson 2-4). Diverting commercial food waste from landfills to compost processing sites and anaerobic digestion facilities offers an opportunity for the City to reduce the amount of waste that is landfilled, in alignment with Mayor Bloomberg's PlaNYC objective to divert 75 percent of New York City's solid waste by the year 2030 ("PlaNYC 2030" 136-145).

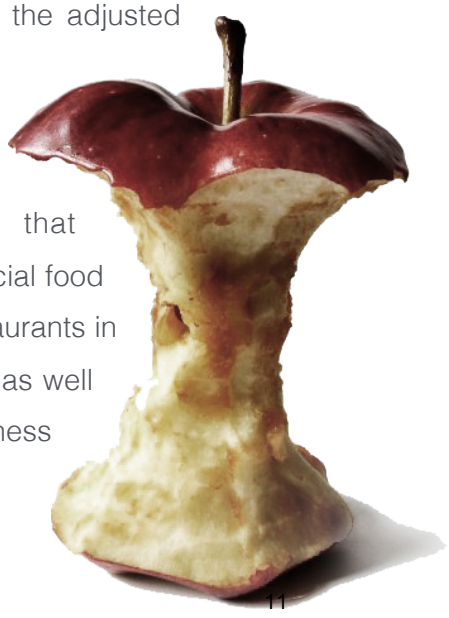
In line with the work of the Bureau of Waste Prevention, Reuse, and Recycling, in the New York City Department of Sanitation, this report identifies the main commercial food waste generators, produces an estimate of the citywide generation of commercial food waste and visualizes trends of commercial food waste generation in New York City.

The main food waste generators that this report focuses its analysis on are the following business categories:

- Accommodation
- Food Services
- Retail Trade
- Wholesale Nondurable Goods
- Manufacturing of Food
- Manufacturing of Beverages
- Health Care & Social Services

This report employs two different methodologies to develop estimates of the commercial food waste generated in New York City – the Commercial Waste Management Study (CWMS) and the Literature-Based Disposed Waste Model (LDW). Both methodologies estimate food waste generation projections based on the number of employees in the business establishments. These ratios were then applied to the InfoUSA data set for the purpose of this report and analysis. The CWMS methodology is based on the Commercial Waste Management Study prepared in 2004, and the ratio introduced in this study was adjusted for business categories that are not directly linked to food waste generation such as retail and wholesale. The LDW methodology derives the ratio for food waste estimation from the New York City Commercial Waste System Analysis and Study, Literature-Based Disposed Waste Model prepared in 2012. This methodology was used as a comparison to understand the impact of the adjusted ratios used as part of the first methodology.

The core of this report is the spatial analysis of the food waste generation data. This report estimates that Manhattan is the source of over 50 percent of the commercial food waste produced in the City. Due to the high density of restaurants in New York City to support over 50 million tourists annually, as well as the City's 8 million residents, Food Service business



establishments, including full service restaurants, are responsible for generating approximately 63 percent of the total commercial food waste ("NYC Tourism, Population, Climate and More"). The Retail Food business establishments including supermarkets are responsible for around 19 percent of the total commercial food waste generated.

To provide recommendations on how New York City's commercial food waste can be diverted from landfills, an analysis of best practices of the type of policies implemented in other states and cities was conducted. The two main types of policy tools analyzed were mandates and incentives for diversion based on the client recommended case studies of food waste diversion programs in Massachusetts and Connecticut.

The report provides three main recommendations on how New York City's commercial food waste can be diverted from landfills based on the assessment completed. The recommendations are targeted towards the main stakeholders of the commercial food waste market including the City of New York and the local regulating bodies, commercial food waste generators, waste haulers, landfills, food waste processors, waste technology companies and experts on the issue of food waste.

Recommendation	Stakeholder	Challenge	Solution
1. Food Waste Diversion Mandate	Commercial Food Waste Generators	Additional costs associated with separating and disposing of food waste	Require only large commercial generators to divert food waste from landfills and lower disposal rate for food waste
2. Incentives for Carters	Private Waste Hauling Carters	Transportation and disposal of food waste is not a profitable business model	Institute a franchise system to ensure haulers comply with diversion requirements and compensate haulers for lower food waste disposal rates
3. Food Waste Processing Capacity	Private Sector	Economic competiveness for siting and funding for composting and waste to energy projects	Provide incentives in the form of public financing options

Figure 1: Recommendations for the Diversion of Commercial Food Waste in NYC

The report proposes a two-tiered food waste diversion mandate that could result in diverting 25 percent and 50 percent of the commercial food waste. Based on the data analysis, it was calculated that the waste generators that contribute to the top 25 percent of total food waste, produce 68 percent of the total food waste.

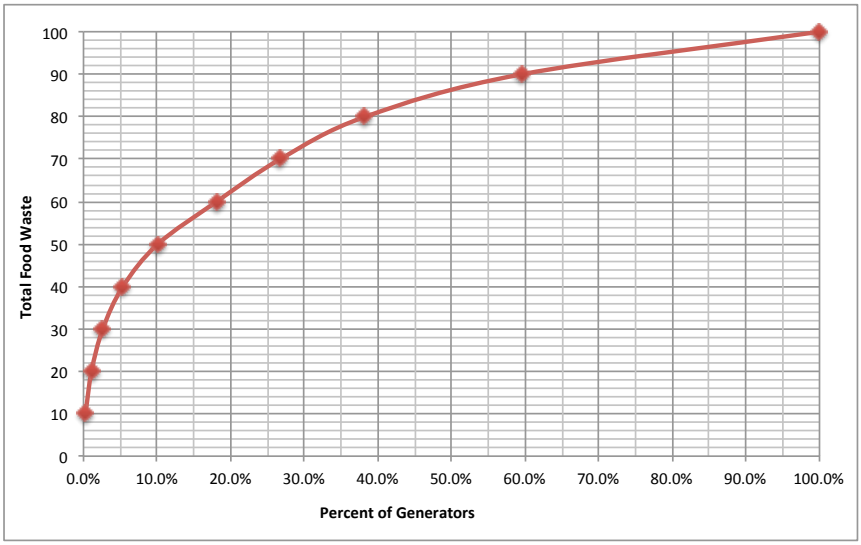


Figure 2: Food Waste Generation in New York City

Another recommendation is the implementation of a franchise system, which authorizes the city to further regulate commercial waste removal agreements, adjust the current pricing controls to lower food waste disposal rates, and ensure carters comply with a food waste diversion mandate along with commercial generators. As current processing infrastructure does not exist for the magnitude of food waste that could potentially be diverted, based on the proposed diversion mandates, this report also evaluates available technologies for processing food waste and provides recommendations on the technologies that could be selected to increase the food waste processing capacity of New York City.

1. Introduction

1.1 Background

This report was prepared at the request of the Bureau of Waste Prevention, Reuse, and Recycling (BWPRR),within the New York City Department of Sanitation (DSNY). This division is responsible for developing and implementing all of DSNY's recycling, composting, and waste prevention programs. The objective of this report was to conduct an assessment of the commercial organic waste generators within the five boroughs of New York City and to identify, quantify, and locate and visualize the main generators and the existing commercial organic waste market. .

This report also includes high-level recommendations and best practices to promote food waste diversion based on financial and logistical considerations. These recommendations are tailored towards meeting the objectives outlined in PlaNYC to divert 75 percent of its solid waste from landfills by 2030 ("PlaNYC 2030" 136).

1.2 Commercial Waste

1.2.1 Overview

Commercial waste is the waste generated by commercial business establishments such as restaurants, office buildings, and other commercial entities. In 2004, the Commercial Waste Management Study (CWMS) was conducted by the architectural and engineering firm of Henningson, Durham & Richardson to analyze commercial waste data collected during the 2002 and

2003 period. The study divided the commercial waste stream into two major categories: putrescible waste and non-putrescible waste. Putrescible waste is waste containing organic matter that has the tendency to decompose (Henningson, Durham & Richardson 5). This study included all the putrescible material from offices, retails, restaurants, food chains and any other business establishments that produced putrescible waste. Non-putrescible waste is waste that does not contain organic matter and that does not tend to form malodorous byproduct (Henningson, Durham & Richardson 5).

A large portion of New York City's food waste ends up in the same waste stream as non-recyclables. Some estimates indicate that less than 3 percent of the food waste produced in the United States is recovered (Global Green, "Food Waste"). With the exception of some isolated diversion initiatives between haulers and commercial entities, most organic waste ends its life cycle at a landfill.

1.2.2 Putrescible or Organic Waste

Putrescible waste, which is interchangeably used with organic waste, characterizes one of the many types of solid waste in the commercial waste stream. This type of waste contains organic matter that has a tendency to decompose and, thus, release leachate, produce biogas and malodorous sulfur byproducts under anaerobic conditions (Arsova Ljupka 6-10). Thus, the Environmental Protection Agency (EPA) suggests that waste reduction and recycling of organic waste can prevent greenhouse gases, reduce pollutants and conserve resources. Moreover, the diversion of organic waste could reduce the need for landfill facilities and save energy ("Resource Conservation – Food Waste"). This waste stream of putrescible waste is primarily collected from office buildings, hotel, manufacturers, retailers and food service establishments.

Food Waste

Definition: Food waste is a subset of putrescible, or organic waste, in the commercial waste stream that has a tendency to decompose and release biogas.

Because of the impact of food waste and the potential for diversion, for the purpose of this report, organic waste refers to food waste only.

1.2.3 Sustainability Challenge of Food Waste

According to the EPA, food waste is the most prevalent material disposed of in landfills ("Resource Conservation - Food Waste"). Landfills and livestock are the largest sources of methane emissions in the U.S due in large part to the organic waste that is disposed (Bracmort et al. 7). Thus, the environmental impact of reducing a ton of food waste from going to the landfill would be to reduce 4.2 tons of CO_2 equivalent from being generated (Humphries, "The Impact of Domestic Food Waste on Climate Change").

From a sustainability perspective, food waste is a significant contributor to climate change due to the release of greenhouse gas emissions (GHGs) in to the atmosphere. As shown in the study "The Climate Change and Economic Impacts of Food Waste in the United States" that was published in April 2012, food waste in the U.S. produces life cycle GHG emissions of at least 113 million metric tons of CO_2 on an annual basis or 2 percent of the current GHG national emission levels (Venkat 14). Research conducted by the University of Surrey in 2008 shows the contribution of food waste to the GHG emissions has both a minor and major impact. The decomposition of the food waste after disposal in landfills is a minor contributor to greenhouse gas emissions; however, the embedded emissions associated with the entire value chain of food are the major contributors to emissions (Garnett 71).

Moreover, the anaerobic biodegradation that occurs if food waste is disposed of in landfills is responsible for the uncontrolled release of methane into the atmosphere. According to the Intergovernmental Panel on Climate Change (IPCC), methane has a global warming potential 25 times higher than CO_2 over a 100 year time horizon and that, due to its embodied energy, could be easily captured and used for electricity production (Forster, et al. 212). The same report conservatively estimates that $200 billion of food is currently being wasted in the

U.S. or a per-capita value of $643.95 per year. Of that total value, it is estimated that $65 billion is within the food retail sector. There is a financial benefit to be gained by these commercial generators to reduce the amount of food waste (Venkat 2.0)

1.3 Food Waste As National Issue

In industrialized countries like the United States, more than 40 percent of the food losses occur at retail and consumer levels. And the amount of food wasted in the United States is on the rise; Americans waste 50 percent more food today than they did 30 years ago (Gunders 4). Based on the EPA's "Municipal Solid Waste in the United States" report from 2009, more than 34 million tons of food waste was generated in the United States, more than any other material category but paper.

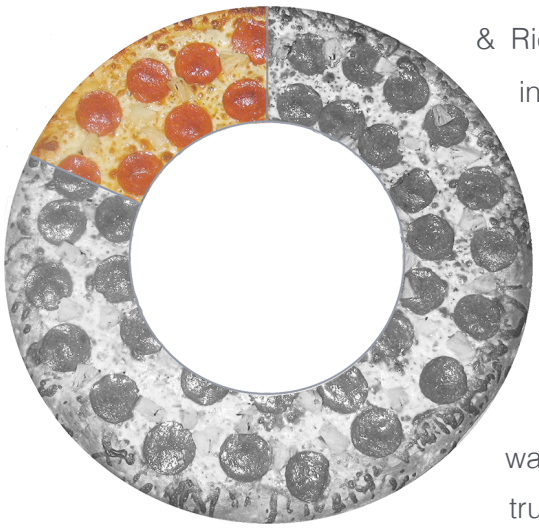
According to Natural Resources Defense Council's (NRDC) recent study "Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill " that was released in mid-2012, 40 percent of food in the United States is never eaten, amounting to $165 billion a year in waste (Gunders 4). The NRDC report investigated the complex causes of food losses at each level of the food supply chain in the U.S. to find opportunities to utilize the food system more efficiently.

Food waste is also responsible for multiple impacts, both on a national and local scale from an environmental, health and economical perspective. Although there is an opportunity to mitigate the negative impacts, while stimulating innovation and a new market, the issue of food waste needs to be managed (Venkat 2).

1.4 New York City Waste Issue

New York City's history can easily be outlined by its' waste production and the evolution of its waste management throughout the past decades. Since the beginning of the nineteenth century, with the first waste to energy plant located under the Williamsburg Bridge, to the opening of Fresh Kills landfill in 1947 as a temporary waste management solution, to the closing of Fresh Kills in 2001, dealing with New Yorkers' trash has always been a challenge (Stohr, "Incinerators").

According to NYC Statistics, New York City has over 200,000 businesses (Lucchesi). Based on data compiled by Trulia and using U.S. Census Data, New York City is considered to have the third highest restaurant density in the United States with a restaurant density of 25.3 per 10,000 households (Wilkey, "San Francisco Restaurants"). More than 50 million tourists visited the city in 2011 and frequented these establishments, including restaurants and accommodations ("NYC Tourism, Population, Climate and More"). The businesses, which include accommodation, food service, and the retail sector, discard around 1,920 tons of food waste per day (Henningson, Durham & Richardson 9). All these factors combined contribute to the increased complexity of the waste management problem and the immediate need for a multi-disciplinary approach for solutions that will reduce the amount of waste produced.



Commercial Waste: 10,380 Tons/Day
Source: Henningson, Durham & Richardson 2-4

The commercial food waste generators in New York City collectively dispose of approximately 600,000 tons of food annually ("PlaNYC 2030" 136-145). The vast majority of this waste is disposed of in landfills outside of New York City, the trucking of which contributes to GHG emissions, in addition to the degradation of the food waste itself which is also a source of methane. In support of the diversion goal of 75 percent of solid waste from landfills set forth by PlaNYC, food waste diversion is a necessary component.

1.5 Current Management Of Commercial Waste

A network of over 200 private carters registered with the Business Integrity Commission (BIC) handle the waste stream for private businesses in New York City. The disposal of commercial waste requires transportation to landfills and waste facilities outside of the boundaries of New York City at a cost of approximately $816 million each year ("Taxes in Garbage Out", 2). BIC has regulated private waste carters since the 1990s to remove the influence of organized crime in the industry and to lower the prices. BIC currently sets a price ceiling (or a "rate cap") for commercial series by weight and volume ranging from $127-$208 per ton ("Taxes in Garbage Out" 2).

1.5.1 Waste Haulers

Waste haulers, or private carters, include only those business licensed by BIC to collect and remove commercial waste. Traditionally, haulers negotiate with commercial generators to set rates for waste removal services that fall within the guidelines of the rate cap. In addition, 59 waste brokers have received licenses from BIC to facilitate waste removal agreements between generators of waste and private haulers (BIC "Trade Waste"). Due to the complexities of waste removal for larger companies to ensure compliance with local regulations, waste brokers have become increasing more popular to help commercial generators navigate the waste process.

BIC regulates private haulers in order to ensure that haulers negotiate fair prices with customers below the rate cap and do not engage in illegal and or violent practices that were commonplace when organized crime had a larger role in the waste trade industry.

The New York City chapter of the National Solid Wastes Management Association (NSWMA) is the primary organization that lobbies in the interests of private haulers. A subsidiary of Environmental Industry Associations, NSWMA represents haulers licensed by BIC, as well as transfer stations in New York City

(Biderman 1). Under the leadership of NSWMA, haulers have actively lobbied against proposals to lower the rate cap for food waste and oppose the rate cap's use for all types of waste. The lobbying efforts of the NSWMA have led to both the DSNY and BIC reviewing the rate cap and considering the possibility of its elimination or increase in late 2012 (NSWMA 1).

It is important to clarify that BIC is responsible for enforcing regulations imposed on haulers, while any regulations regarding commercial waste generators are enforced by DSNY. The specific responsibilities of BIC are further outlined in section 1.6.2 "Regulatory Environment around Licensing Haulers.

1.5.2 The Economics of Commercial Waste

In 2008 the national average landfill cost was $44 per ton, but the costs ranged widely across the different states ($68 in NJ to $32 in Ohio) based on land space and population density ("Taxes in, Garbage Out" 10). The New York City commercial putrescible transfer station tip fee is estimated to be $65-$80 per ton (de la Houssaye and White 2), which is one of the highest one in the country. Moreover, while the tipping fee costs include the handling of the waste at the transfer station, shipping it to landfill, and the landfill tip fee, it does not include the cost of collection, which can range between $38-$80 per ton (de la Houssaye and White 2). Therefore, while the price waste haulers can charge based on the rate cap is between $127-$208 per ton, the total cost of collection can range between $103-$160 per ton (de la Houssaye and White 2). The current cost structure results in economic incentives to ship out New York City waste as far as Pennsylvania and Virginia before dumping.

1.6 Legal And Regulatory Environment

1.6.1 Overview

New York City has developed distinct rules and regulations for municipal and commercial generators of waste. Municipal generators include residential households, public schools, city agencies, non-governmental organizations and farmers markets, whereas commercial generators include all private businesses including sport arenas within the five boroughs.

For the purposes of this analysis on organic waste diversion, the following discussion focuses on the regulatory environment surrounding commercial waste in New York City. To regulate commercial waste collection, several local laws have been added to the Administrative Code and complementary rules have been published in the official "Rules of the City of New York" (DSNY, "About Local, State, and Federal Legislation").

1.6.2 Regulatory Environment around Licensing Haulers

Local Law 42 of 1996 established the Trade Waste Commission (TWC) to regulate the private waste carting industry. TWC was responsible for overseeing the licensing of waste haulers and ensuring their compliance with the city's recycling laws (DSNY, "NYC Commercial Waste Removal Law"). This initiative to regulate privatized waste trade arose in response to the presence of organized crime that corrupted the waste industry with respect to prices imposed on commercial waste generators, limited transparency of the waste management industry, and public health concerns from undisclosed waste disposal practices. The rules approved in tandem with this legislation outlined expectations for the TWC on how to set price caps, criteria for classifying recyclable materials, collection, procedures, and reporting requirements for private haulers (DSNY, "NYC Commercial Waste Removal Law").

In 2002, Local Law 21 created the Business Integrity Commission (BIC), which replaced TWC as the regulatory body responsible for commercial waste removal (DSNY, "NYC Waste Commercial Removal Law"). BIC also became responsible for overseeing public wholesale markets, seafood distribution areas, and shipboard gambling in order to consolidate regulatory activities for all of these sectors under one agency (BIC, "About BIC").

BIC's primary responsibilities regarding the commercial waste services are to:

- License and register haulers and trade waste brokers.
- Investigate violations for regulatory infractions.
- Serve as an information clearinghouse for waste generators and haulers, including information on contract negotiations, hauler billing, distinguishing recyclables from non-recyclables, and the Customer's Bill of Rights (BIC, "Frequently Asked Questions").

Along with regulatory enforcement and communication, BIC plays a critical additional role setting the price ceiling, referred to as a "rate cap," for waste removal services. Currently, BIC allows haulers to charge either based on volume at $15.89 per cubic yard of loose refuse or based on weight at $10.42 per 100 pounds of refuse (BIC, "Frequently Asked Questions").

1.7 Current Processing

Through the 1980's, New York City utilized thousands of incinerators operated by the City and individual apartment buildings, as well as 89 city-owned landfills to dispose of the waste. By the mid-1990's incineration had stopped and all of the landfills, except Fresh Kills had been closed. This established the need for a complex system of transfer stations, transportation and landfills both in upstate New York and out of state for disposal of New York City's waste ("PlaNYC 2030" 136-145).

New York State is home to 26 active municipal solid waste landfills that receive approximately 7.7 million tons of waste each year (NYS DEC, "Municipal Solid Waste Landfills"). Municipal solid waste landfills accept residential, commercial and institutional waste. These landfills have approximately 220 million tons of capacity remaining, which means if waste disposal remains constant; the landfills have another 28.5 years until they are at capacity. However, the closest landfill to New York City is more than 150 miles away.

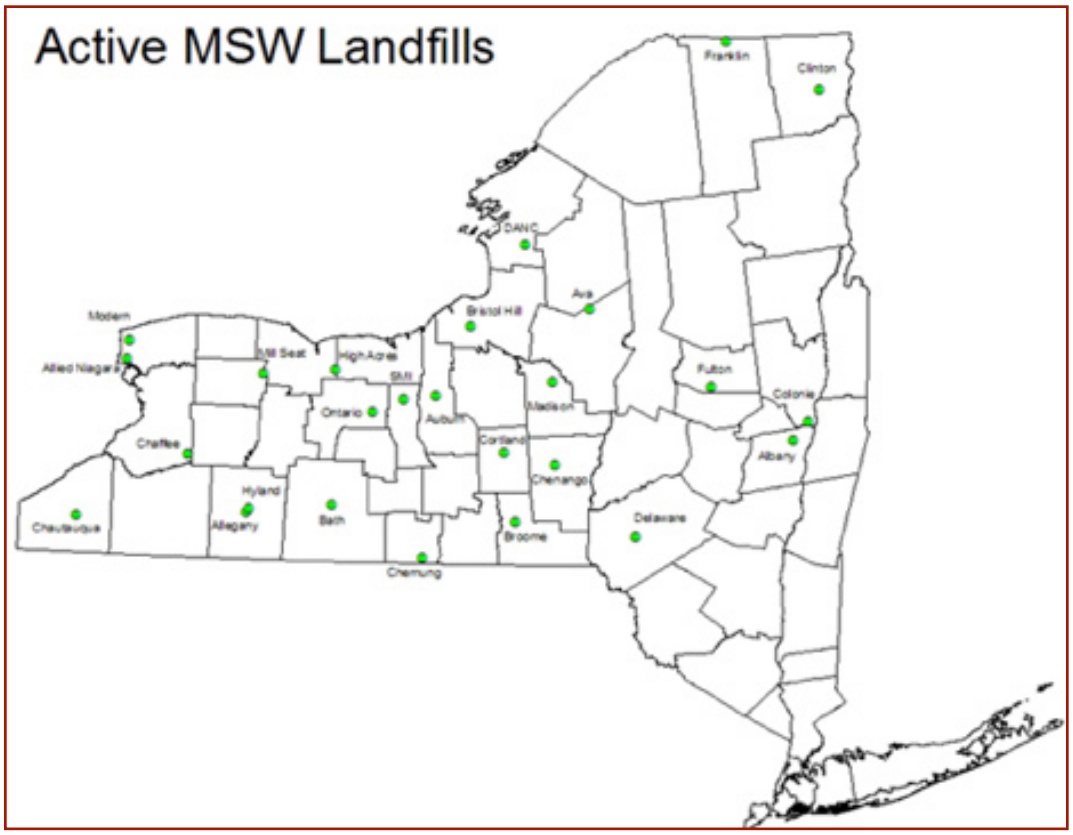


Figure 3: NYS Active Municipal Solid Waste Landfills

As of May 2012, the New York State Department of Environmental Conservation (NYS DEC) recorded 361 registered transfer stations and 168 regulated or permitted transfer stations. (NYS DEC, "Transfer Stations"). A registered transfer station accepts less than 12,500 tons of municipal waste per year. In 2010, these 361 registered transfer stations received approximately 907,000 tons of waste, whereas the 168 regulated transfer stations received approximately 9.9 million tons of solid waste (NYS DEC, "Transfer Stations". Within the NYS DEC Region that includes New York City and its boroughs, there

are currently twenty regulated transfer stations and one registered transfer station. The only transfer station in that group that currently accepts organic waste is the Waste Management transfer station in Brooklyn (NYS DEC, "Transfer Stations").

There are currently 63 compost facilities in New York State, but of that number only 3 accept food waste and the closest is more than 100 miles from New York City (NYS DEC "Composting of Organic Waste"). The other composting facilities accept primarily biosolids and yard waste. Proximity to New York City is a primary concern, but there is one composting facility for yard waste location in the Bronx, one composting facility in Nassau County, four composting facilities in Rockland County, five composting facilities in Suffolk County and three composting facilities in Westchester County (NYS DEC, "Composting of Organic Waste).

1.8 PlaNYC

In response to the growing challenge of waste, and other sustainability challenges in New York City, PlaNYC 2030 was created by the City's Office of Long-Term Planning and Sustainability (OLTPS). The visionary proposal that is seen to define Mayor Bloomberg's tenure, sets a 75 percent solid waste-diversion goal ("PlaNYC 2030" 136) to shrink the escalating expenses associated with waste disposal transportation and logistics and to improve the efficiency of waste disposal.

PlaNYC contains specific initiatives to make changes at every stage of the waste management system in the city. General initiatives are proposed to systemically and effectively reduce the amount of waste produced citywide and the amount of waste that is sent to landfills. In that respect, the City plans to expand opportunities to encourage commercial food waste recovery operations. The plan addresses the potential of converting food waste into a valuable resource for agricultural applications and energy generation ("PlaNYC 2030" 136-145).

More specifically, the City proposes the following actions to target commercial food waste:

- Pursue the establishment of an on-site organics recovery facility at the city-owned Hunts Point Food Distribution Center.
- Support the developing industry of using yellow grease, i.e. cooking oil, as a fuel for heating buildings in the city.
- Promote commercial organics recovery as part of the proposed business recognition and award program to encourage sustainable solid waste management practices.
- Evaluate the potential of pilot projects of new dewatering technologies to remove the water from food waste, and encourage businesses and institutions to adopt them ("PlaNYC 2030" 136-145).

According to PlaNYC every year restaurants, grocery stores, hospitals, hotels, sports arenas, educational and cultural institutions throw away approximately 600,000 tons of food waste, out of which only approximately 12,000 tons or 2 percent is sent to commercial processing facilities for composting and resource recovery ("PlaNYC 2030" 141). These 12,000 tons of food waste are recovered from generators including Yankee Stadium and Citi Field and processed in Peninsula located in Wilmington Delaware, which is more than 130 miles away from New York City. "The lack of commercial processing facilities in close proximity to the city poses a challenge to fostering the market for commercial food waste recovery" ("PlaNYC 2030" 142).

2. Methodology

2.1 Overview

The methodology for this report can be outlined through the following four main sections:

- Literature Review and Data Collection
- Analysis of Data
- Best Practices Assessment
- Development of Recommendations and conclusions

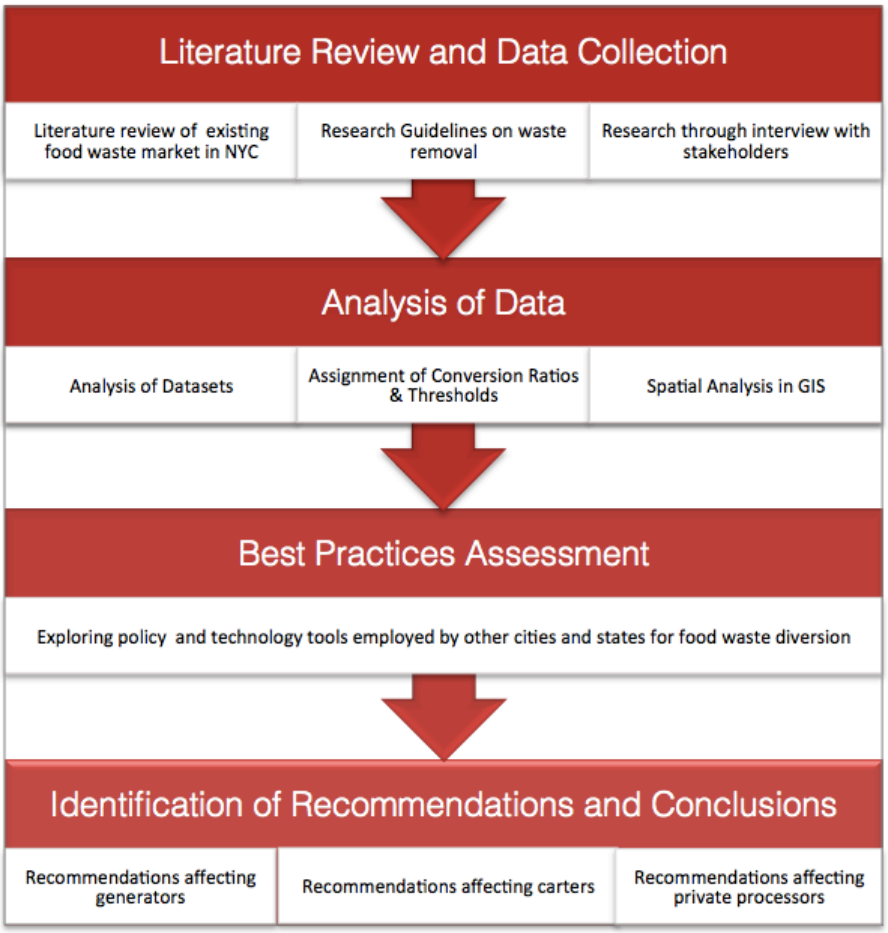


Figure 4: Methodology Overview

Literature Review and Data Collection

The existing commercial food waste market in New York City was reviewed through previous case studies and reports, as well as interviews with industry professionals, stakeholders and key waste generators. An analysis of government issued reports and private institutional studies was completed to identify the main stakeholders in the waste market. Research was conducted on the key regulations that have created laws and guidelines for commercial waste removal in New York City. Finally, a review and analysis of interview transcripts provided by DSNY was completed.

Analysis of Data

The datasets that were provided by DSNY were analyzed to identify, quantify and categorize the different food waste generators in New York City. After the generators were categorized, ratios that were developed through the analysis were applied to estimate the amount of food waste generated by each business category. Utilizing ArcGIS software to complete the spatial analysis of this data is the core of this report.

Best Practices Assessment

An assessment of policy tools, best practices and technological innovations was used to analyze what other cities and states are employing to promote food waste diversion practices. In this phase of the project, research was conducted on the different technologies available to divert food waste from landfills and the feasibility of these best practices in New York City.

Identification of Recommendations and Conclusions

Identification of appropriate recommendations was the final phase of this project. Recommendations were developed to target the main stakeholders impacted by food waste generation while also considering the impact of such recommendations. Next steps were also outline at the end of the report to assist the client in determining what additional data they could utilize, as well as the areas they should focus on to effectively divert food waste from landfills.

2.2 Stakeholder Analysis

When evaluating the current state of food waste generation and diversion, as well as the potential initiatives or recommendations for increased diversion, it is important to consider the impact to the various stakeholders involved. For the purpose of this report, the primary stakeholders consist of:

- New York City and the local waste regulating bodies
- Commercial Food Waste Generators
- Waste Haulers
- Landfills
- Food Waste Processors
- Waste Technology Companies
- Food Waste Experts

The stakeholders above the bar in the graphic below could potentially benefit from a change in the way food waste is disposed of or an increase in food waste diversion. The stakeholders below the bar could potentially perceive any change to the status quo in terms of policy changes or incentives for food waste diversion negatively.

Figure 5: Food Waste Stakeholders

The City of New York

The City of New York has the potential to benefit greatly from a food waste diversion program to establish a best practice for other cities around the United States. An initiative around food waste diversion would enhance the currently established sustainability-minded reputation of the city and generate additional support for PlaNYC and its objectives. Any initiative pursued would require the full support of the City for successful implementation. For the purposes of this stakeholder analysis, the New York City Department of Sanitation, the Mayor's Office of Long-Term Planning and Sustainability and the Business Integrity Commission are included as sub-groups of the City of New York.

The New York City Department of Sanitation (DSNY) – Bureau of Waste Prevention, Reuse and Recycling (BWPRR)

The BWPRR is responsible for developing and implementing all recycling, composting, and waste prevention programs. While DSNY is not responsible for the collection of commercial waste, DSNY would be a stakeholder as it relates to any potential mandate or incentive structure for food waste diversion, as well as the structuring of potential pilot programs. DSNY is responsible for enforcing commercial waste and recycling regulations. Additionally, DSNY is responsible for the education of the general public as it relates to recycling, composting and waste reduction (DSNY, "Refuse Collection"). For preexisting waste types that are designated as recyclable materials, DSNY is authorized to enforce the NYC Commercial Recycling Law, which includes financial penalties for commercial generators that fail to comply ("NYC Business Recycling: Enforcement and Penalties"). If a food waste diversion mandate were established, commercial generators would face new recycling requirements. In turn, DSNY would have additional regulations to enforce for commercial generators, inspections to carry out to ensure food waste is properly sorted into separate bins, and penalties to issue for noncompliant generators.

The Mayor's Office of Long-Term Planning and Sustainability (OLTPS)

The OLTPS released the PlaNYC proposal and is responsible for coordinating with all other city agencies on the progress of the plan. Additionally, one aspect of OLTPS's mission is to integrate sustainable practices into the goals of agencies throughout the city, as well as the lives of the residents of New York ("Who We Are"). PlaNYC established a goal to divert 75 percent of solid waste from landfills ("PlaNYC 2030" 138). Creating a policy or an incentive for significant food waste generators to divert their food waste from the landfill would be directly aligned with the greater goal of solid waste diversion. Therefore, OLTPS would be a critical stakeholder that would support any proposed initiative for waste diversion.

Business Integrity Commission (BIC)

As discussed, BIC is responsible for the licensing and registration of all commercial haulers and trade waste brokers, along with monitoring the waste removal sector for illegal activities and the presence of organized crime (BIC, "Frequently Asked Questions"). BIC would benefit from a food waste mandate or incentive in that it would generate more of a market for food waste processing, and therefore, hauling. If a diversion mandate were created, the agency would be responsible for ensuring generators achieve compliance with the mandate, while continuing to enforce preexisting regulations for trade waste, wholesale markets, and shipboard gambling.

Food Waste Generators

Food Waste Generators consist of any commercial entity in the city of New York that generate a commercial waste stream that would include food scraps. This is a key stakeholder group as they would be the group that was responsible for the separation of food scraps from the rest of the waste stream for diversion from the landfill. This would require increased training, communications and a behavioral change to ensure the separation and handling of such materials was a sustainable change. It would be important to consider that these generators vary in size and volume of waste generation and initiatives should be scaled appropriately to not overburden smaller generators with the additional resources

required. Any initiative pursued would only be effective with the support of these generators.

Waste Haulers

The Waste Haulers stakeholder group consists of all haulers currently licensed to haul commercial waste in New York City. This stakeholder group would be greatly impacted by any potential change to the existing disposal method of the food waste currently generated by a significant number of their clients. Because waste haulers charge customers by the weight of the materials hauled, reducing that weight by removing the food scraps, which are notoriously heavy because of the moisture content, would reduce the revenue a waste hauler currently generates from a customer.

However, the early adopters already licensed to haul food waste could benefit from an increase in food waste diversion and the potential to increase the number of customers on the route. Route density is critical in the current state of food waste diversion to balance the costs to the hauler for the logistics and resources and increasing customers positively impacts that (Klockau, "Impact of Food Waste on Haulers").

Landfills

While PlaNYC and its objectives are explicit in the goal for reduction of solid waste being sent to landfills, but they are still considered a stakeholder to the process as the majority of food waste currently ends up there. Landfills, like waste haulers, benefit from food waste being a heavy material as they are paid by the ton of waste disposed of at the location. As of 2001 when Fresh Kills landfill closed, the city no longer has any operational landfill within its boroughs and therefore the transport and cost of disposal is a significant portion of the costs associated with disposal. When analyzing the DSNY budget, the expense of transportation and charges by landfill operators is the second highest budget item – almost $300 million ("Taxes In, Garbage Out" 8). Additionally, the EPA estimates that about two-thirds of all landfills capture their significant methane release in the form of waste-to energy projects and therefore reduce the amount

of other fuel sources required ("Taxes In, Garbage Out" 13-14). While this does decrease the impact of methane on the environment, this also reduces the expense required to operate the landfill. While methane release can continue for as long as 60 years after disposal, landfills could see a decrease in this waste stream as a potential for increased expense in the future ("Taxes In, Garbage Out" 13-14). Landfills as a stakeholder group likely would view food waste diversion as having a negative impact to their revenue and therefore would not be in support of such an initiative.

Food Waste Processors

Food Waste Processors is a group of stakeholders who have a significant opportunity to benefit from a potential initiative for food waste diversion. This group includes composting facilities, both large and small scale, as well as anaerobic digestion (AD) facilities. Many of the more advanced technologies, like anaerobic digestion, require a constant stream of food waste not only to operate, but also to be financially viable (Ostrem 15). One such processor that would benefit from an increase in food waste diversion is Peninsula Compost Group in Wilmington, Delaware. Peninsula can accept 160,000 tons of food waste annually and is currently the only facility with the capacity to handle large volumes of commercial waste in the proximity of New York City ("Wilmington Organic Recycling Center"). If such an initiative was created, there would be an incentive for additional Food Waste Processors to enter the market in the New York City region. Any initiative which increased the diversion of food waste to processors like these would benefit this stakeholder.

Waste Technology Companies

Waste Technology Companies is another group of stakeholders who have a significant opportunity to benefit from a potential initiative for food waste diversion. Because waste generators range in scale and volume of food waste generated, a range of technologies will be required to meet the needs of different types of generators. Technologies to process food waste will become more critical and the companies that already have a patented solution will have an advantage in the market. The increased demand for technology and

processing will also generate innovation in the market and potentially yield the introduction of new products or technologies.

Waste Experts & Others

Waste Experts is a stakeholder group that includes waste brokers and waste consultants. If an initiative on food waste diversion was introduced in New York City, this stakeholder group would benefit. Many food waste generators in the city would require assistance to better understand their waste stream and to implement a source separation program. Because currently this market is relatively small as compared to the amount of food waste generated, there is a lack of knowledge and expertise in this field. Those companies that can provide a service to help generators navigate the process to meet whatever initiative is proposed will be a required commodity.

2.3 Data Analysis Methodology

The commercial waste market has been analyzed by multiple independent consultants through the collection and synthesis of data on the amount of waste generated within New York City. For the purpose of this report, two datasets were provided by DSNY.

The first dataset was collected by InfoUSA (InfoUSA, 2012) in 2010 for marketing purposes and re-mapped and organized in a database of private businesses classified by the North American Industry Classification System (NAICS) by Halcrow. The data was developed to support the New York City Commercial Waste System Analysis and Study, including detailed data on business attributes. Location, contacts, size, type and number of employees were collected for each establishment. Business locations were mapped to provide geographic context, enabling spatial analysis and facilitating data visualization.

The second source of data was the BIC Customer Registry dataset (NYC Business Integrity Commission, 2012), which included approximately 138,000 businesses classified by type using an internal categorization method that differs from the standardized NAICS coding system. This dataset was also collected in support of the New York City Commercial Waste System Analysis and Study and tracks the amount of putrescible commercial waste disposed of by clusters of establishments and spatially aggregates the waste. It should be noted that the amount of putrescible waste reported in this dataset does not match other analyses available for New York City as a total or for each borough. The difference in the amount of waste reported made it somewhat difficult to define a proper conversion ratio between total putrescible waste and food waste specifically, and to identify a method applicable across the entire dataset to link waste generators and pickup locations in the city.

Both sets of data were analyzed to evaluate the type and the quality of the information contained, and to determine which source of data would better serve the purpose of a spatial analysis of the food waste generation in the five boroughs of New York City. The BIC database has been discarded as a basis for the spatial analysis for the following reasons:

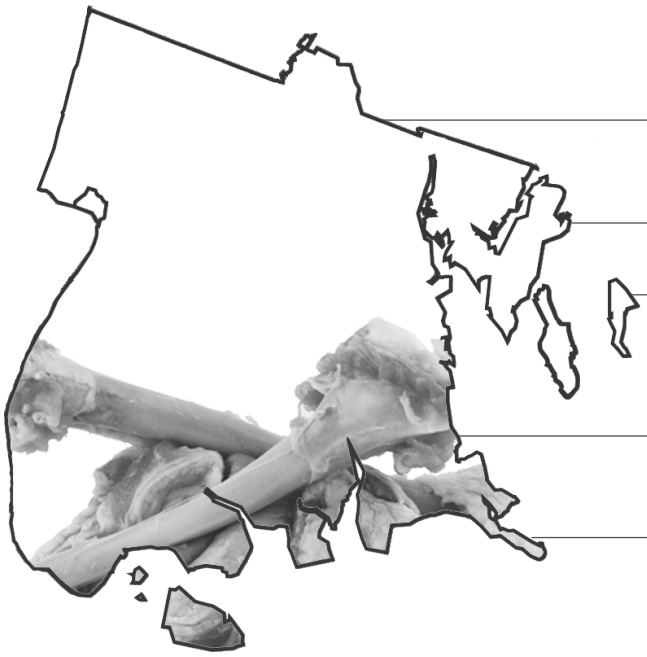
- A lack of strict correlation between putrescible waste and food waste;
- The total amount of Waste reported does not match with the expected generation based on PlaNYC and the Commercial Waste Management Study commissioned in 2004 by the Department of Sanitation;
- The waste reported is spatially aggregated and, thus, a statistical analysis is required to properly link the generators and the total amount of waste generated.

The following studies have been analyzed to determine the most appropriate methodology for food waste generation within the 5 boroughs:

- Commercial Waste Management Study (CWMS), Volume II from 2004;
- New York City Commercial Waste System Analysis and Study, Literature-Based Disposed Waste (LDW) Model from 2012;

Generator Categories

For the purpose of this report, and to align the result with the standardized system used in the InfoUSA database, the business categories included in this report comply with the North American Industry Classification System (NAICS). Based on each industry description, the final business categories considered are: Accommodation & Food Services, Retail Trade, Wholesale, Manufacturing, Healthcare & Social Service.



Industry Categories	NAICS Classification
Accommodation & Food Service	72
Accommodation	721
Food Service and Drinking place	722
Retail trade	44
Food and Beverage Store	445
Wholesale	42
Groceries & related	4244
Farm product	4245
Beer, Wine an alcoholic beverage	4248
Manufacturing	31
Food manufacturing	311
Beverage	312
Healthcare & Social Assistance	62
Hospitals	622
Nursing and Residential Care Facilities	623
Social Assistance	624

Figure 6: NAICS Classification Categories

The Accommodation & Food Services category (NAICS 72) is comprised of establishments providing customers with lodging and/or food, snacks and drink for immediate consumptions. The sector includes both accommodation and food services, since these two activities are often combined within the same establishment. For the purposes of this analysis, the two categories were separated given the nature of the food service industry in New York City.

The Retail Food category (NAICS 44) is comprised of establishments engaged in retailing merchandise, generally without transformation ("Industries

at a Glance"). This category includes retail food and beverages merchandise from fixed point-of-sale locations. Food street vendors are not included in this category ("Industries at a Glance"). More specifically, the only sub-category included was 4451 for grocery stores and supermarkets. Specialty food stores and liquor stores (4452 and 4453) were not considered due to the negligible amount of food waste produced.

The Wholesale Trade category (NAICS 42) is comprised of establishments engaged in wholesaling merchandise, generally without transformation ("Industries at a Glance"). Wholesalers are organized to sell or arrange the purchase or sale of goods for resale. In this case the analysis includes two subcategories under the non-durable goods category: Groceries and Related Product Wholesalers (4244) and Farm Product Raw Material Merchant Wholesalers (4245).

The Manufacturing category (NAICS 31) includes the Food Manufacturing category (code 311) and the Beverage and Tobacco Manufacturing category (312). It is important to note that according to the Census Bureau, there are currently no manufactory establishments actively operating within the tobacco sector within any of New York City's five boroughs (U.S. Census Bureau, "Introduction to NAICS").

The final major category was Healthcare and Social Service (NAICS 62), which includes establishments providing healthcare and social services for individuals (15). The generators included are Hospitals (NAICS 622), Nursing and Residential Care Facilities (NAICS 623) and Social Assistance (NAICS 624).

Commercial Waste Management Study Methodology

This study included a complete evaluation of the 2002, 2003 and future commercial waste production in New York City. Commissioned in 2004, the engineering firm of Henningson, Durham & Richardson analyzed the waste generations in New York City and the collection of waste by private waste haulers.

The initial setback of this methodology was that the study used commercial business categories that were not directly linked with the standardized NAICS system. Thus, there was no strict correlation between the methodology and the InfoUSA database that has been used to identify each establishment in New York City.

The absence of the standardized categorization system was overcome by limiting the scope of the study to the top five food waste generator categories identified by the author; the final categories included in the present analysis and responsible for almost 85 percent of the total commercial food waste production, are:

- Accommodation & Food Services
- Retail Trade
- Wholesale Nondurable Goods
- Manufacturing
- Healthcare & Social Service

Lastly, this study determines the total amount of waste by type and per business category through an employment-based model, as detailed below:

- The CWMS methodology provided an estimate of the total amount of food waste generated by each of the categories identified, and the number of employees was used to generate the total tonnage per year.
- For the purpose of the present study the average ratios have been determined by dividing the total food waste generated for a specific category by the total number of employee included in this study.
- To increase the accuracy of the factors identified, a subcategory of employee was used for business categories that are not exclusively food waste related, since the number of employee reported for Wholesale Trade, Retail Trade and Manufacturing were not representative of solely food-related establishments.

- The ratios for these categories haves been then adjusted by dividing the total food waste generated for that category by the number of employees correctly reflecting the business subcategories that are generating food waste. A second adjustment has been introduced for the accommodation and food services categories to reflect more accurately the difference between the two subcategories (NAICS code 721 and 722): the accommodation ratio in the current analysis is 50 percent of the food service ratio. The absence of previous studies or methodologies that assess the ratio discrepancy between the food services subcategory and the accommodation subcategory resulted in creating a 50 percent reduction for the latter subcategory (NAICS code 721) and introducing it to reflect the difference in employee counts among the two subcategories.

- It should be noted that since the data analysis methodology for this report only took into account the number of employees in each business establishment, this methodology might not accurately represent all business categories in New York City. For instance, the number of beds in hospitals was not taken into account when estimating the total amount of food waste produced in Hospitals (NAICS 622), Nursing and Residential Care Facilities (NAICS 623) and Social Assistance (NAICS 624). This aspect may influence the amount of waste produced by these generators.

Literature Disposal Waste Model (LDW)

DSNY provided a second Commercial Waste Analysis authored by Halcrow Engineers, with a model that has been developed for the commercial putrescible waste stream in New York City and it is based on the CWMS methodology. This model introduces a statistical analysis of the current waste stream and reports the total amount of waste disposed per business categories and selected geographies.

For the purpose of the present study the average ratios have been determined by dividing the total food waste disposed of for a specific category by the total number of employee included in this study; the ratios from this study

were not adjusted due to the similarity between the two methodologies and to show the difference between the adjusted ratios and the non-adjusted ratios.

The Data Analysis Approach

The first revision of the InfoUSA database contained more than 300,000 businesses divided accordingly with the NAICS system. Also, the database included over 20 characteristics per business. Therefore, for the purpose of this report, the database was filtered down to accommodate exclusively the stakeholders (or business type) that were identified as food waste generators and could be linked with the categories used in the CWMS methodology. The final revision of the database, based on the InfoUSA dataset, included more than 37,000 establishments and was used to spatially analyze the establishments that are food waste related.

Finally, a manual revision of the entire database has been performed to assess the establishments included and to ensure the overall quality of this dataset, by removing any outlier establishments that could bias the final result and the spatial analysis. The establishments that were manually removed include mostly headquarters of businesses, since they account for the total number of employees of the business; also miss-localized and miss-categorized establishments were removed. This process affected less than 1 percent of the total number of businesses and less than 5 percent of the total food waste generated on an annual basis across the five boroughs.

The amount of food waste generated by each of these 37,000 establishments was thus determined by applying the ratios for each methodology,, to each establishment and by multiplying it by the number of employees reported in the cleaned InfoUSA database; both the ratios have been applied to ensure the quality of the findings and to evaluate the consistency of the adjusted ratios derived from the CWMS methodology. The two methodologies provided overall similar results in terms of total amount of food waste produced within the City; notable differences could be seen in each borough because of the relative impact of certain categories that have been affected by the ratio adjustment for

the CWMS methodology: by adjusting these ratios, the food waste production for categories such as Wholesale has been narrowed down to more specific subcategories and, thus, census track. A more in depth analysis is provided for each borough in their respective section. The following table includes the total number of establishments included in the analysis, divided by NAICS categories level 2, 3 and 4, and the two set of ratios identified.

The total sales per establishments included in the InfoUSA dataset were not considered since its value is linearly correlated to the number of employees and the specific NAICS category by an internal factor.

Classification Code				InfoUSA database Aggregate					CWMS	CWGM
BIC - CWMS	NAICS		Descprition	Establishment number			Employee total	Employee Average	FoodWaste	FoodWaste
Man. Food	31	3111	Animal Food Manufacturing	3	1532	1578	9	3.0	1.85	0.168
		3112	Flour Milling	6			30	5.0	1.85	0.168
		3113	Confectionery Mfg From Purchased Chocolate	42			1691	40.3	1.85	0.168
		3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	20			910	45.5	1.85	0.168
		3115	Dairy Product Manufacturing	18			197	10.9	1.85	0.168
		3116	Animal Slaughtering and Processing	72			1293	18.0	1.85	0.168
		3117	Seafood Product Preparation and Packaging	25			1252	50.1	1.85	0.168
		3118	Bakeries and Tortilla Manufacturing	1251			10145	8.1	1.85	0.168
		3119	Other Food Manufacturing	95			1847	19.4	1.85	0.168
Man. Beverage	31	3121	Beverage Manufacturing	46	46		1750	38.0	1.85	0.168
		3122	Tobacco Manufacturing	0			0	0.0	1.85	0.168
Retail Food	44	4451	Supermarkets and Other Grocery (except Convenience) Stores	5386	9184	9184	38836	7.2	2.03	0.271
		4452	Specialty food Store	2611			14456	5.5	2.03	0.271
		4453	Beer, Wine, and Liquor Stores	1187			4461	3.8	2.03	0.271
Wholesalers, Nondurable Goods	42	4244	Grocery and Related Product Merchant Wholesalers	1645	1735	1735	17006	10.3	2.06	0.379
		4245	Farm Product Raw Material Merchant Wholesalers	8			71	8.9	2.06	0.379
		4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers	82			3153	38.5	2.06	0.379
Health Care	62	6221	General Medical and Surgical Hospitals	104	505	1255	64849	623.5	0.09	0.119
		6222	Psychiatric and Substance Abuse Hospitals	381			13504	35.4	0.09	0.119
		6223	Specialty Hospitals	20			8866	443.3	0.09	0.119
	62	6231	Nursing Care Facilities	248	750		37209	150.0	0.09	0.119
		6233	Homes for the Elderly	344			9859	28.7	0.09	0.119
		6239	Other Residential Care Facilities	158			2456	15.5	0.09	0.119
Accomodation	72	7211	Traveler Accommodation	831	967	23633	56104	67.5	0.63	1.306
		7212	Recreational and Vacation Camps	97			1670	17.2	0.63	1.306
		7213	Rooming and Boarding Houses	39			413	10.6	0.63	1.306
Food Service	72	7221	Full-Service Restaurants	15325	22666		191676	12.5	1.26	1.306
		7222	Limited-Service Restaurants	4880			28901	5.9	1.26	1.306
		7223	Food Service Contractors	1236			14847	12.0	1.26	1.306
		7224	Drinking Places (Alcoholic Beverages)	1225			8739	7.1	1.26	1.306

Figure 7: Commercial Food Waste Establishments and Corresponding Ratio by Methodology

2.4 GIS Technology

As part of the analysis, the client requested the creation of maps to locate and analyze the distribution of waste generators in New York City. Utilizing the methodology and ratios described above, the annual total commercial food waste per generator was calculated and then spatially analyzed in ArcGIS.

A series of maps were created in which annual food waste concentrations were aggregated by 2000 New York City census tract. Using graduated colors, the waste concentrations were broken into fifteen classes ranging from 0 to 4,500+ tons of food waste generated per year. This was performed for all generators as well as each of the seven business categories analyzed: Manufacturing of Food, Manufacturing of Beverages, Accommodation, Food Services, Retail Food, Healthcare and Social Services, and Wholesalers of Non-durable Goods. These maps were intended to visualize the regions with the highest density of food waste; waste was taken over a predefined area rather than continuously.

While importing the data into ArcGIS was relatively seamless, there were some challenges while manipulating this data to visually represent and reflect the diversity of the dataset. One of the main challenges encountered in the GIS process was the inconsistency of the datasets themselves. While all of the InfoUSA data was correctly categorized by census tract, a very small percentage of the geolocations on the map were not entirely precise. This was corrected for by aggregating data by census tract and numerous quality control checks for accuracy and consistency in its representation.

2.5 Benchmarking

2.5.1 Overview

Two types of policy tools that have been employed at the state and municipal level to divert food waste from landfills are mandates and incentives. In studying the states and cities that have employed these policy tools, an analysis was conducted to understand the applicability for New York City. For food diversion mandates, the focus was primarily on two states and one city that recently passed waste diversion mandates: Connecticut, Massachusetts, and San Francisco. For pricing incentives the best practices analyzed were from Seattle, San Francisco, and Los Angeles.

2.5.2 Mandates

Mandates serve as a command and control mechanism wherein thresholds are established at the state or city level requiring an action.

Connecticut

Connecticut 's Public Act 11-127, passed in 2011, requires commercial generators of food waste that generate at least 104 tons per year (approximately 2 tons per week) to separate and recycle organic material (Duva, "Recycling means business: Connecticut signals food scrap recycling facilities are welcome"). The law applies to large-scale businesses, specifically:

- Commercial food wholesalers or distributors
- Industrial food manufacturers or processors
- Supermarkets (large stores, typically with 69 employees or more)
- Resorts and conference centers

The diversion mandate seeks to create incentives for both commercial waste generators and waste processing companies. The law provides that a commercial food waste generator is not required to divert their food scrap if there is not a recycling facility within 20 miles of the generator (Duva, "Recycling means business: Connecticut signals food scrap recycling facilities are welcome"). This provision addresses the infrastructure challenges that might result in non-compliance.

In fact, the Public Act 11-127 states that "establishment of service in the state by two or more permitted source-separated organic material compositing facilities" need to be in place at least six months before these large generators are required to separate food waste. In addition, the mandate seeks to make recycling food waste a simple economic decision for generators since Connecticut has one of the highest tipping fees in the country with $60-$65 per ton (CRRA Trash disposal fees).

Once the recycling facilities are in operation, the fee charged by food waste recyclers is expected to be lower than the fees charged by resource recovery facilities and landfills (Duva, "Recycling means business: Connecticut signals food scrap recycling facilities are welcome"). Moreover, this policy aims to attract composting, anaerobic digestion, and other food waste processing companies to site facilities in Connecticut by providing a growing and guaranteed supply of food waste in order to operate (Duva, "Recycling means business: Connecticut signals food scrap recycling facilities are welcome").

Massachusetts

At the beginning of 2013, Massachusetts will have a draft regulation mandating a ban for hospitals, universities, hotels, large restaurants and other big businesses and institutions that generate more than one ton per week of food waste (or 52 tons per year) from discarding food waste in the trash. Massachusetts disposes of 1.5 million of organic food waste annually, of which only 100,000 tons are currently composted. The Massachusetts DEP's goal is for an additional 350,000 tons of organic food waste to be diverted from landfills for

a total of 450,000 tons per year by 2020 (Abel, “Commercial Food Waste to be Banned or 30 percent diversion goal”).

State officials envision a new, parallel waste system that would have its own transportation network to deliver the organic waste, which includes refuse such as weeds and manure to a host of anaerobic digesters (Abel, “Commercial Food Waste to be Banned or 30 percent diversion goal”). Those plants, one of which already exists on a farm in Rutland, convert methane from degraded food into power that feeds into the region’s electrical grid. When the regulations take effect, state officials hope to begin diverting the 350,000 tons to new or expanded plants built on public land by private companies.

Massachusetts is passing the mandate as a response to the high waste disposal rates associated with limited landfill capacity. Massachusetts has the highest solid waste disposal rates in the country – between $60 and $90 a ton, compared with a national average of about $45 a ton, and fees will continue to rise as landfill capacity declines. Given the difficulties of issuing permits for a new site, no new landfills are planned requiring the state to divert organic food waste (Abel, “Commercial Food Waste to be Banned or 30 percent diversion goal”). Once the parallel system for food waste diversion envisioned by State officials is in place, it will provide an economic incentive for businesses to lower their waste disposal costs. In fact, half of the 600 supermarkets in the state already divert their food waste from landfills as a way to reduce their waste disposal costs (Abel, “Commercial Food Waste to be Banned or 30 percent diversion goal”).

San Francisco

Mandatory Recycling and Composting Ordinance (No. 100-09) is a local municipal ordinance requiring all persons and businesses located in San Francisco to separate their recyclables, compostables and landfilled trash and to participate in recycling and composting programs. Commercial and residential generators must separate their waste in three types of trash receptacles, including one for recycling, one for composting, and one for landfill waste ("Mandatory Recycling and Composting Ordinance Fact Sheet"). In 2009, this became the first ordinance in the United States mandating source separation of food scraps for composting collection, requiring participation by everyone, including property managers setting up programs for tenants (Sullivan, "Food Waste Critical To San Francisco's High Diversion").

In October of 2012, Mayor Ed Lee announced that the City of San Francisco is diverting 80 percent of all waste from landfills (CBS News, "San Francisco Reports 80 Waste Diversion Rate"). The City has a set a goal to become zero waste by 2020, meaning that no waste goes to landfills or incinerators by reducing, reusing, recycling and composting (CBS News, "San Francisco Reports 80 Waste Diversion Rate").

2.5.3 Economic Incentives

Pricing incentives serve as a market-based mechanism to incentivize generators of waste to separate their food waste from the landfill waste stream and to participate in organic waste collection programs. Seattle, Washington's pricing incentive utilized such a policy to shift generators' material handling procedures of organic waste. In addition, to incentivize haulers for carting heavier commercial food waste, the City of Los Angeles implemented a franchise system, which has proven successful to keep the market competitive even for smaller haulers.

Seattle

Although food waste is not banned from the regular waste stream, the City incentivizes its commercial generators to separate food waste through lower disposal rates. The rates for commercial compost collection are generally 32 percent less than regular garbage pickup. However, rates depend on the type and size of container, pick-up frequency, and whether the material is compacted (City of Seattle, "Commercial Customers").

The City provides commercial generators the option of participating in the compost program using City waste haulers or a private hauler of the generator's choice. Seattle is also providing outreach and education to educate commercial generators and residents on the benefit of food waste diversion and market for compost using the Seattle Public Utilities' Resource Venture (City of Seattle, "Commercial Customers").

The city of Seattle also has an exclusive franchise system that includes more than one hauler, and requires all sorted food waste be charged 32 percent less than other types of waste (City of Seattle, "Commercial Customers").

San Francisco

The City has a franchise system with a single private hauler, Recology, to manage all of the city's waste and provide an incentive laden rate structure that encourages businesses to sort and recycle their food waste. Specifically, businesses pay Recology based on the volume and type of trash thrown away such that businesses can save a maximum of 75 percent of their variable waste disposal charges for sorting 100 percent of their food waste (San Francisco Department of the Environment, "Understanding your Recology Bill").

According to the Recology website, many restaurants are composting over 75 percent of their waste, which translates into 75 percent discounts off the restaurant's garbage bill for recycling and composting. Recology provides customers with either 32 or 64-gallon bright green, leak proof bins on wheels, in addition to free multi-lingual training to staff and easy to follow signs and posters.

Los Angeles

Waste haulers in Los Angeles County pay a franchise fee for earning a waste removal contract. In Los Angeles it is equivalent to 10 percent of annual revenue for each carter. This “fee” can used to provide a tax revenue base to rebate carters hauling heavier food waste with higher costs when the city underprices the disposal rate for food waste. Haulers carting less than 1,000 tons per year are exempt from the fee to limit impact on smaller haulers (City of Los Angeles Department of Sanitation, “Food Waste Diversion”). While a franchise system is not enforced yet in Los Angeles, in San Jose, CA the franchise system is already in place with a similar fee that can be used for such rebate programs (HF&H Consultants 22).

3. Spatial Analysis of Food Waste in NYC

3.1 Overview

One of the main objectives of this report was to identify, quantify and categorize the different commercial food waste generators in New York City. The following sections illustrate the major generators by business category, as well as by borough.

3. 2 Takeaways

The following points outline the major takeaways from the spatial analysis.

CWMS Methodology

- Staten Island produces the lowest amount of food waste in New York City, roughly 4 percent of the total annual food waste.
- The total food waste produced by Manhattan is approximately equal to the amount of food waste generated by the four other boroughs combined.
- The Food Service business category is the largest food waste generator in all of the boroughs, comprising 63 percent of the total food waste, followed by the Retail Food Category contributing 19 percent.
- The Manufacturing of Beverage business category is the smallest food waste generator in each borough as it comprises only 0.4 percent of the total number of food waste generators.
- Due to the high concentration of Food Service and Accommodation business establishments in midtown Manhattan associated with tourist destinations, food waste generation is higher there than other areas of the city. Over half of all Food Service generators are located in Manhattan.

- The food waste generated by the Retail Food business category is fairly evenly distributed among the three highest generating boroughs: Manhattan, Brooklyn and Queens due in part to the presence of delis and corner stores in residential areas in these boroughs.

LDW Methodology

- Staten Island produces the lowest amount of food waste in New York City, roughly 3 percent of the total annual food waste.
- The total food waste produced by Manhattan is slightly greater than to the amount of food waste generated by the four other boroughs combined, at 58 percent of the total food waste.
- The Food Service business category is the largest food waste generator in all of the boroughs, comprising 73 percent of the total food waste, followed by the Accommodation category at 17 percent.
- The Manufacturing of Beverage business category is the smallest food waste generator in each borough as it comprises only 0.7 percent of the total number of commercial generators.
- Due to the high concentration of Food Service and Accommodation business establishments in midtown Manhattan associated with tourist destinations, food waste generation is higher there than other areas of the city.
- Hunts Point in The Bronx also proved to be a large source of food waste, including 936 generators.

3.3 Analysis of Generator by Business Category

3.3.1 Overview

The following maps illustrate the distribution of food waste aggregated by census tract for all commercial business categories. The maps below were created using the CWMS methodology and the LDW methodology for food waste. There are a total of 37,385 commercial food waste generators in NYC producing 487,158.17 tons of food waste per year based on the CWMS methodology or 437,770.21 tons per year based on the LDW methodology. The majority of the food waste is concentrated in midtown Manhattan, with additional regions of high generation in high producing areas such as the Hunts Point food distribution facility in the South Bronx.

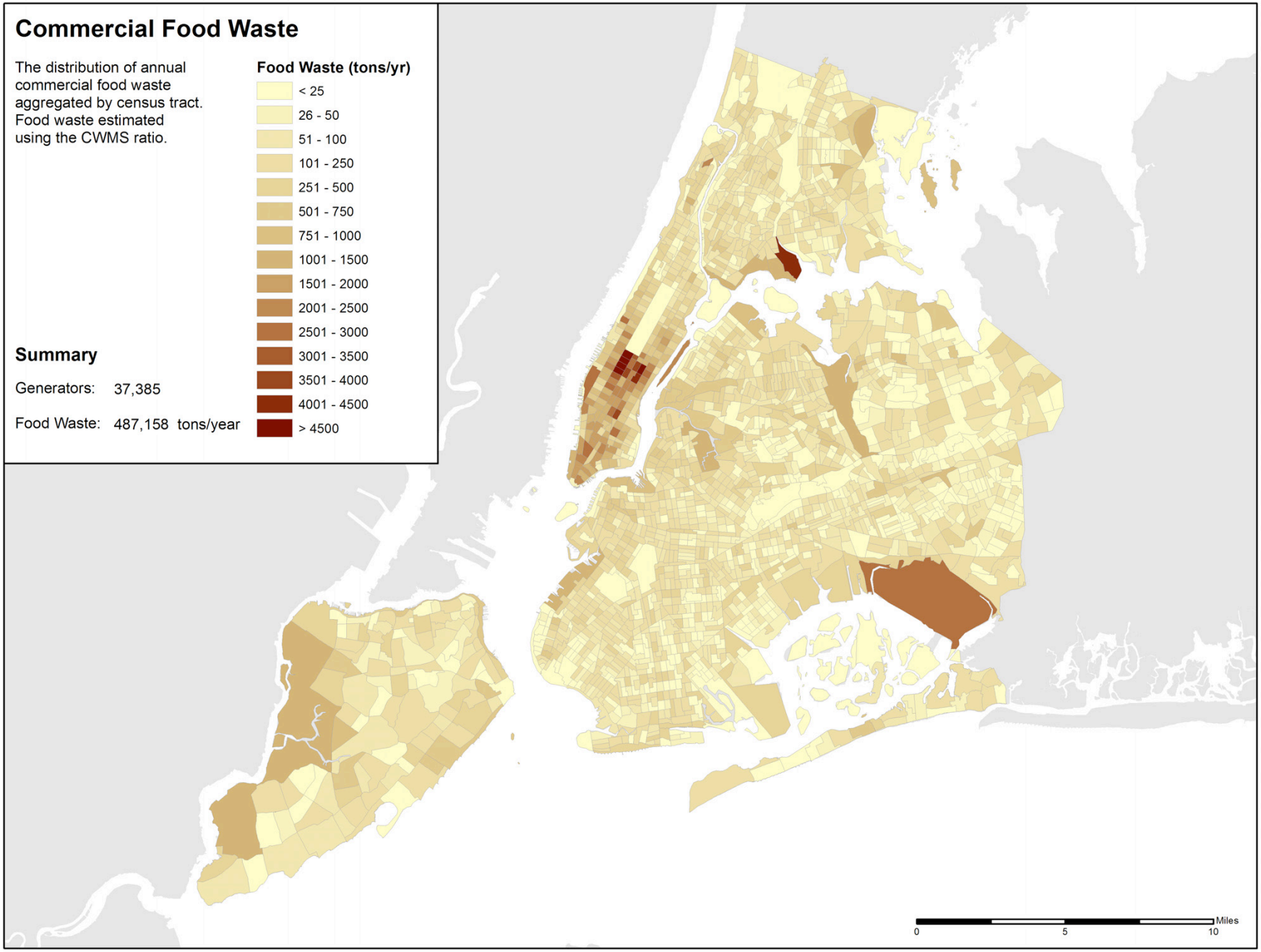


Figure 8: Aggregate Commercial Food Waste Using the CWMS Methodology

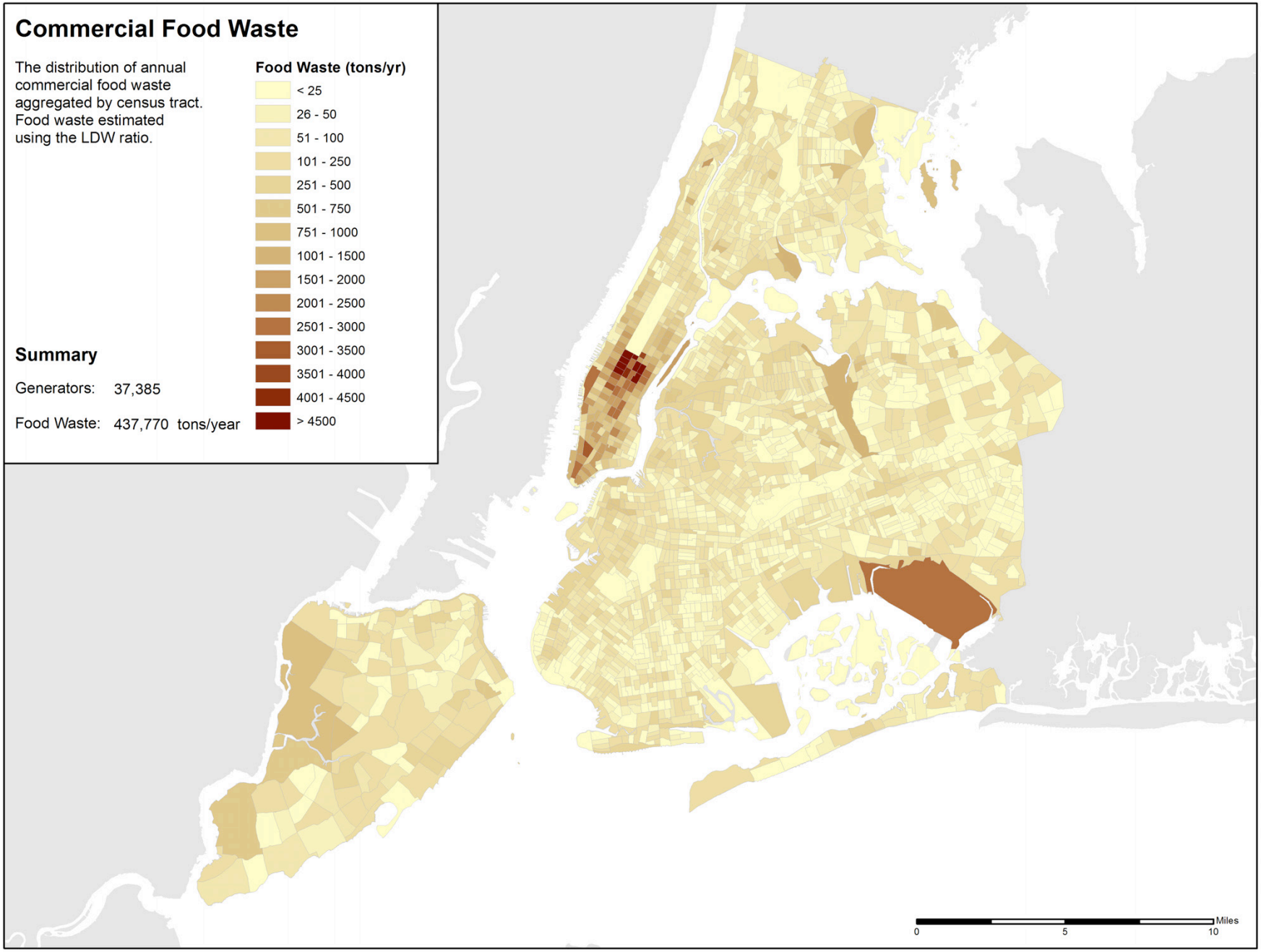


Figure 9: Aggregate Commercial Food Waste Using the LDW Methodology

For the purposes of this study, both the CWMS methodology and the LDW methodology were used to provide a basis of comparison for the estimation of food waste. However, there was little statistical difference between the two methodologies. The following detail sections by business category include maps generated using both methodologies.

Generator Categories

The 2004 Commercial Waste Management Study identified five major commercial categories that are responsible for approximately 506,470 tons per year, or 85 percent of the total food waste generated by commercial activities (Henningson, Durham & Richardson 84). Within the InfoUSA dataset, businesses are divided according to the North American Industry Classification System (NAICS). The data points were then classified by estimated tons of food waste produced per year, to better understand the type of industries and to link the data from the CWMS report to the last available census survey (2007). The following table is the matrix used to identify and categorize each individual business, and to then aggregate those businesses into the 7 categories listed in the left-hand column.

The total commercial food waste was broken down by specific generator types that were categorized using NAIC's codes shown in the table below. Seven categories were identified: Manufacturing of Food, Manufacturing of Beverages, Retail Food, Wholesalers-Nondurable Goods, Healthcare and Social Service, Accommodation and Food Service.

Classification Code			
BIC - CWMS	NAICS		Descprition
Man. Food	31	3111	Animal Food Manufacturing
		3112	Flour Milling
		3113	Confectionery Mfg From Purchased Chocolate
		3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing
		3115	Dairy Product Manufacturing
		3116	Animal Slaughtering and Processing
		3117	Seafood Product Preparation and Packaging
		3118	Bakeries and Tortilla Manufacturing
		3119	Other Food Manufacturing
Man. Beverage	31	3121	Beverage Manufacturing
		3122-	Tobacco Manufacturing
Retail Food	44	4451	Supermarkets and Other Grocery (except Convenience) Stores
		4452	Specialty food Store
		4453	Beer, Wine, and Liquor Stores
Wholesalers, Nondurable Goods	42	4244	Grocery and Related Product Merchant Wholesalers
		4245	Farm Product Raw Material Merchant Wholesalers
		4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers
Health Care	62	6221	General Medical and Surgical Hospitals
		6222	Psychiatric and Substance Abuse Hospitals
		6223	Specialty Hospitals
	62	6231	Nursing Care Facilities
		6233	Homes for the Elderly
		6239	Other Residential Care Facilities
Accomodation	72	7211	Traveler Accommodation
		7212	Recreational and Vacation Camps
		7213	Rooming and Boarding Houses
Food Service	72	7221	Full-Service Restaurants
		7222	Limited-Service Restaurants
		7223	Food Service Contractors
		7224	Drinking Places (Alcoholic Beverages)

Source: U.S. Census Bureau, “Introduction to NAICS”

Figure 10: Classification Code Groupings

The following sections illustrate the distribution of food waste per census tract for each of these categories.

3.3.2 Food Service Category

The Food Service category includes 22,666 generators in New York City, which account for 61 percent of the total food waste generators. 41 percent of the Food Service businesses are located in Manhattan, while 24 percent are located in Brooklyn, and 20 percent are located in Queens.

Based on the CWMS methodology, the Food Service category generates 307,121 tons of food waste per year or 63 percent of New York City's total food waste. The Food Service category is the largest category in terms of number of generators and waste produced. The map below illustrates the distribution of waste generated by Food Service generators within New York City using the CWMS methodology. The increase in food waste production can be seen in the darker coloring of census tracts throughout the entire map, highlighting the increased generation and number of businesses. There are two main regions of high food waste concentrations generated by the Food Service industry: midtown Manhattan and John F. Kennedy Airport in Queens. 55 percent of the food waste generated by Food Service businesses is located in Manhattan. This is largely due to the clustering of establishments that prepare meals, snacks, and beverages.

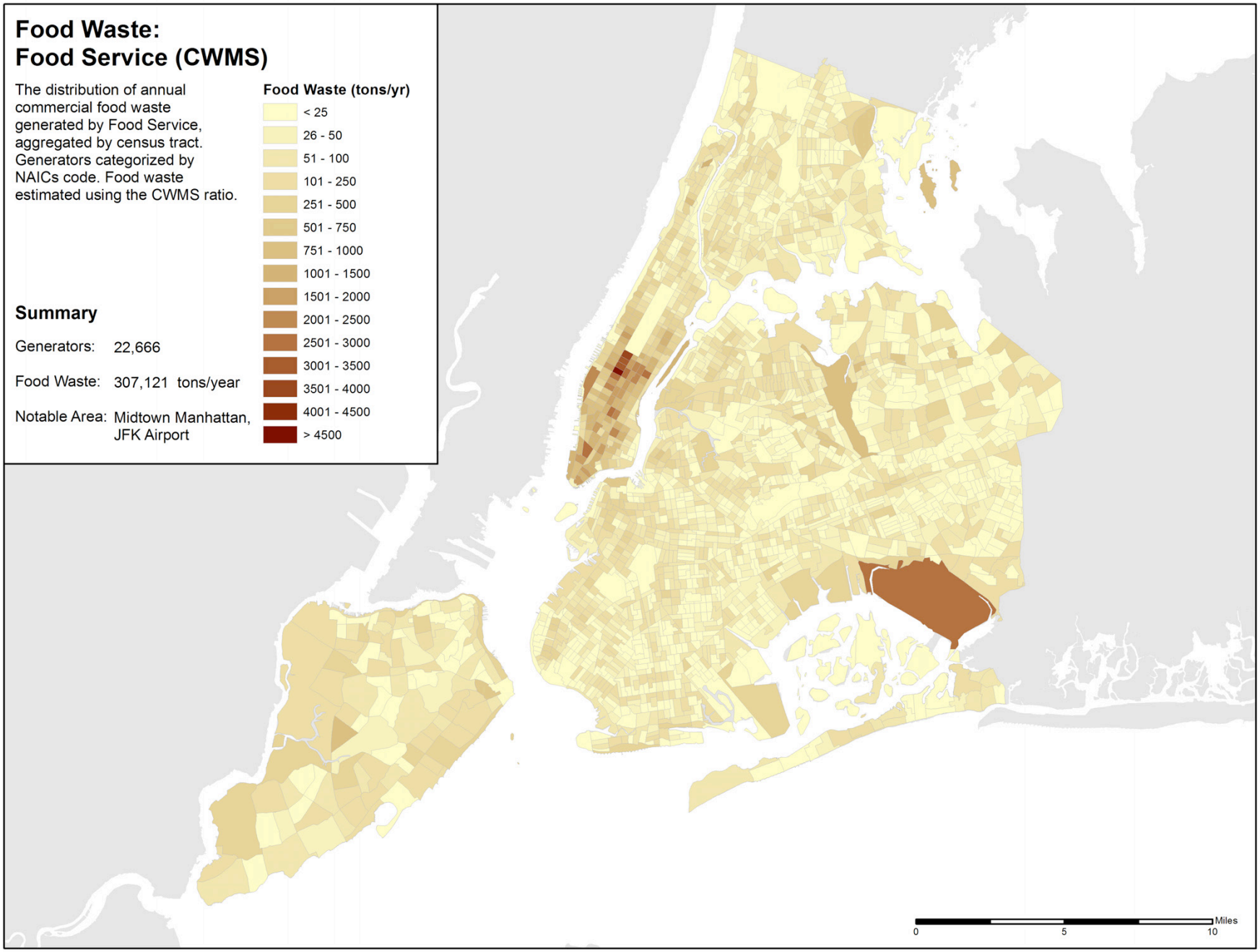


Figure 11: Food Waste Generated by the Food Service Category, CWMS Methodology

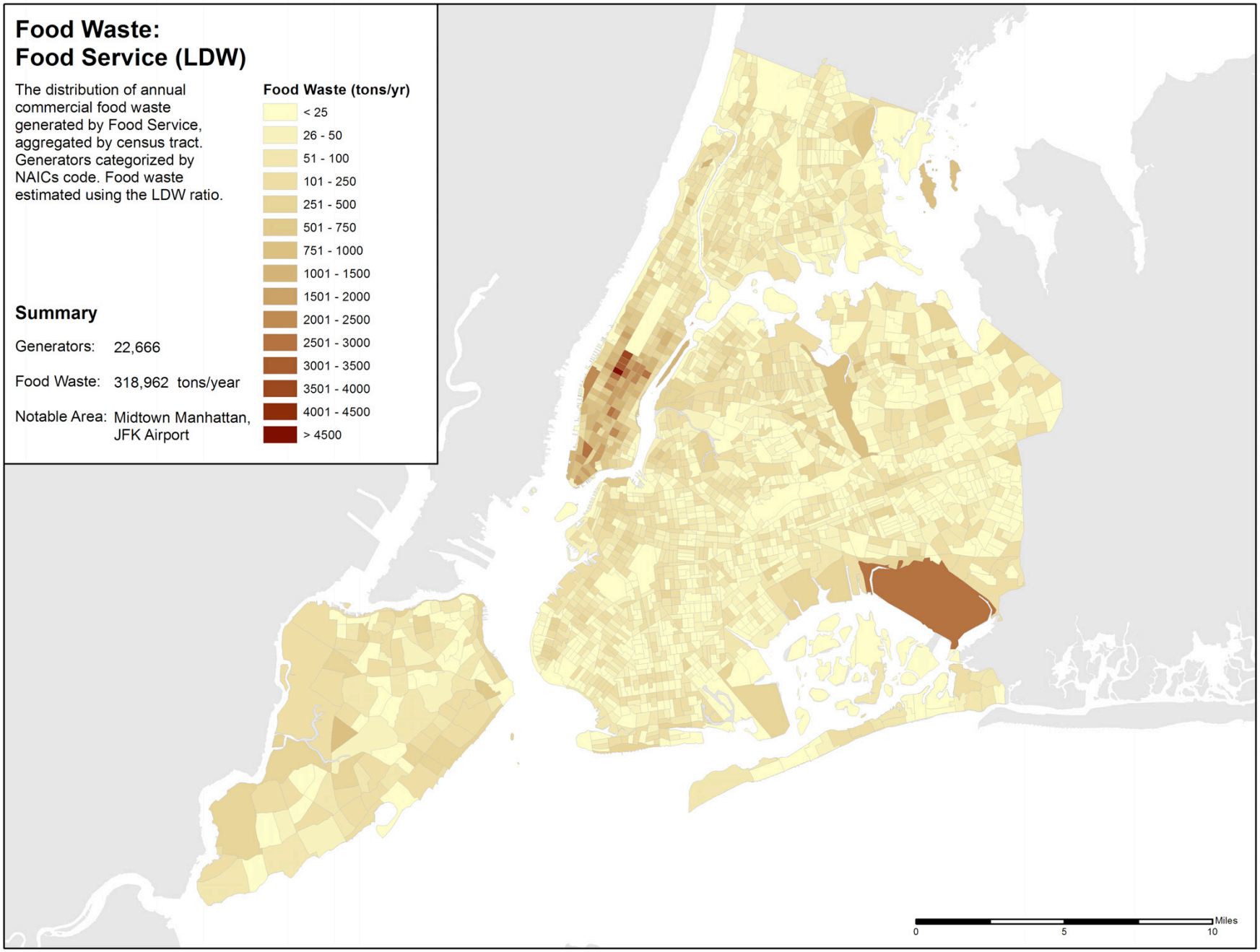


Figure 12: Food Waste Generated by the Food Service Category, LDW Methodology

Based on the LDW methodology, the Food Service category generates 318,962 tons of food waste per year or 73 percent of New York City's total food waste. Similar to the CWMS methodology, the Food Service category is the largest category in terms of number of generators and waste produced. The map below illustrates the distribution of waste generated by Food Service generators within New York City using the LDW methodology. As with the CWMS methodology, there are two main regions of high food waste concentrations generated by the Food Service industry: midtown Manhattan and John F. Kennedy Airport in Queens. The LDW methodology produced a 2 percent increase in food waste generated by the Food Service industry, which proves to be a marginal difference in the overall analysis.

3.3.3 Retail Food Category

The Retail Food category includes 9,184 generators in New York City, which account for 25 percent of the total food waste generators. Retail Food businesses are distributed nearly evenly between Brooklyn, Manhattan, and Queens, housing 34 percent, 26 percent and 19 percent of the generators respectively.

Based on the CWMS methodology. Retail Food accounts for 90,906 tons of food waste per year or 19 percent of New York City's total food waste. The map below illustrates the distribution of waste generated by Retail Food generators within New York City. This mirrors the near even distribution of food waste generated within those boroughs as well, with Manhattan accounting for 35 percent of the food waste generated by Retail Food. The high concentration of generators in Manhattan is also seen with a higher concentration of food waste in midtown due to clustering of businesses there.

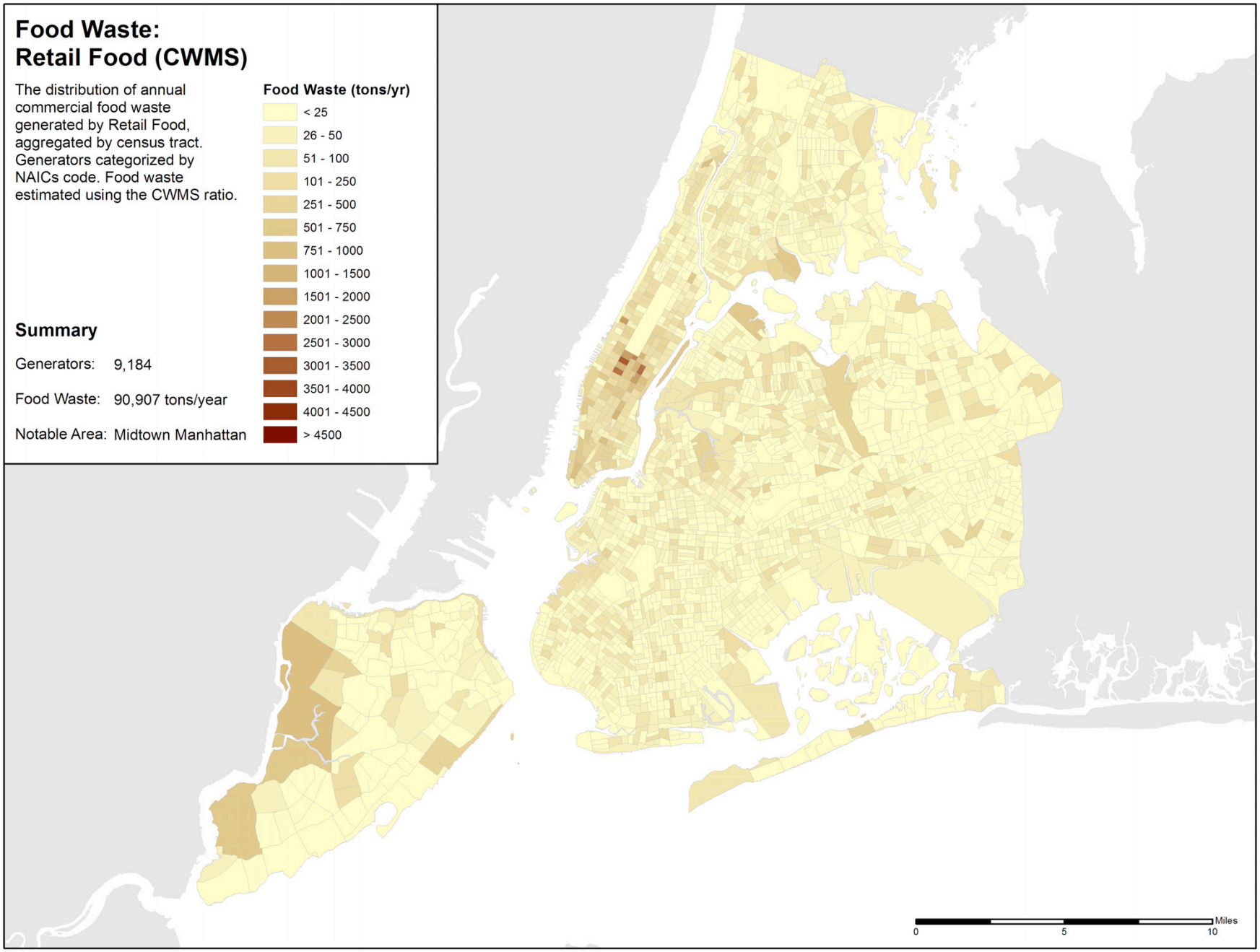


Figure 13: Food Waste Generated by the Retail Food Category, CWMS Methodology

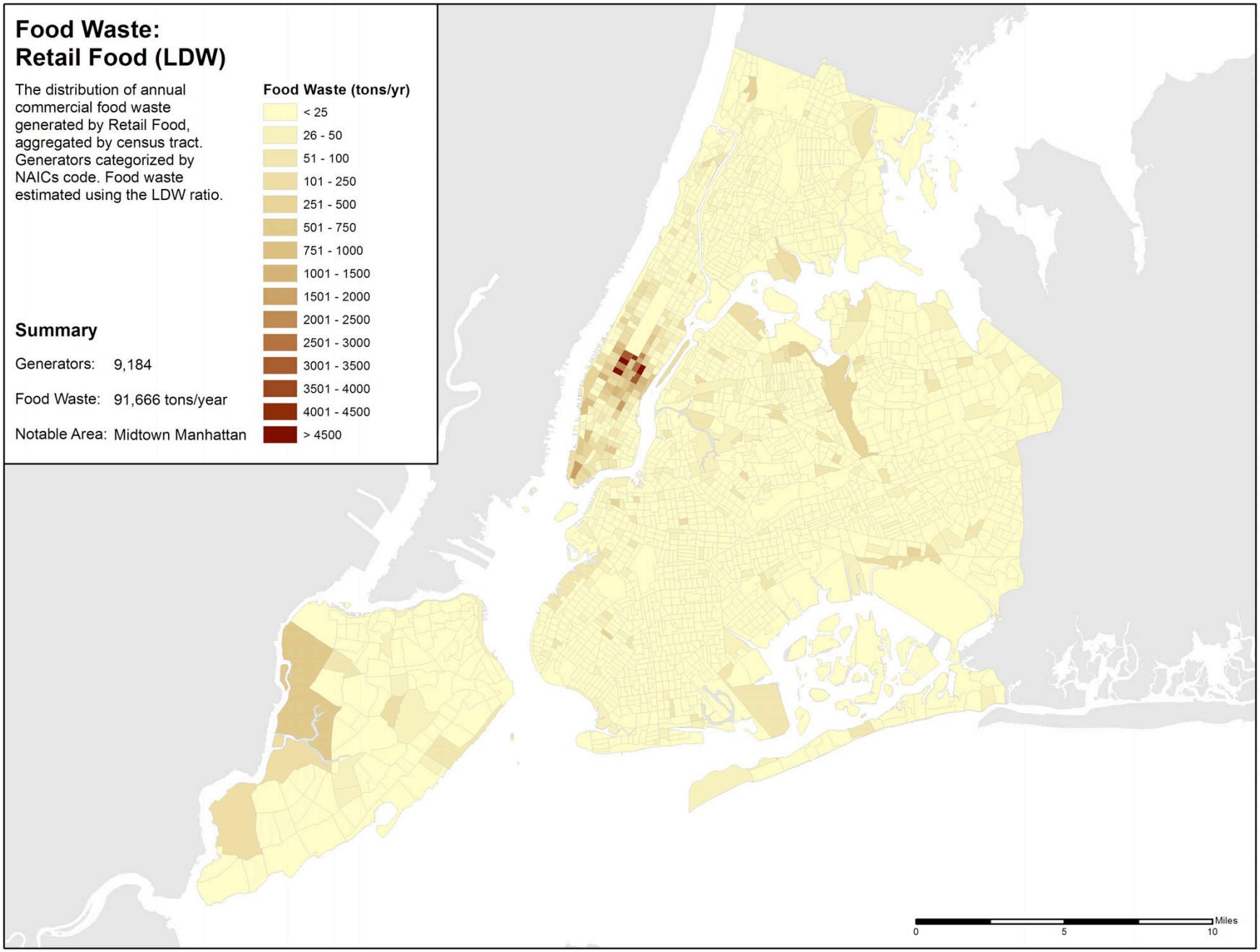


Figure 14: Food Waste Generated by the Retail Food Category, LDW Methodology

Based on the LDW methodology. Retail Food accounts for 15,654 tons of food waste per year or 4 percent of New York City's total food waste. The map below illustrates the distribution of waste generated by Retail Food generators within New York City. As with the CWMS methodology, Manhattan accounts for 35 percent of the food waste generated by Retail Food and there is a high concentration of food waste in midtown. The LDW methodology produced a 71 percent decrease in food waste generated by the Retail Food industry, which proves to be a quite difference in the overall analysis.

3.3.4 Accommodation Category

The Accommodation category includes 967 generators in New York City, which account for 3 percent of the total food waste generators. More than two-thirds (67 percent) of the Accommodation generators are located within Manhattan and centered in the midtown region. 13 percent and 14 percent of the generators are located in Brooklyn and Queens, respectively.

Based on the CWMS methodology, the Accommodation category produces 36,595 tons of food waste per year or 8 percent of New York City's total food waste. The map below illustrates the distribution of waste generated by Accommodation generators within New York City. Due to the high frequency of hotels, there is a clear hot spot of generation in midtown Manhattan, as well as John F. Kennedy Airport in Queens.

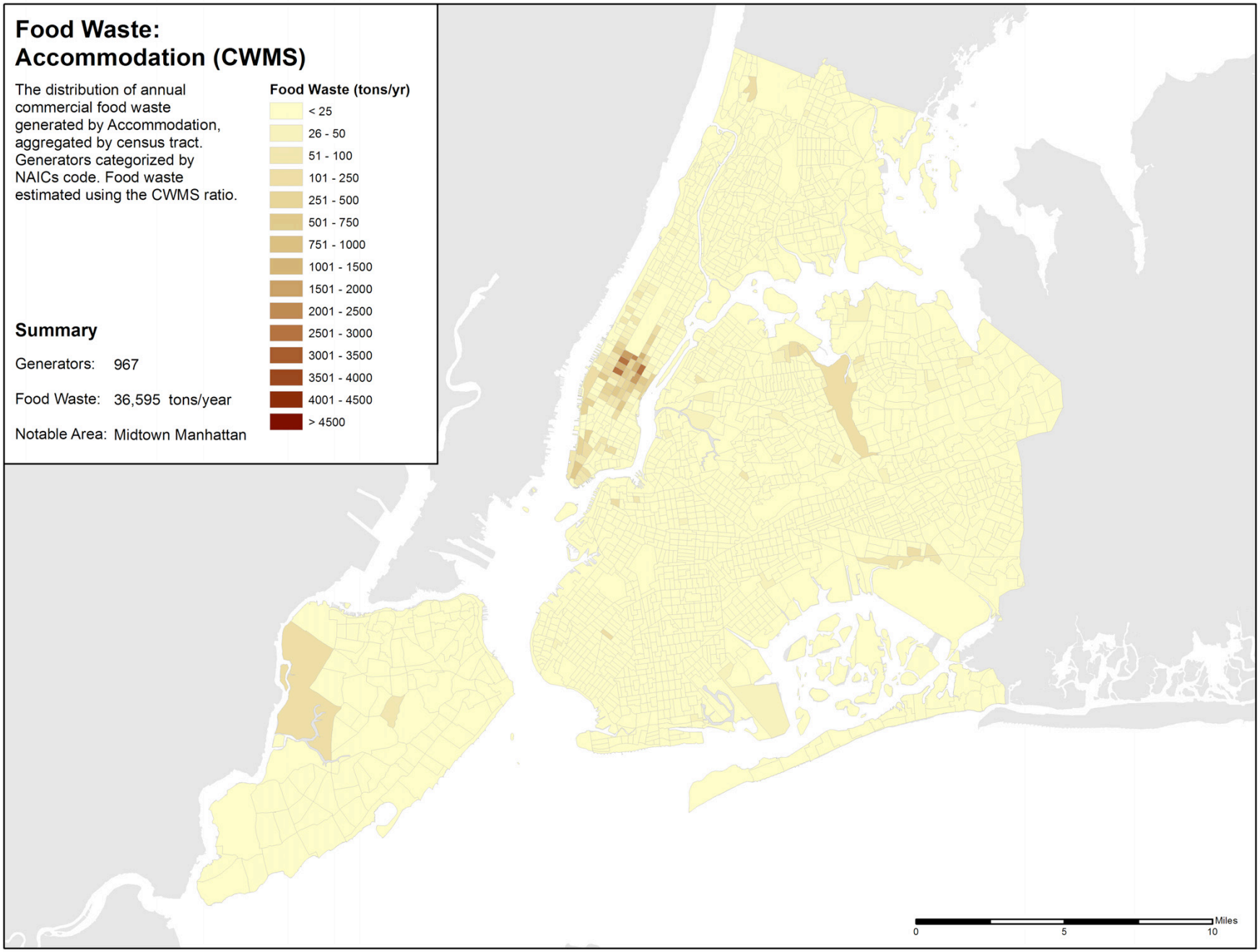


Figure 15: Food Waste Generated by the Accommodation Category, CWMS Methodology

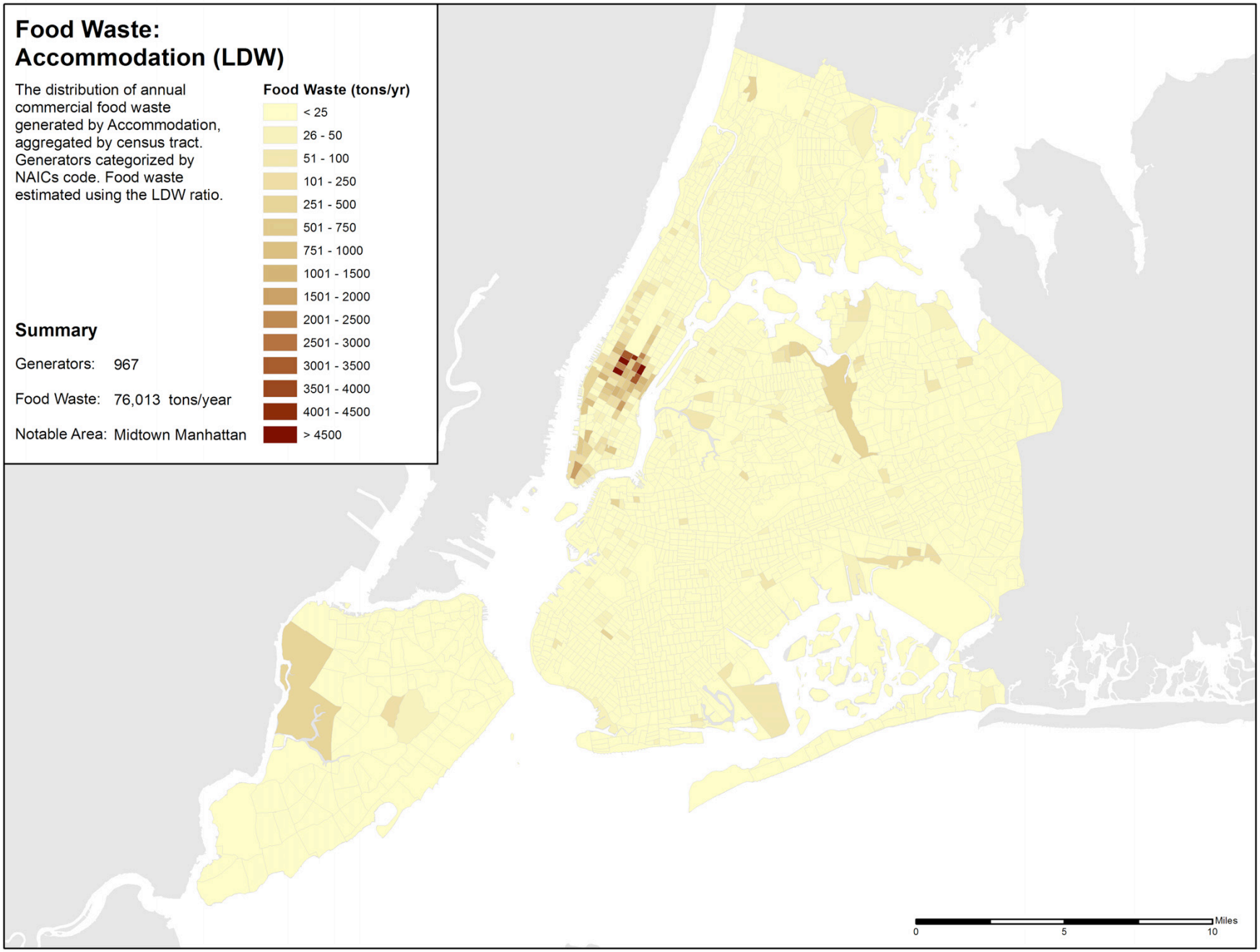


Figure 16: Food Waste Generated by the Accommodation Category, LDW Methodology

Based on the LDW methodology, the Accommodation category produces 76,013 tons of food waste per year or 17 percent of New York City's total food waste. The map below illustrates the distribution of waste generated by Accommodation generators within New York City. The LDW methodology shows a 35 percent increase in food waste generated by the Accommodation category when compared with that of the CWMS methodology. The difference in the amounts produced in this category based on the two methodologies is not clearly illustrated in the maps due to extremely high concentration of food waste generated in midtown Manhattan.

3.3.5 Manufacturing of Food Category

The Manufacturing of Food category includes 1,532 generators in New York City, which account for 4 percent of the total food waste generators. These generators are distributed fairly evenly between Manhattan, Brooklyn, and Queens; containing 28 percent, 33 percent, and 24 percent of the total commercial food waste generators, respectively.

Based on the CWMS methodology, the Manufacturing of Food category generates 17,088 tons of food waste per year or 4 percent of New York City's food waste. The map below illustrates the distribution of waste generated by Manufacturing of Food generators within New York City. The Manufacturing of Food comprises such a minimal portion of the commercial food waste stream that the map of waste generation shows few regions of higher than 1,000 tons per year.

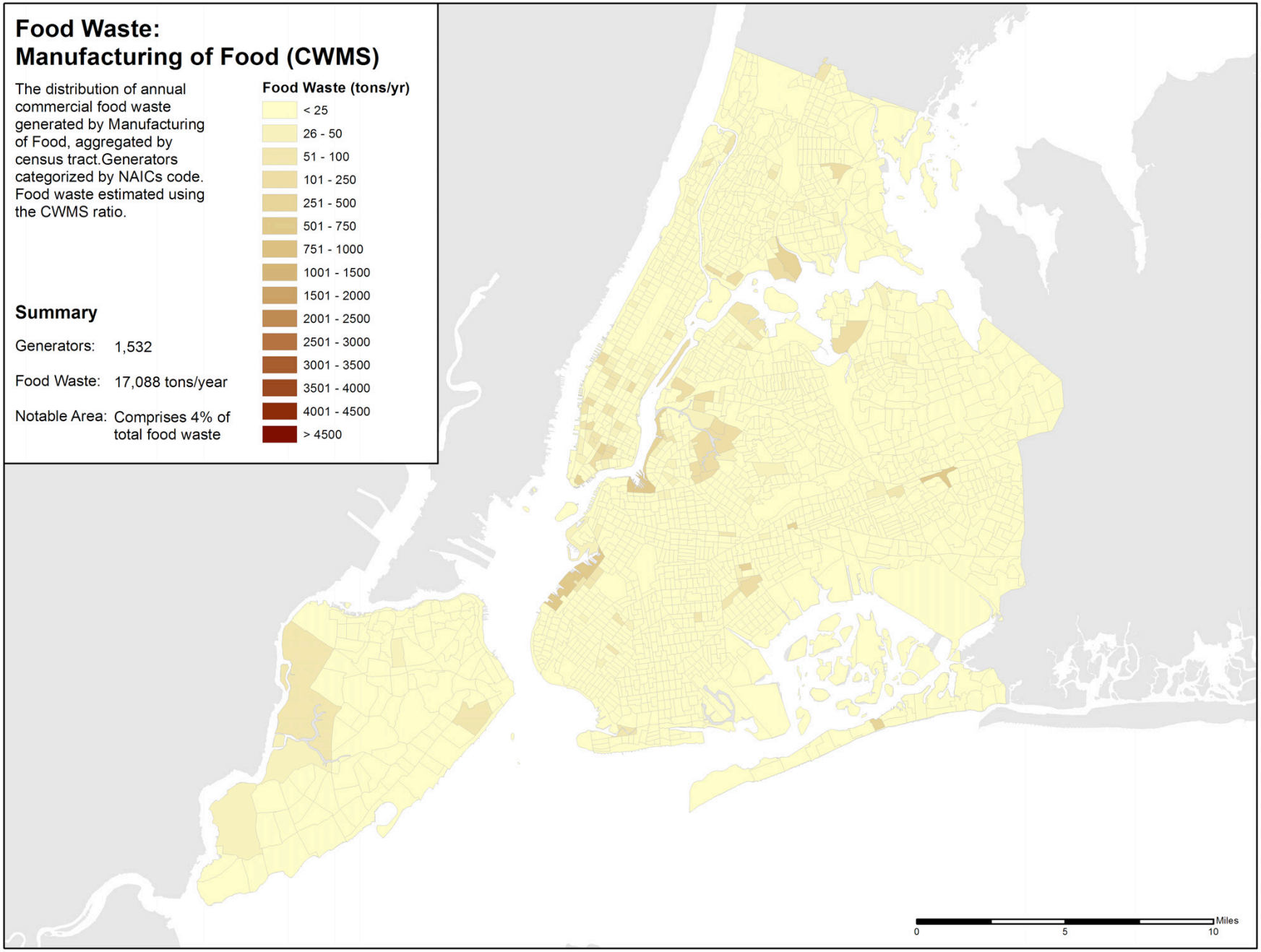


Figure 17: Food Waste Generated by the Manufacturing of Food Category, CWMS Methodology

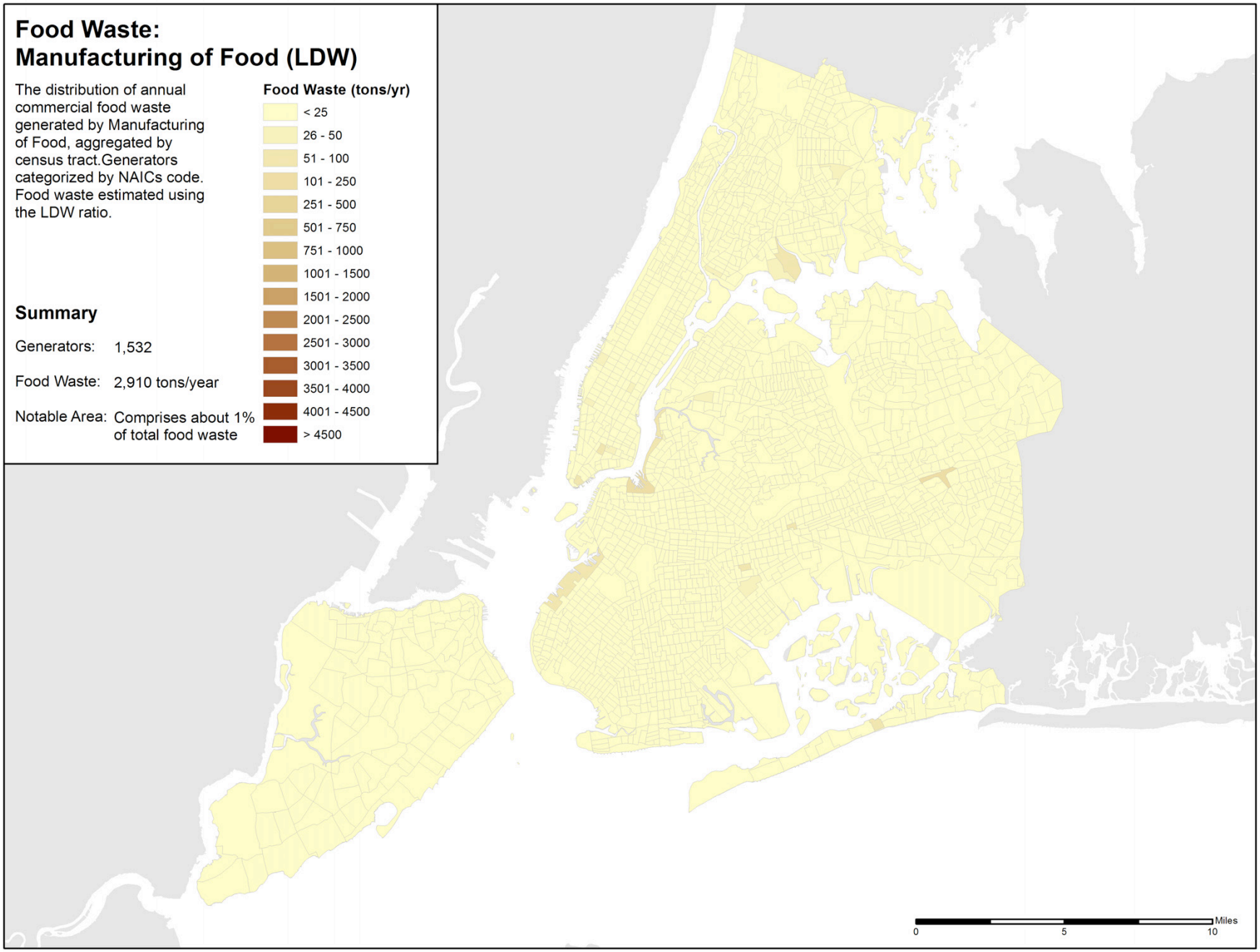


Figure 18: Food Waste Generated by the Manufacturing of Food Category, LDW Methodology

Based on the LDW methodology, the Manufacturing of Food category generates 2,910 tons of food waste per year or 1 percent of New York City's food waste. The map below illustrates the distribution of waste generated by Manufacturing Food generators within New York City using the LDW ratio. As with the CWMS methodology, the map is fairly homogeneous on the lower end of the food waste concentration spectrum. The total food waste generated by the Manufacturing of Food category using the LDW methodology is 71 percent less than that of the CWMS. This accounts for the lighter coloring of the map below when compared to the CWMS methodology.

3.3.6 Wholesalers – Nondurable Goods Category

The Wholesalers – Nondurable Goods category includes 1,735 generators in New York City, which account for 5 percent of the total food waste generators. There is a high concentration of food waste generated by Wholesalers within Brooklyn, The Bronx, and Queens with 36 percent, 24 percent, and 22 percent of the total annual Wholesalers food waste, respectively.

Based on the CWMS methodology, the Wholesalers – Nondurable Goods category generates 21,877 tons of food waste per year or 4 percent of NYC's food waste. The map below illustrates the distribution of waste generated by Wholesalers – Nondurable Goods generators within New York City. There is a noticeably high concentration of food waste located in The Bronx generated by the Hunts Point wholesale markets.

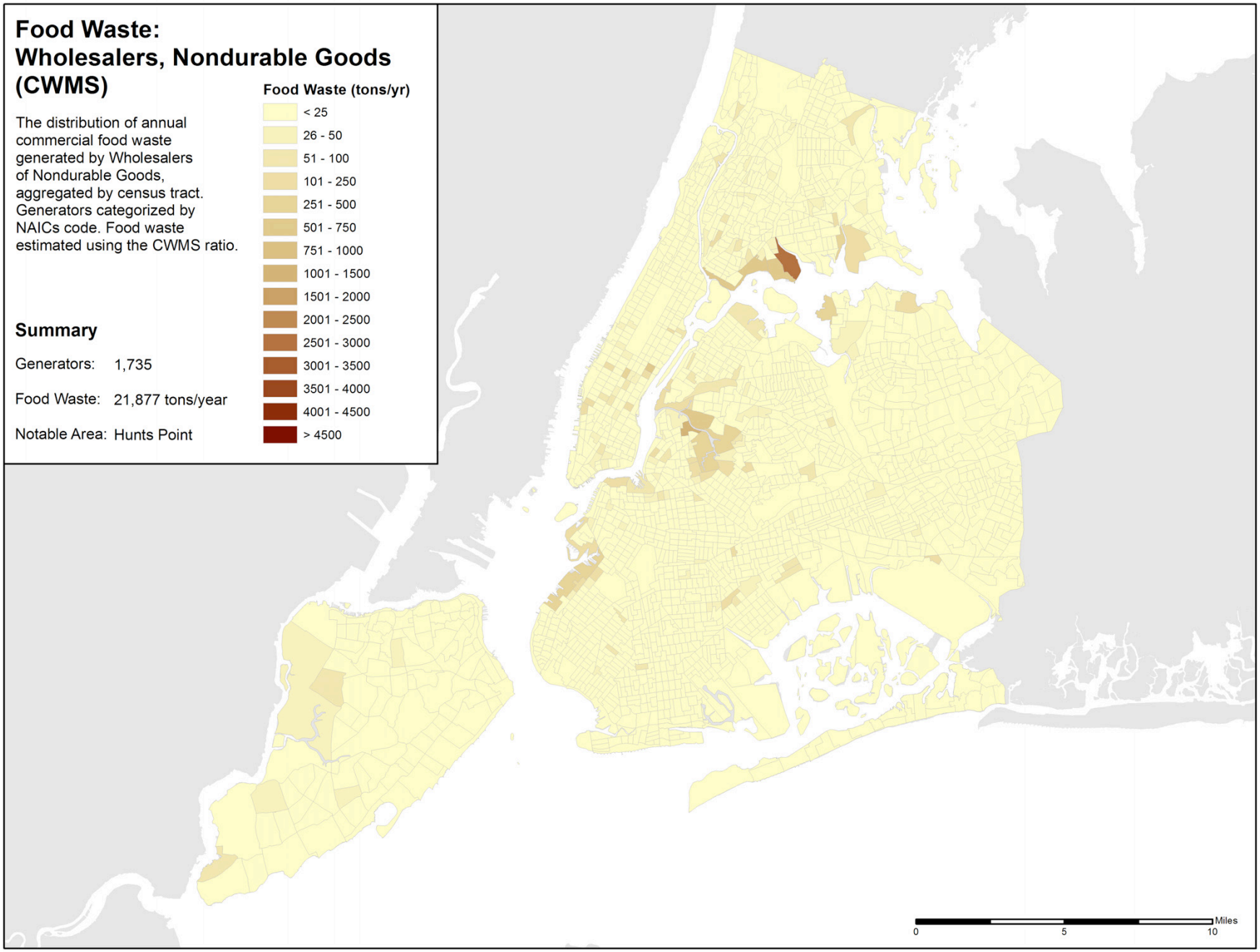


Figure 19: Food Waste Generated by the Wholesalers, Nondurable Goods Category, CWMS Methodology

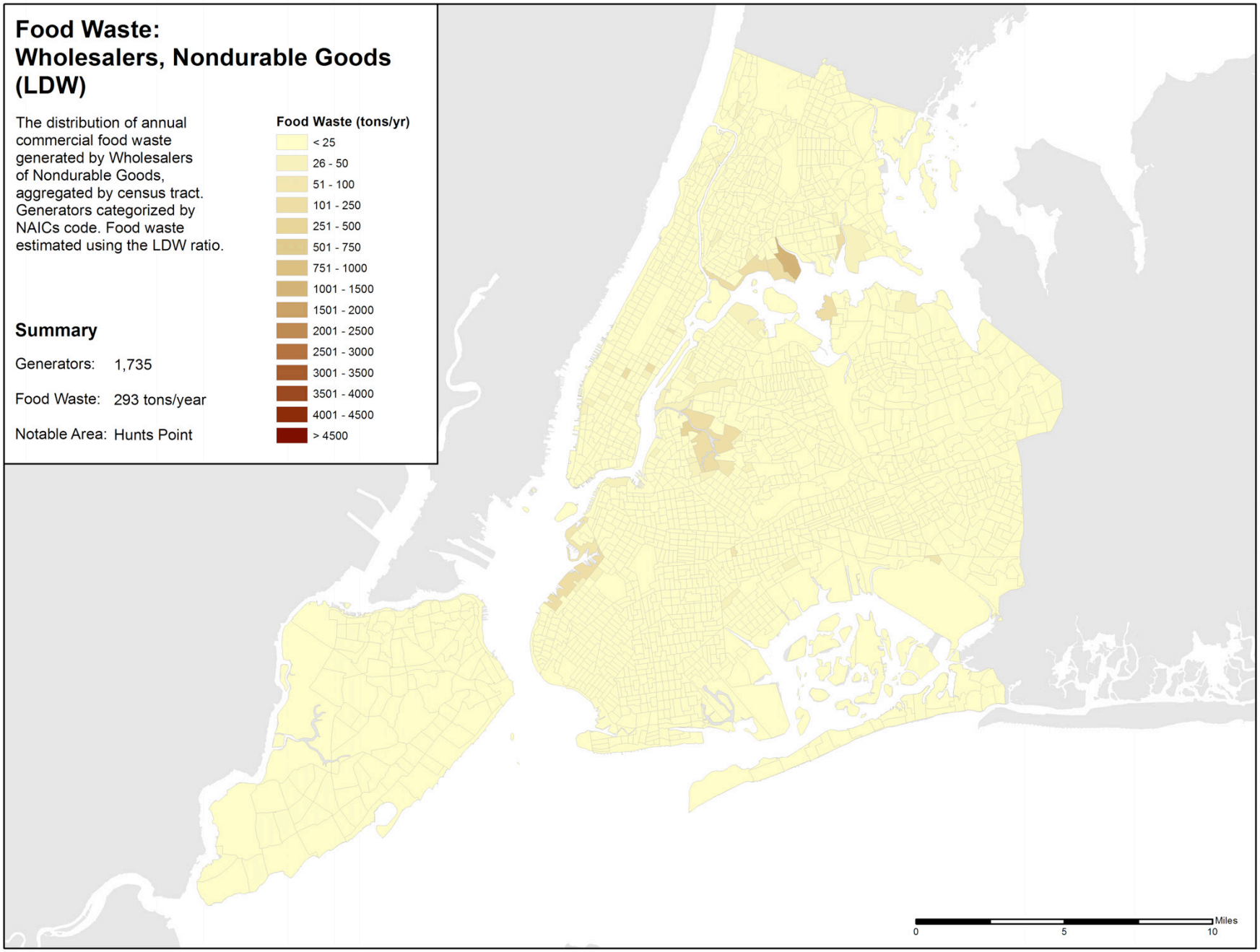


Figure 20: Food Waste Generated by the Wholesalers, Nondurable Goods Category, LDW Methodology

Based on the LDW methodology, the Wholesalers – Nondurable Goods category generates 7,666 tons of food waste per year or 2 percent of New York City's food waste. The map below illustrates the distribution of waste generated by Wholesalers – Nondurable Goods generators within New York City. As with the CWMS methodology, there is a noticeably higher concentration of food waste located in The Bronx generated at Hunts Point. The LDW methodology estimates Wholesalers annual food waste at just under 50 percent less than the CWMS methodology. This can be seen in the lighter coloring of the LDW map below when compared with the CWMS map.

3.3.7 Health Care and Social Services Category

The Healthcare and Social Services category includes 1,255 generators in New York City, which account for 3 percent of the total food waste generators. These generators are fairly evenly distributed within the 5 boroughs.

Based on the CWMS methodology, the Healthcare and Social Services category generates 11,849 tons of food waste per year or 2 percent of New York City's food waste. The map below illustrates the distribution of waste generated by Healthcare and Social Services generators within New York City. Healthcare and Social Services generates the second smallest amount of food waste and is the third smallest generator category. Although 32 percent of this category's food waste is generated in Manhattan, it is fairly evenly distributed across the boroughs.

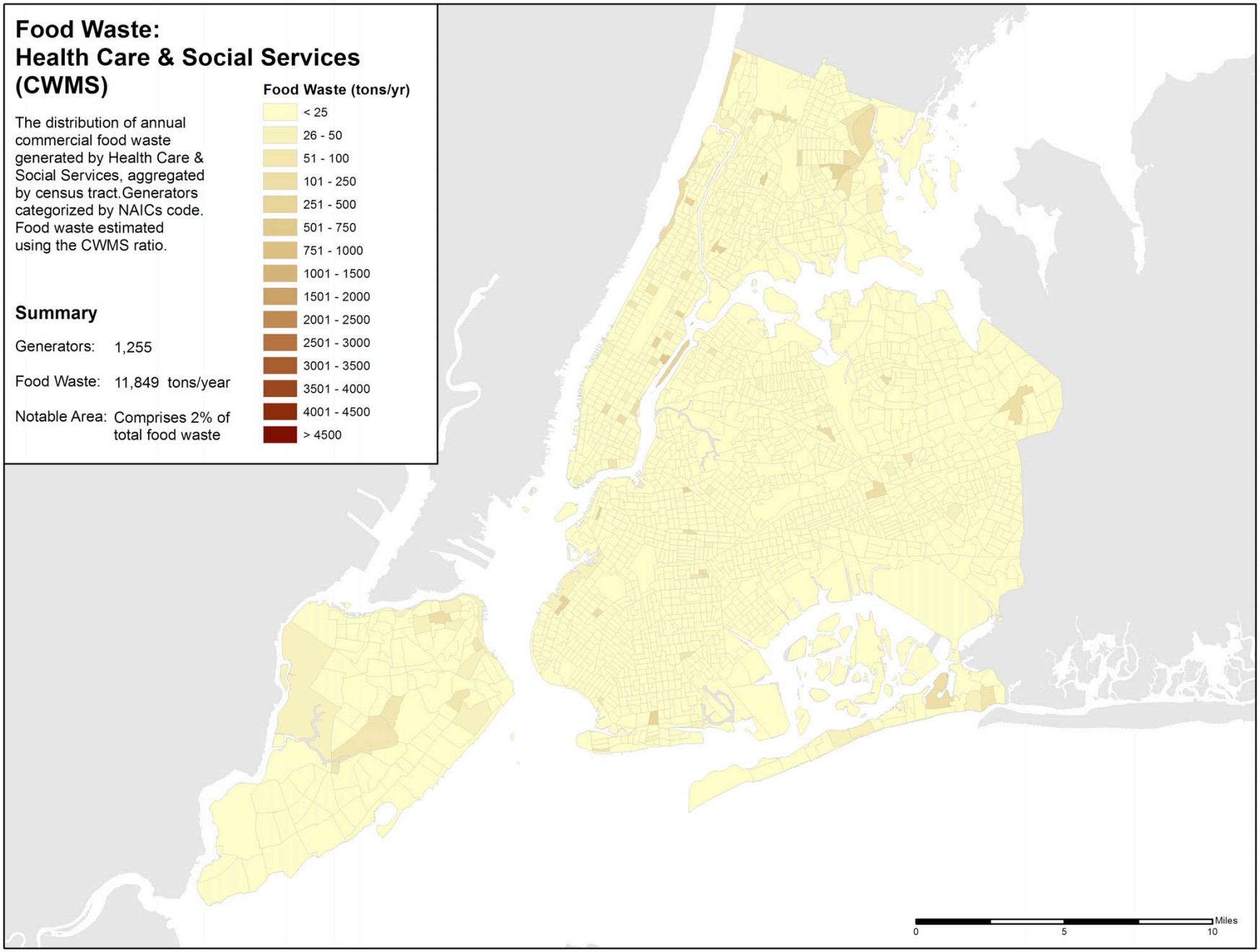


Figure 21: Food Waste Generated by the Healthcare & Social Services Category, CWMS Methodology

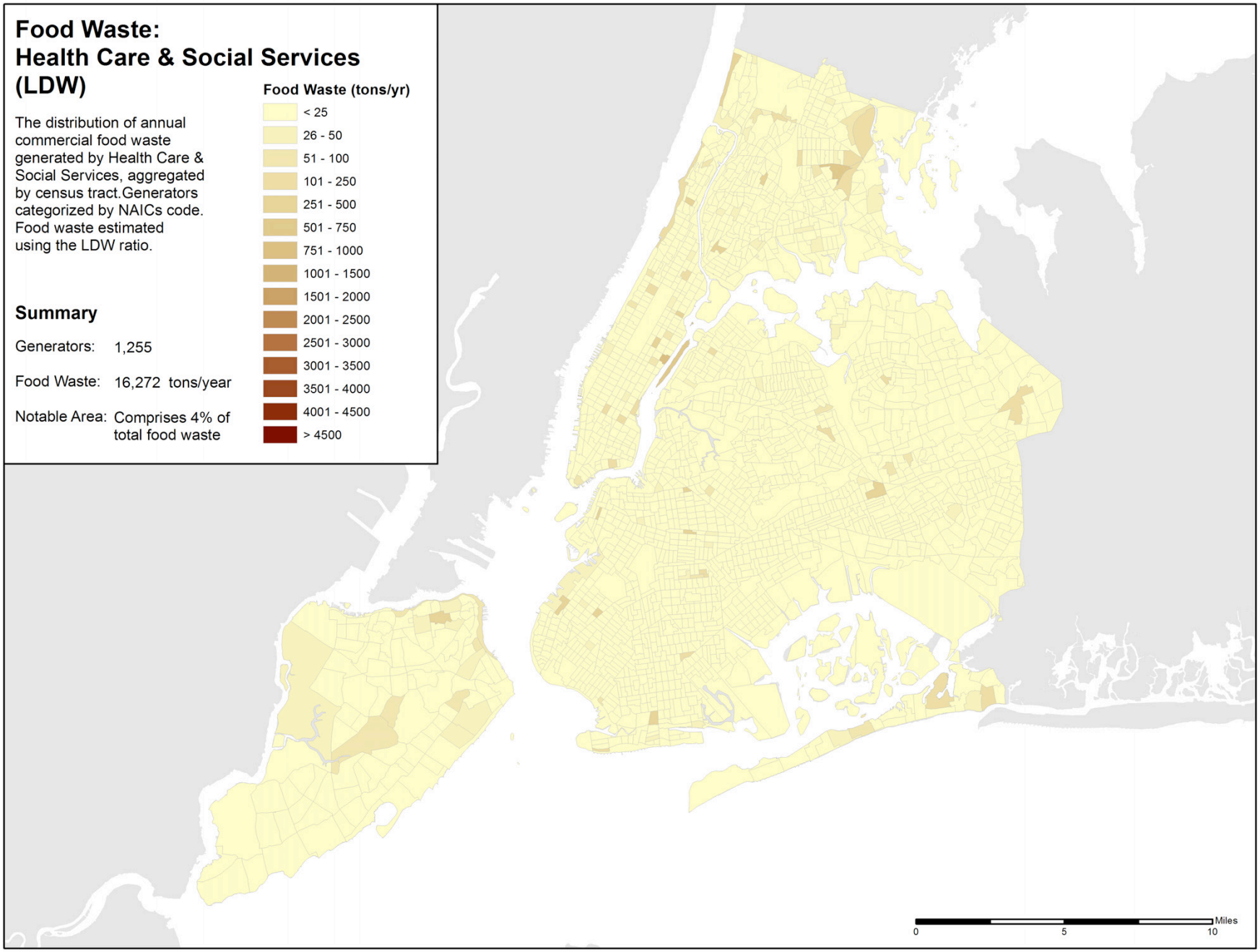


Figure 22: Food Waste Generated by the Healthcare & Social Services Category, LDW Methodology

Based on the LDW methodology, the Healthcare and Social Services category generates 16,272 tons of food waste per year or 4 percent of New York City's food waste. The map below illustrates the distribution of waste generated by Healthcare and Social Services generators within New York City. Under the LDW methodology, the Healthcare and Social Services generates the fourth largest amount of food waste though it is the third smallest generator category. Although 32 percent of this category's food waste is generated in Manhattan, it is fairly evenly distributed. There is only a 15 percent increase in total food waste generated by this category when comparing the LDW estimates to those of the CWMS. This is seen in the overall similarity of the two maps.

3.3.8 Manufacturing of Beverages Category

The Manufacturing of Beverages category includes 46 generators in New York City which accounts for essentially zero percent of the total food waste generators. These few generators are pretty evenly distributed with 35 percent in Brooklyn and 37 percent in Manhattan.

Based on the CWMS methodology, the Manufacturing of Beverages category produces 1,721 tons of food waste per year, which is comparatively none of the total of New York City's food waste. The map below illustrates the distribution of Manufacturing of Beverages businesses in New York City. Given the low number of Manufacturing Beverage generators and minimal waste produced within New York City, there was minimal variation in the spatial distribution on the category's annual food waste per census tract.

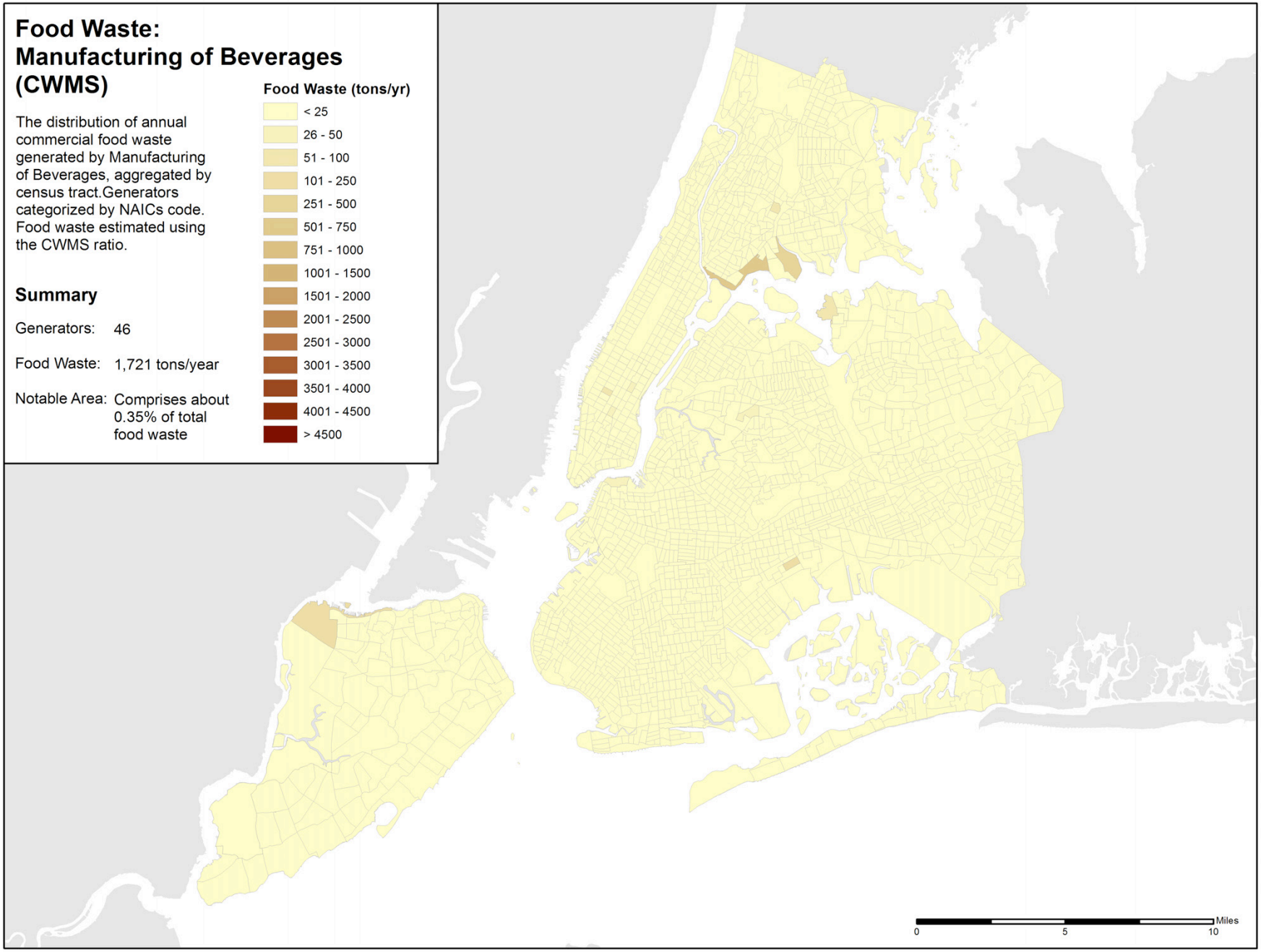


Figure 23: Food Waste Generated by the Manufacturing of Beverages Category, CWMS Methodology

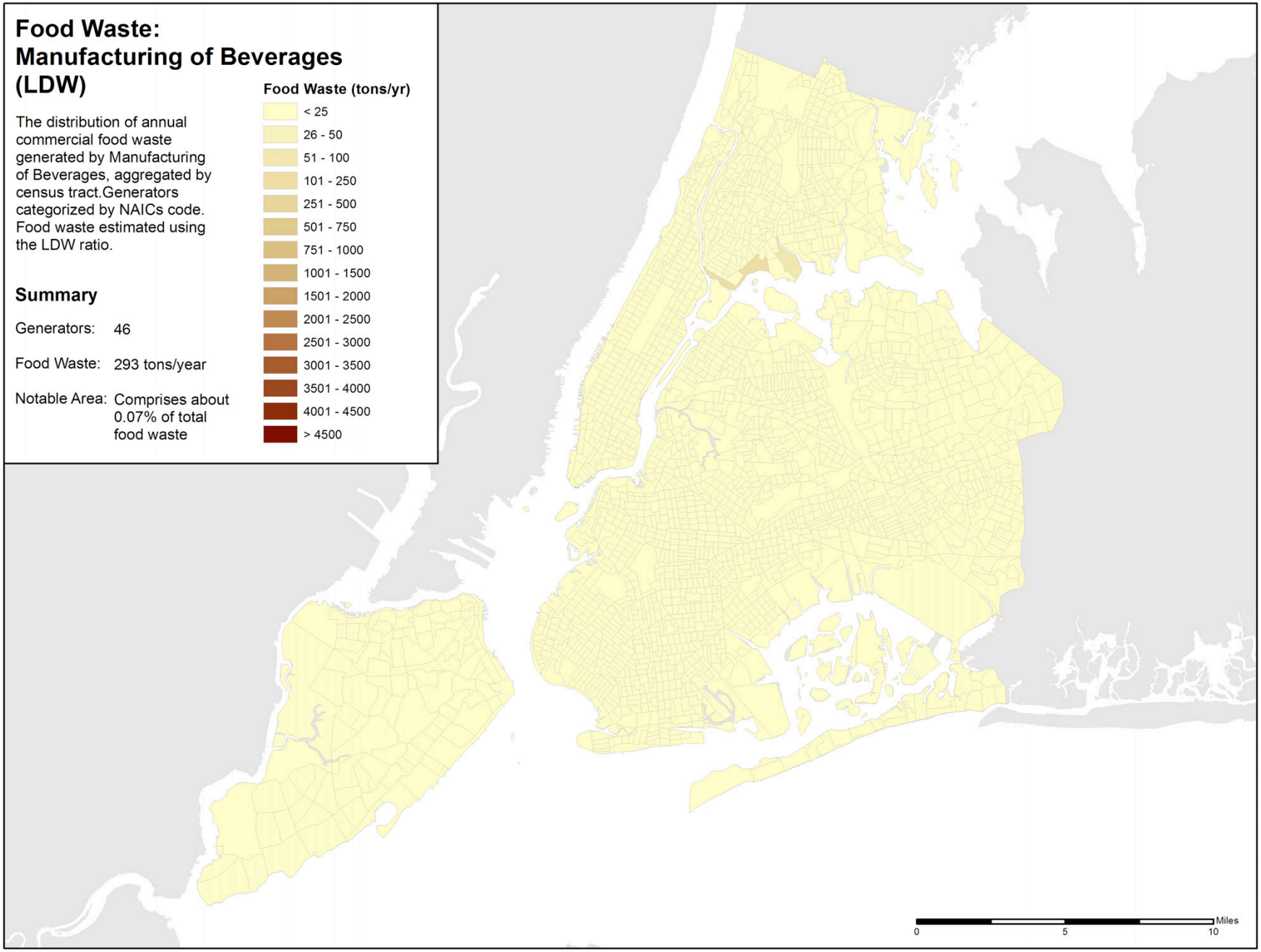


Figure 24: Food Waste Generated by the Manufacturing of Beverages Category, LDW Methodology

The same holds true based on the LDW methodology, the Manufacturing of Beverages category produces 293 tons of food waste per year, which is comparatively none of the total of New York City's food waste. The map below illustrates the distribution of Manufacturing of Beverage businesses in New York City. As with the CWMS estimates, there are few points of high generation represented visually.

3.4 Analysis of Generation by Borough

3.4.1 Overview

The analysis by borough informed where in New York City the majority of the waste was being generated, across all business categories. This analysis was critical not only to understand the current state of commercial food waste, but also to inform potential recommendations for processing sites or policy decisions. As the following maps illustrate, Manhattan is the highest food waste-generating borough in New York City. This is as a result of containing the highest number of business establishments of any borough.

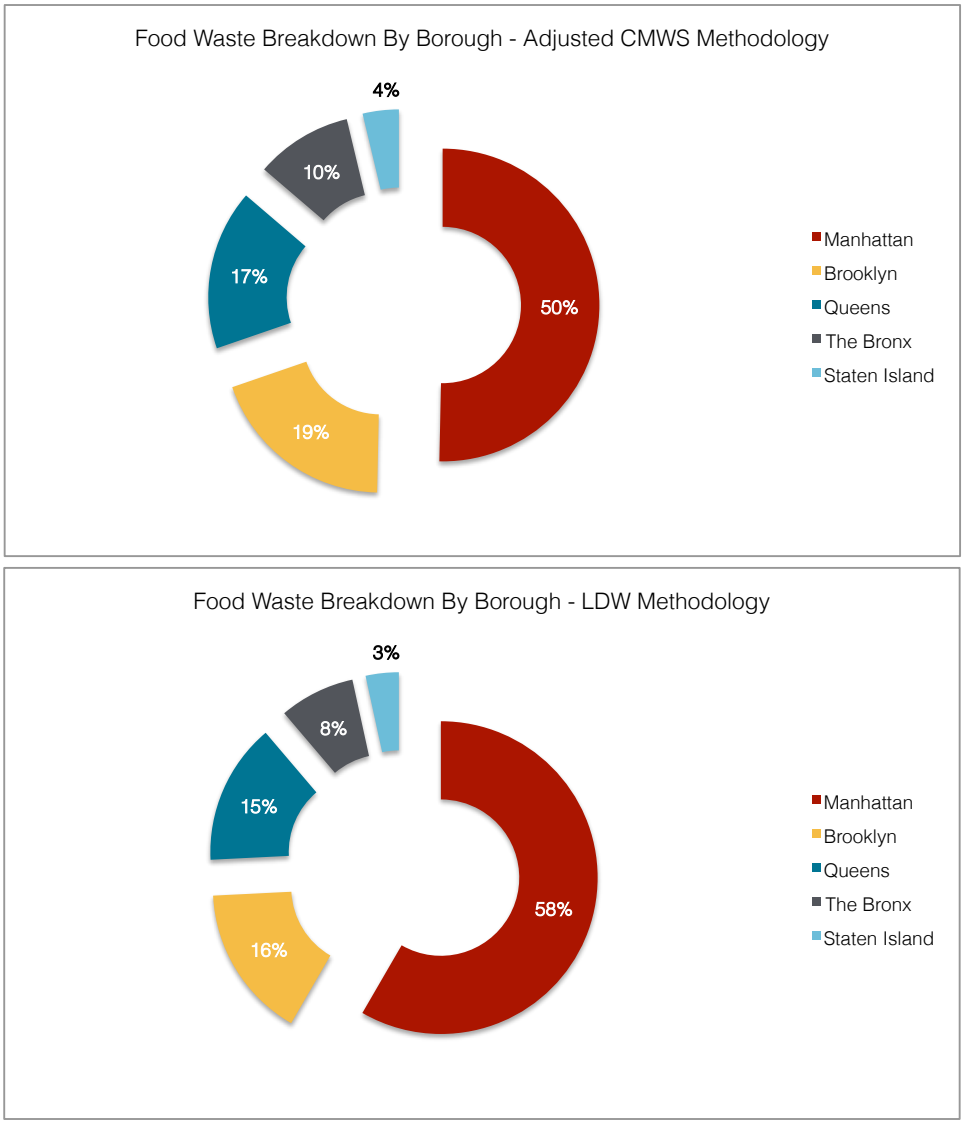


Figure 25: Food Waste Generated by Borough

3.4.2 Brooklyn

Brooklyn produces the second highest amount food waste of all of the boroughs. Based on the CWMS methodology, Brooklyn generates 94,400 tons of food waste per year or 19 percent of New York City's food waste. Based on the LDW methodology, Brooklyn generates 69,412 tons per year or 16 percent of New York City's food waste.

Based on both methodologies, the Food Service business category is the highest food waste generator in Brooklyn. The category produces 53,495 tons or 57 percent of the total food waste based of the borough based on the CWMS methodology or 55,558 tons or 80 percent of the total food waste based on the LDW methodology. The charts below illustrate the breakdown of the food waste generation by business category in Brooklyn.

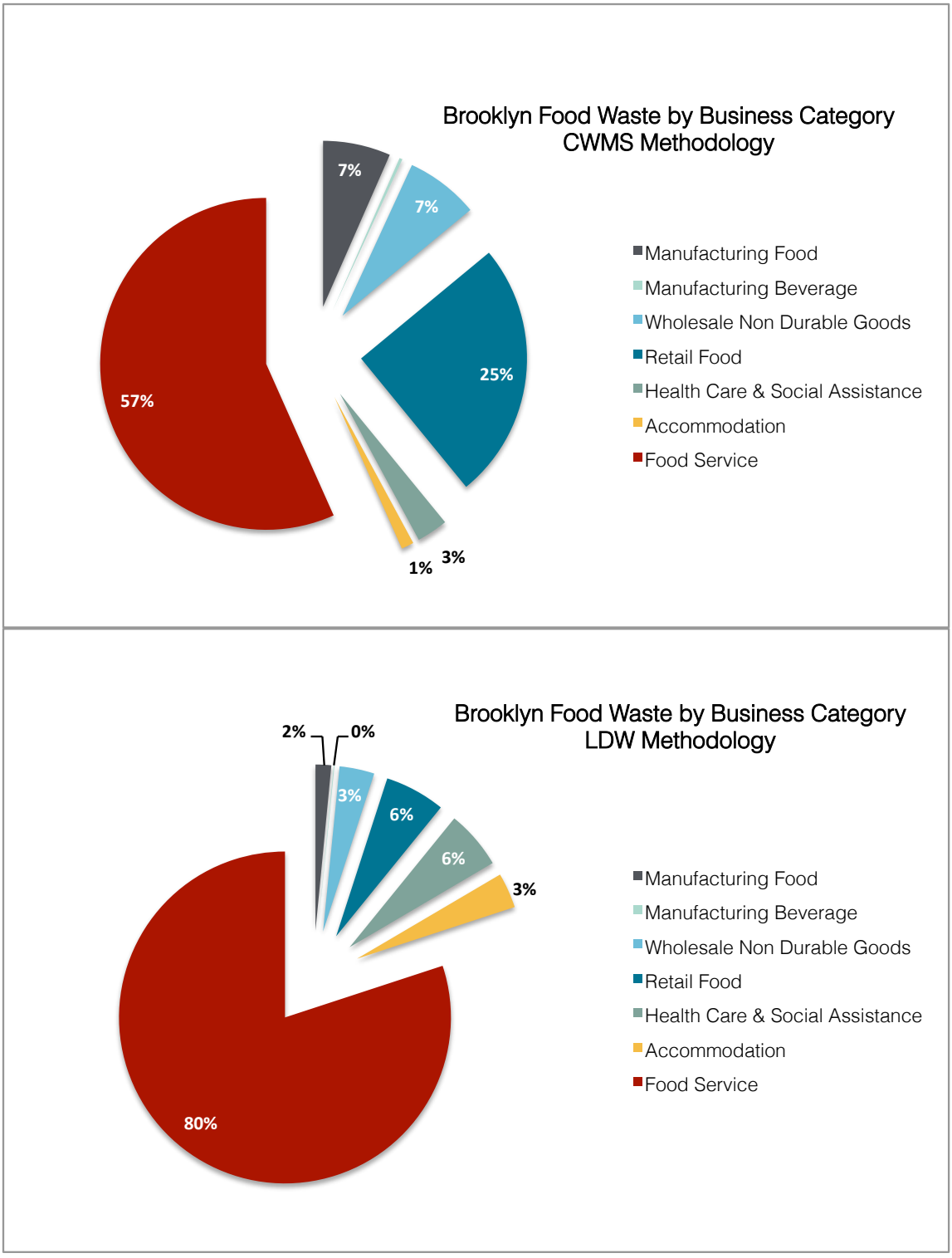


Figure 26: Graphical Summary of Food Waste Generated in Brooklyn by Business Category

The table below provides a breakdown of the tons per year produced by each business category in Brooklyn using both methodologies.

Business Category	CWMS Methodology	LDW Methodology
Manufacturing Food	6,216	1,059
Manufacturing Beverage	273	47
Wholesale Non Durable Goods	6,726	2,357
Retail Food	23,677	4,077
Health Care & Social Assistance	2,869	3,940
Accommodation	1,143	2,375
Food Service	53,495	55,558
Grand Total	94,400	69,412

Figure 27: Food Waste Generated in Brooklyn by Business Category

3.4.3 Manhattan

Manhattan produces the most food waste of all of the boroughs. Based on the CWMS methodology, Manhattan produces 245,203 tons of food waste per year, contributing 50 percent of New York City's food waste. Based on the LDW methodology, Manhattan produces 255,436 tons per year or 58 percent of New York City's food waste.

Based on both methodologies, the Food Service business category is the highest food waste generator in Manhattan. The category produces 175,133 tons or 69 percent of the total food waste based of the borough based on the CWMS methodology or 168,632 tons or 68 percent of the total food waste based on the LDW methodology. The charts below illustrate the breakdown of the food waste generation by business category in Manhattan.

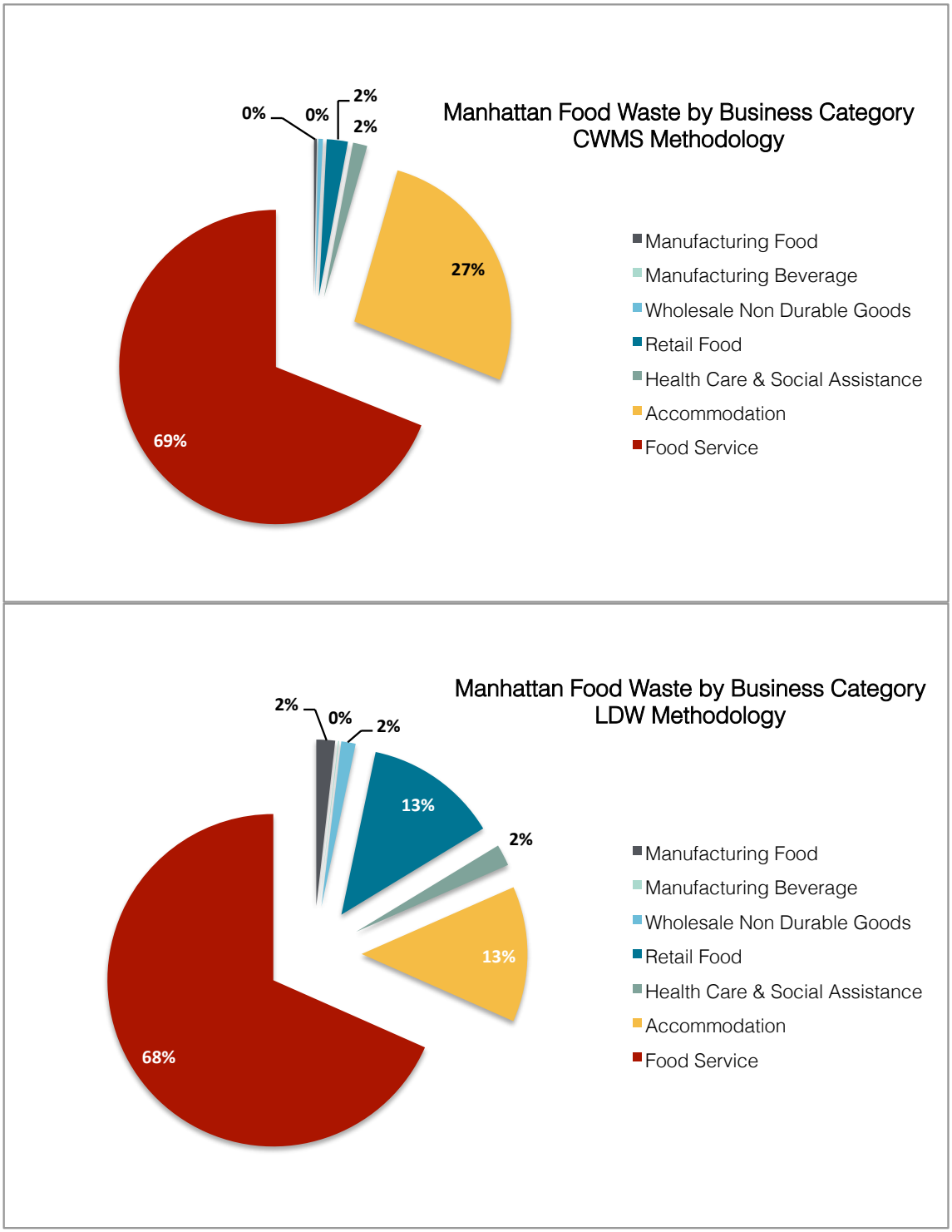


Figure 28: Graphical Summary of Food Waste Generated in Manhattan by Business Category

The table below provides a breakdown of the tons per year produced by each business category in Manhattan using both methodologies.

Business Category	CWMS Methodology	LDW Methodology
Manufacturing Food	765	4,495
Manufacturing Beverage	39	231
Wholesale Non Durable Goods	1,208	3,448
Retail Food	5,527	32,095
Health Care & Social Assistance	3,755	5,157
Accommodation	67,606	32,548
Food Service	175,133	168,632
Grand Total	254,034	246,606

Figure 29: Food Waste Generated in Manhattan by Business Category

3.4.4 Queens

Queens is the third highest food waste generating borough in New York City. Based on the CWMS methodology, Queens generates 80,746 tons of food waste per year, or about 17 percent of New York City's food waste. Based on the LDW methodology, Queens generates 63,862 tons per year or 15 percent of New York City's food waste.

Based on both methodologies, the Food Service business category is the highest food waste generator in Queens. The category produces 49,702 tons or 62 percent of the total food waste based of the borough based on the CWMS methodology or 51,618 tons or 81 percent of the total food waste based on the LDW methodology. The charts below illustrate breakdown of the food waste generation by business category in Queens.

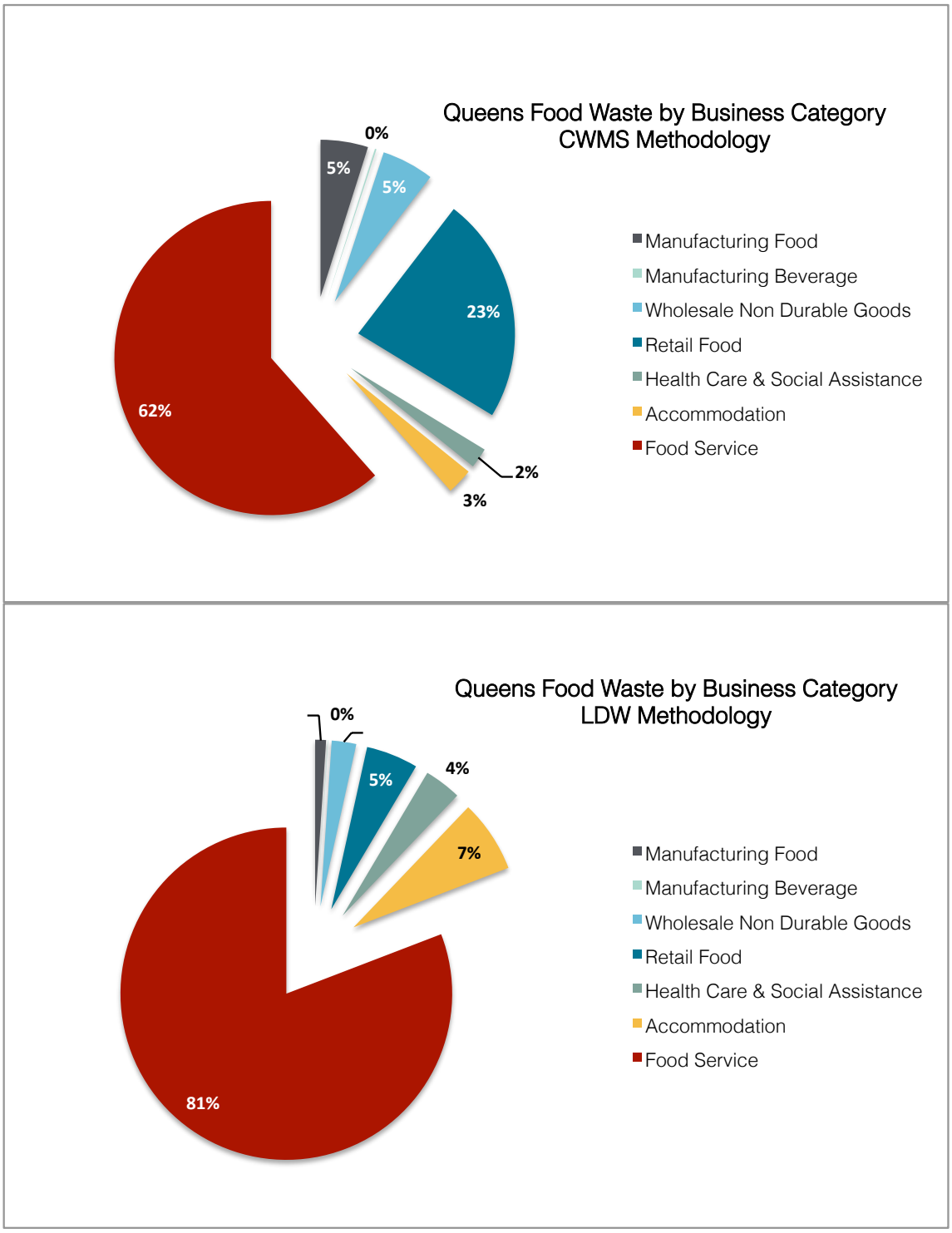


Figure 30: Graphical Summary of Food Waste Generated in Queens by Business Category

The following tables provide a breakdown of the tons per year produced by each business category in Queens using both methodologies.

Business Category	CWMS Methodology	LDW Methodology
Manufacturing Food	3,956	674
Manufacturing Beverage	125	21
Wholesale Non Durable Goods	4,348	1,524
Retail Food	18,777	3,233
Health Care & Social Assistance	1,678	2,304
Accommodation	2,161	4,489
Food Service	49,702	51,618
Grand Total	80,746	63,863

Figure 31: Food Waste Generated in Queens by Business Category

3.4.5 Staten Island

Staten Island generates the least amount of food waste of any of the boroughs. Based on the CWMS methodology, Staten Island generates 18,143 tons of food waste per year or 4 percent of New York City's food waste. Based on the LDW, Staten Island generates 14,936 tons per year or 3 percent of New York City's food waste.

Based on both methodologies, the Food Service business category is the highest food waste generator in Staten Island. The category produces 11,560 tons or 64 percent of the total food waste based of the borough based on the CWMS methodology or 12,005 tons or 80 percent of the total food waste based on the LDW methodology. The charts below illustrate the breakdown of the food waste generation by business category in Staten Island.

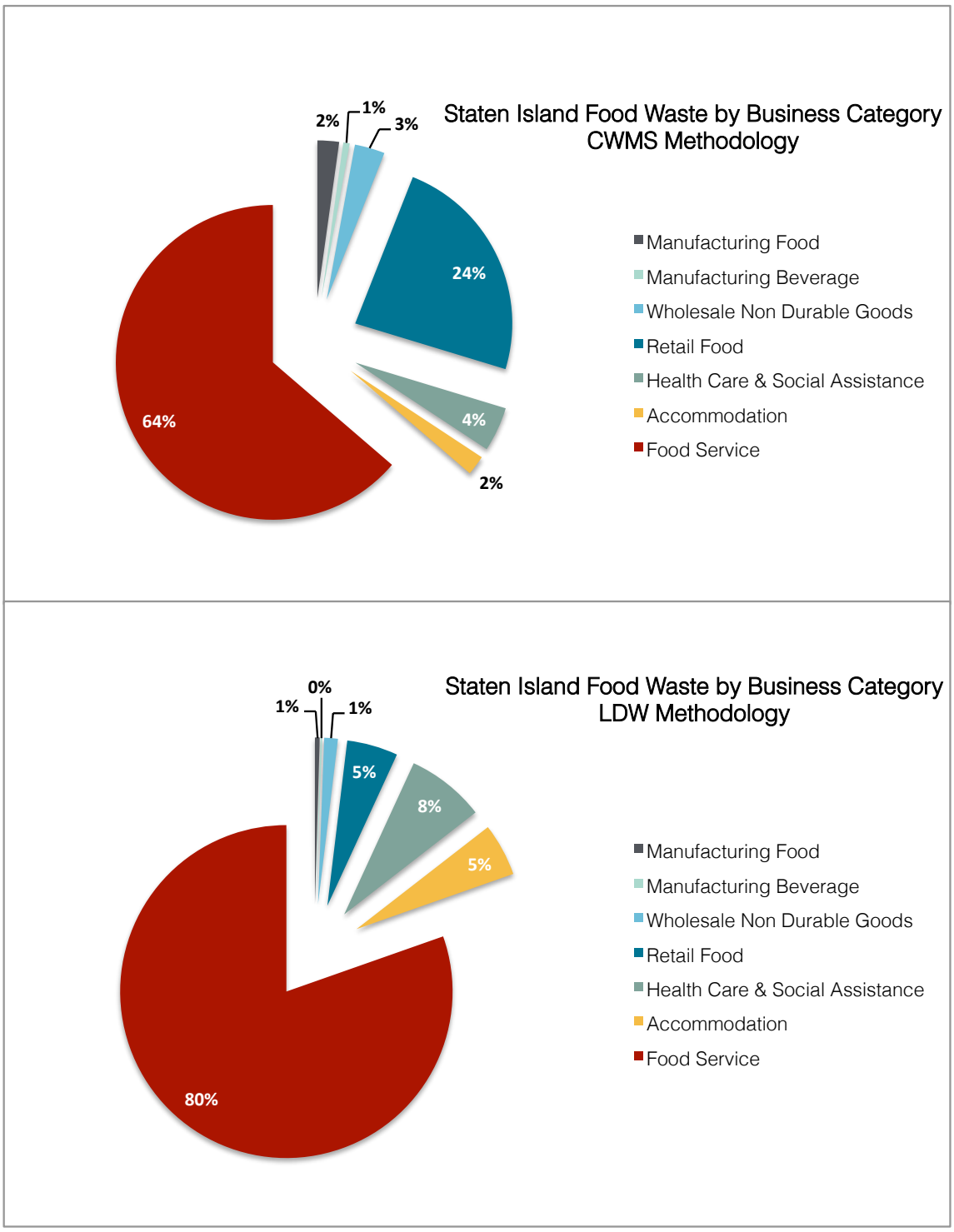


Figure 32: Graphical Summary of Food Waste Generated in Staten Island by Business Category

The following table provides a breakdown of the tons per year produced by each business category in Staten Island using both methodologies.

Business Category	CWMS Methodology	LDW Methodology
Manufacturing Food	403	69
Manufacturing Beverage	119	20
Wholesale Non Durable Goods	563	197
Retail Food	4,300	740
Health Care & Social Assistance	830	1,140
Accommodation	368	764
Food Service	11,560	12,005
Grand Total	18,144	14,936

Figure 33: Food Waste Generated in Staten Island by Business Category

3.4.6 The Bronx

The Bronx produces the second lowest amount of food waste of all of the boroughs. Based on the CWMS ratio, The Bronx generates 48,664 tons of food waste per year or 10 percent of New York City's food waste. Based on the LDW methodology, the Bronx generates 34,123 tons per year or 8 percent of the New York City food waste.

Based on both methodologies, the Food Service business category is the highest food waste generator in the Bronx. The category produces 23,733 tons or 49 percent of the total food waste based of the borough based on the CWMS methodology or 24,648 tons or 72 percent of the total food waste based on the LDW methodology. The charts below illustrate the breakdown of the food waste generation by business category in the Bronx.

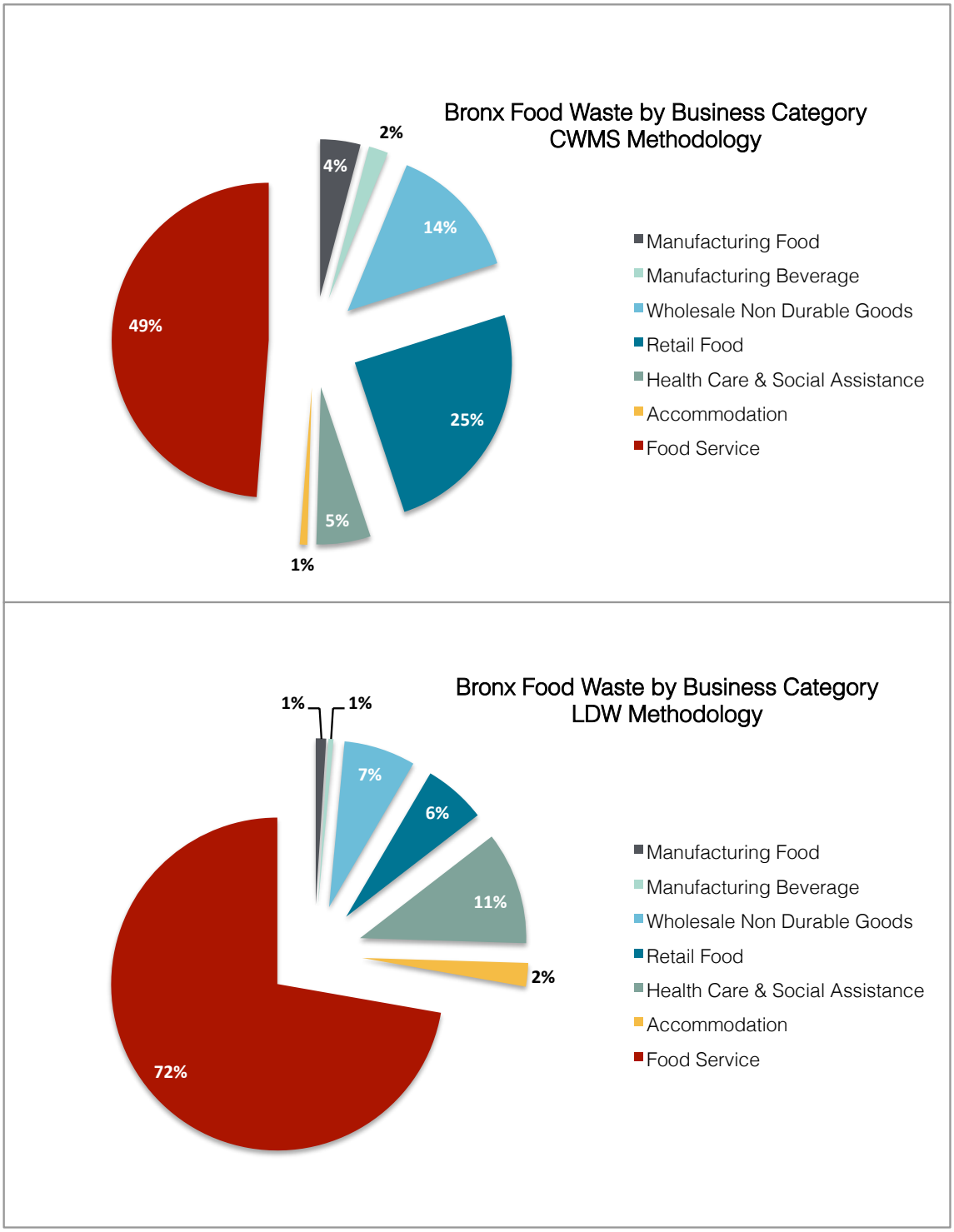


Figure 34: Graphical Summary of Food Waste Generated in The Bronx by Business Category

The following table provides a breakdown of the tons per year produced by each business category in the Bronx using both methodologies.

Business Category	CWMS Methodology	LDW Methodology
Manufacturing Food	2,018	344
Manufacturing Beverage	973	166
Wholesale Non Durable Goods	6,791	2,380
Retail Food	12,057	2,076
Health Care & Social Assistance	2,716	3,731
Accommodation	375	779
Food Service	23,733	24,648
Grand Total	48,664	34,123

Figure 35: Food Waste Generated in The Bronx by Business Category

3.5 Analysis of Anomalies in Generation

3.5.1 Overview

The spatial analysis of commercial food waste in New York City identified certain areas containing noticeably higher generation of food waste. These hotspots are due in large part to concentration of generators or type of businesses located within that specified region. Below is an analysis of the anomalies of JFK International Airport, Hunts Point, and midtown Manhattan.

3.5.2 John F. Kennedy International Airport

The John F. Kennedy International Airport (JFK) in Jamaica Bay, Queens stands out as a region of significantly higher food waste generation that is most noticeable when isolating the Food Service generators. Ranked as the 17th largest airport by the Airports Council International (Airports Council International, “Year to Date Passenger Traffic”), the airport covers 4,930 acres, employs a total of roughly 36,000 people (Port Authority of NY & NJ, “Facts and Information”), and the region is comprised of 37 businesses. Both the CWMS and LDW food waste estimation ratios were based on the number of employees

and passengers traveling through JFK are not taken into account. The JFK airport generates a total of 2,582 and 2,641 tons of food waste per year respectively. Given the size of the census tract containing JFK as well as the number of employees, JFK appears as a significant generator of food waste.

The map below illustrates the concentration of generators and food waste in the JFK airport census tract. In contrast, LaGuardia Airport, a smaller New York City airport located in Flushing, Queens, occupies 689 acres and employs a total of roughly 10,000 people (Port Authority of NY & NJ, “Facts and Information”). The LaGuardia Airport generates a total of 1,319 and 1,362 tons of food waste per year based on the CWMS and LDW methodologies respectively. For this reason, collectively it is not visually represented as large of a waste generator as JFK.

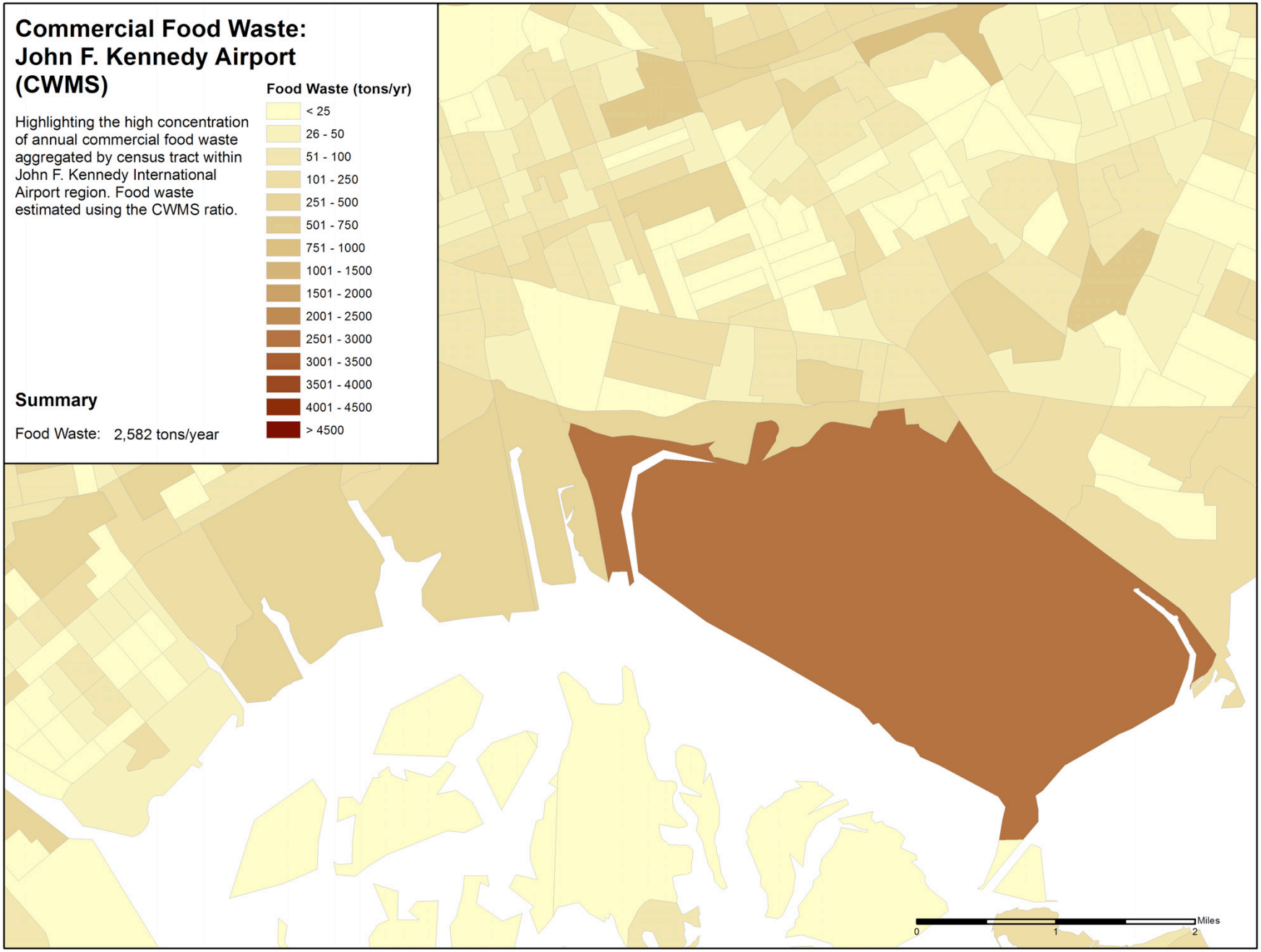


Figure 36: Aggregate Food Waste Generated by JFK Airport, CWMS Methodology

3.5.3 Hunts Point

Hunts Point in The Bronx is the largest food distribution center in the world (Hunts Point). It consists of large, wholesale produce, meat, and seafood markets including 936 generators and approximately 2,400 employees (Hunts Point Cooperative Market). Hunts Point is a significant generator of food waste in New York City, generating 4,437 and 1,325 tons of food waste per year according to the CWMS and LDW methodologies respectively. The variation between these values is due to differences in weightings of the Wholesale, Nondurable Goods business category between the two methodologies. The wholesale markets at Hunts Point contribute to around 20 percent of the food waste generated by the Wholesalers, Nondurable Goods business category.

The map below illustrates the concentration of generators as well as the amount of food waste generated by Hunts Point out of all Wholesale, Nondurable Goods generators.

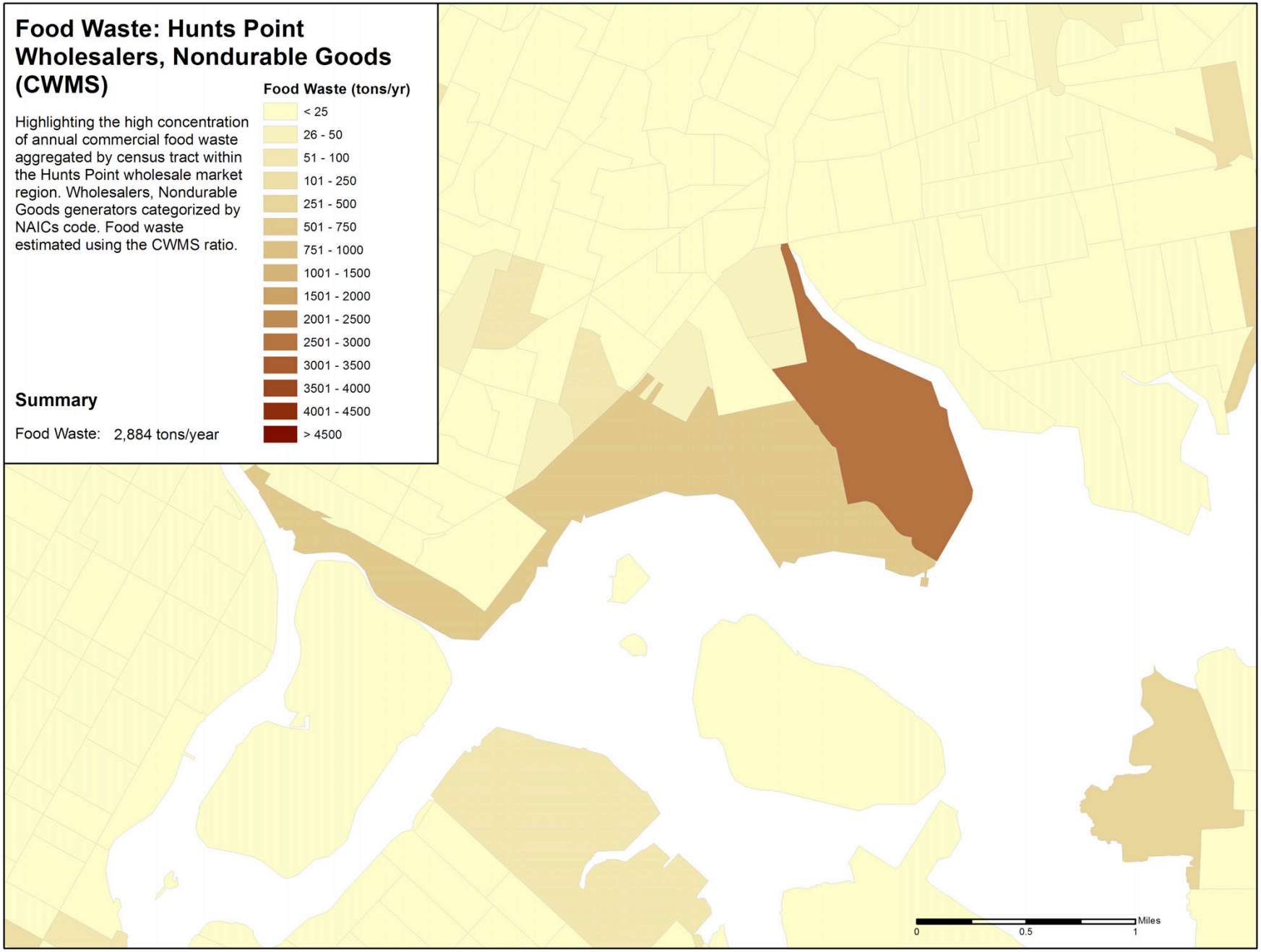


Figure 37: Wholesale Nondurable Goods Aggregate Food Waste Generated by Hunts Point, CWMS Methodology

3.5.4 Midtown Manhattan

Midtown Manhattan is another large source of food waste in New York City. As a tourism hotspot, there is a higher than average clustering of Retail Food, Food Service, and Accommodation generators within that region. This concentration is compounded by the fact that those categories have higher yields in overall annual food waste generation. The zip codes 10019, 10026, 100200, 10036, 10018, 10022, 10017, 10016 are centered within midtown Manhattan. This region contains 3,387 commercial food waste generators, or 9 percent of the total generators. According to the CWMS methodology, midtown is generates 89,438 tons of food waste annually, comprising 18 percent of the total generation. While the LDW methodology points to midtown as comprising 25 percent of the total food waste generation in New York City with 110,881 tons per year. Differences in values of food waste generation are due to variations in weightings between the two methodologies.

The map below illustrates the concentration of generators as well as the amount of food waste generated by midtown Manhattan.

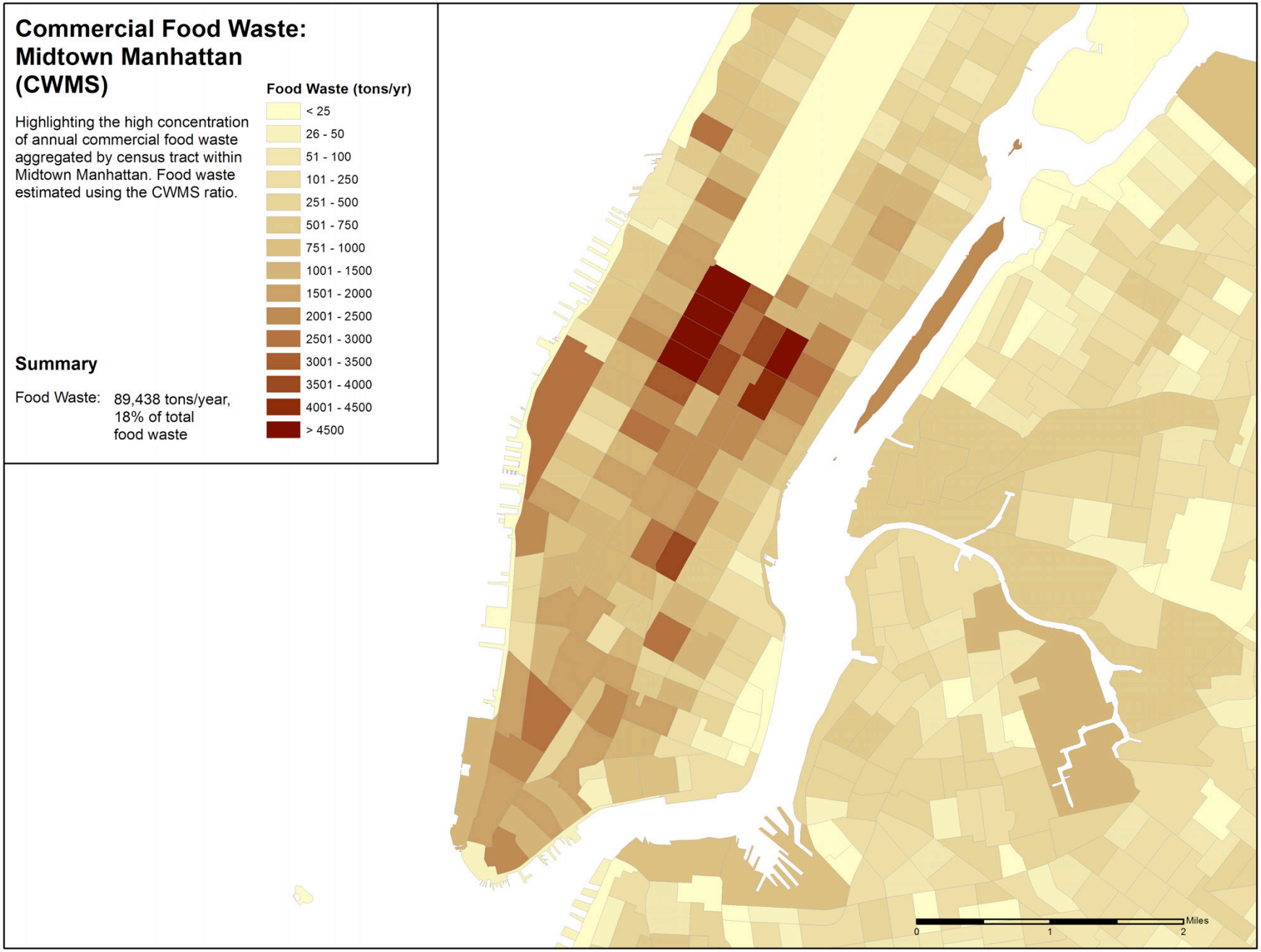


Figure 38: Aggregate Food Waste Generated by Midtown Manhattan, CWMS Methodology

4. Recommendations

4.1 Overview

The proposed recommendations take into account the challenges faced by each of the key stakeholders involved to ultimately support the end-goal of food waste diversion. The first recommendation is a food waste diversion mandate that would impact and regulate commercial generators. The second recommendation provides economic incentives for private carters to make food waste diversion a more lucrative business model. The third recommendation focuses on increasing processing capacity by targeting private sector companies with the adequate solutions and technologies to process food waste in the New York City area.

Stakeholders Involved	Recommendations
Commercial Food Waste Generators	Food Waste Diversion Mandate
Waste Hauling Carters	Incentives for Carters
Private Sector	Food Waste Processing Capacity

4.2 Policy Recommendations

4.2.1 Food Waste Diversion Mandate

Connecticut and Massachusetts provide a baseline for some of types of mandates New York City can pursue with respect to commercial food waste diversion. Yet, New York City faces unique challenges with respect to food waste both in complexity and scale as compared with other cities and states. For example, Massachusetts produces three times more food waste than New York City, but has thirty five times the land size of New York City to handle the waste. Therefore, a diversion mandate in New York City would require a phased approach supported in parallel by incentives to the private carters to make picking up food waste economically feasible in addition to investment in the city's waste management infrastructure.

Designing a Waste Diversion Mandate Through Data Analysis

As discussed in the benchmarking section, the Connecticut and Massachusetts diversion mandates take a very straightforward approach of regulating generators that produce either more than two tons of food waste per week (104 tons per year) or one ton per week (52 tons per year). If New York City were to pursue a similar mandate, based on the data analysis (using the CWMS methodology) the potential impacts on generators and total food waste diversion are listed below:

Diversion Mandate at the 104 tons/year

- 505 generators impacted
- 23% food waste diversion
- 111,451 tons/year of total food waste diverted

Diversion Mandate at the 52 tons/year

- 1,256 generators impacted
- 34% food waste diversion

- 164,924 tons/year of total food waste diverted

Generator Thresholds

Because the end-goal of a diversion mandate for New York City is to maximize the amount of food waste diverted from landfills while minimizing the number of stakeholders impacted, thresholds at the 25 percent target diversion and 50 percent target diversion were set to identify the number of and types of stakeholders that would be impacted. The threshold numbers vary slightly (approximately 2-5 percent) depending on which methodology is used (CWMS or LDW). However, using the adjusted CWMS methodology, it is clear that the relationship between the amount of food waste produced in New York City and the percent of generators is not linear, but rather a logarithmic function (as seen in Figure 39). In terms of policy impact, because a large proportion of food waste is generated by a very small number of generators, it is easier to implement and manage. For example, the graph below indicates that 30 percent of the generators produce over 70 percent of the total food waste in New York City.

Addition detailed information on the waste generation thresholds is provided in Figure 39.

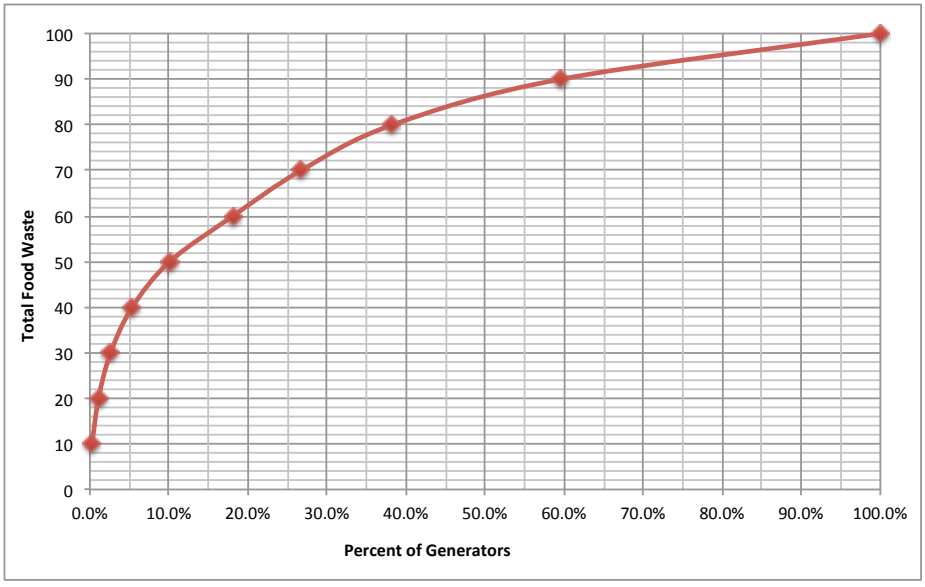


Figure 39: Total Food Waste Generation as a Percent of Total Generators

Generation Thresholds as Percentage of the Total	Percent of Total Generators	Number of Businesses	Lowest food waste threshold (tons/year)	Total Food Waste (tons/year)
0-10%	0.00	113.00	251.60	51,057.00
11-20%	0.01	292.00	125.80	48,786.00
21-30%	0.02	573.00	62.90	48,717.00
31-40%	0.03	1,022.00	37.70	48,709.00
41-50%	0.05	1,775.00	21.40	48,740.00
51-60%	0.08	2,986.00	15.10	48,708.00
61-70%	0.09	3,228.00	15.10	48,724.00
71-80%	0.12	4,325.00	7.90	48,721.00
81-90%	0.21	7,963.00	5.00	48,715.00
91-100%	0.40	15,108.00	0.10	46,281.00
TOTAL		37,385.00		487,158.00

Figure 40: Generator Thresholds

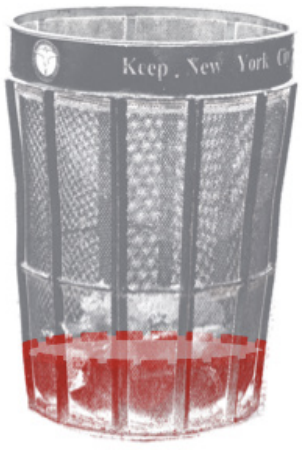
25% and 50% Target Diversion Mandate

One alternative is for the City to pursue a tiered approach to mandate commercial food waste diversion targeting the top 25 percent and top 50 percent of food waste generators. The mandate will have specific timelines for compliance that are contingent upon the development of the City's food waste recovery infrastructure. Targets and timelines for food waste diversion mandates should also be consistent with PlaNYC goals of 75 percent diversion by 2030.

25% Food Diversion Target

Pass a mandate or city ordinance to divert 25 percent of the waste, which will target only 2 percent of the total generators (approximately 600 businesses) by the year 2015. These are generators with more than 86 tons of food waste per year according to the CWMS data analysis. The total food waste diverted at this threshold level is 124,137. According to the EPA Greenhouse Gas Equivalences Calculator, diverting this amount of food waste per year is equivalent to:

- Metric Tons of CO_2 emissions ($MTCO_{2e}$) = 85,861
- GHG emissions from 16,835 passenger vehicles
- CO_2 emissions of electricity use of 10,706 homes for a year
- CO_2 emissions from 9,625,673 gallons of gasoline consumed



Adjusted CWMS Top 25%	>85.7 t/y				
Generator Type	CWMS_FW	Diverted FW	% FW Diverted	# Gen Affected	% Gen Affected
Man. Food	5,944	5,430	1%	26	0%
Man. Bev	1,133	1,047	0%	4	0%
Retail Food	25,848	25,591	5%	134	0%
Wholesalers, Nondurable	8,492	8,215	2%	42	0%
Health Care & Social Services	6,671	6,243	1%	33	0%
Accommodation	25,826	25,655	5%	91	0%
Food Service	50,499	50,156	10%	308	1%
Grand Total	124,137	122,338	25%	638	2%
LDW Top 25%	>129.3 t/y				
Generator Type	DSNY_FW	Diverted FW	% FW Diverted	# Gen Affected	% Gen Affected
Man. Food	0.00	0.00	0%	0.00	0%
Man. Bev	0.00	0.00	0%	0.00	0%
Retail Food	325.00	67.00	0%	2.00	0%
Wholesalers, Nondurable	758.00	499.00	0%	3.00	0%
Health Care & Social Services	8924.00	8278.00	2%	31.00	0%
Accommodation	58374.00	58116.00	13%	124.00	0%
Food Service	41168.00	40651.00	9%	199.00	1%
Grand Total	109550.00	107610.00	25%	359.00	1%

Figure 41: Characterizing the Generators Comprising the Top 25%

Adjusted CWMS Top 25% by Generator Category and Borough						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	5	6	9	6	-	26
Man. Bev	-	2	1	-	1	4
Retail Food	53	10	20	39	12	134
Wholesalers, Nondurable Goods	7	19	7	9	-	42
Health Care & Social Services	11	8	8	5	1	33
Accommodation	82	1	2	5	1	91
Food Service	236	13	20	27	12	308
Grand Total	394	59	67	91	27	638

Figure 42: Top 25% by Generator Category and Borough, CWMS Methodology

Adjusted CWMS Top 25% by Generator Category and Borough (Percentage)						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	1.0%	1.0%	1.0%	1.0%	0.0%	4.0%
Man. Bev	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Retail Food	8.0%	2.0%	3.0%	6.0%	2.0%	21.0%
Wholesalers, Nondurable Goods	1.0%	3.0%	1.0%	1.0%	0.0%	7.0%
Health Care & Social Services	2.0%	1.0%	1.0%	1.0%	0.0%	5.0%
Accommodation	13.0%	0.0%	0.0%	1.0%	0.0%	14.0%
Food Service	37.0%	2.0%	3.0%	4.0%	2.0%	48.0%
Grand Total	62.0%	9.0%	11.0%	14.0%	4.0%	100.0%

Figure 43: Percentages of Top 25% by Generator Category and Borough, CWMS Methodology

LDW Top 25% by Generator Category and Borough						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	0	0	0	0	0	0
Man. Bev	0	0	0	0	0	0
Retail Food	2	0	0	0	0	2
Wholesalers, Nondurable Goods	1	0	1	1	0	3
Health Care & Social Services	10	7	8	5	1	31
Accommodation	112	1	2	7	2	124
Food Service	161	6	13	14	5	199
Grand Total	286	14	24	27	8	359

Figure 44: Top 25% by Generator Category and Borough, LDW Methodology

LDW Top 25% by Generator Category and Borough (Percentage)						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Man. Bev	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Retail Food	1.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Wholesalers, Nondurable Goods	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Health Care & Social Services	3.0%	2.0%	2.0%	1.0%	0.0%	9.0%
Accommodation	31.0%	0.0%	1.0%	2.0%	1.0%	35.0%
Food Service	45.0%	2.0%	4.0%	4.0%	1.0%	55.0%
Grand Total	80.0%	4.0%	7.0%	8.0%	2.0%	100.0%

Figure 45: Percentages of Top 25% by Generator Category and Borough, LDW Methodology

50% Food Diversion Target

As the processing capacity of food wasted is scaled up in the city, the mandate could be increased to target 25-50% of top generators by the year 2020, for example. These are generators with more than 22 tons of food waste per year according to the adjusted CWMS data. The total food waste diverted at this threshold level is 246,158 tons per year. According to the EPA Greenhouse Gas Equivalences Calculator, diverting this amount of food waste per year is equivalent to:

- Metric Tons of CO_2 emissions (MTCO2e) = 170,033
- GHG emissions from 33,340 passenger vehicles
- CO_2 emissions of electricity use of 21,201 homes for a year
- CO_2 emissions from 19,061,996 gallons of gasoline consumed.

Adjusted CWMS Top 50%	>21.3t/y				
Generator Type	CWMS_FW	Diverted FW	% FW Diverted	# Gen Affected	% Gen Affected
Man. Food	9,822	9,672	2%	125	0%
Man. Bev	1,471	1,450	0%	11	0%
Retail Food	46,394	46,330	10%	627	2%
Wholesalers, Nondurable	13,014	12,950	3%	179	0%
Health Care & Social Services	8,828	8,700	2%	91	0%
Accommodation	31,721	31,657	6%	226	1%
Food Service	134,909	134,823	28%	2,523	7%
Grand Total	246,158	245,583	50%	3,782	10%
LDW Top 50%	>26.17				
Generator Type	DSNY_FW	Diverted FW	% FW Diverted	# Gen Affected	% Gen Affected
Man. Food	783	652	0%	14	0%
Man. Bev	153	127	0%	2	0%
Retail Food	2,984	2,905	1%	61	0%
Wholesalers, Nondurable	2,989	2,936	1%	46	0%
Health Care & Social Services	12,318	12,161	3%	98	0%
Accommodation	67,787	67,708	15%	280	1%
Food Service	120,567	120,462	28%	1,751	5%
Grand Total	207,580	206,952	47%	2,252	6%

Figure 46: Characterizing the Generators Comprising the Top 50%

Adjusted CWMS Top 50% by Generator Category and Borough						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	36	18	40	27	4	125
Man. Bev	3	3	2	2	1	11
Retail Food	246	82	140	139	20	627
Wholesalers, Nondurable Goods	24	65	57	28	5	179
Health Care & Social Services	26	20	21	13	11	91
Accommodation	192	2	8	22	2	226
Food Service	1687	139	273	327	97	2523
Grand Total	2214	329	541	558	140	3782

Figure 47: Top 50% by Generator Category and Borough, CWMS Methodology

Adjusted CWMS Top 50% by Generator Category and Borough (Percentage)						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	1.0%	0.0%	1.0%	1.0%	0.0%	3.0%
Man. Bev	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Retail Food	7.0%	2.0%	4.0%	4.0%	1.0%	17.0%
Wholesalers, Nondurable Goods	1.0%	2.0%	2.0%	1.0%	0.0%	5.0%
Health Care & Social Services	1.0%	1.0%	1.0%	0.0%	0.0%	2.0%
Accommodation	5.0%	0.0%	0.0%	1.0%	0.0%	6.0%
Food Service	45.0%	4.0%	7.0%	9.0%	3.0%	67.0%
Grand Total	59.0%	9.0%	14.0%	15.0%	4.0%	100.0%

Figure 48: Percentages of Top 50% by Generator Category and Borough, CWMS Methodology

LDW Top 50% by Generator Category and Borough						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	3	2	6	3	-	14
Man. Bev	-	2	-	-	-	2
Retail Food	25	6	8	13	9	61
Wholesalers, Nondurable Goods	7	22	7	10	-	46
Health Care & Social Services	26	23	23	15	11	98
Accommodation	231	2	12	32	3	280
Food Service	1176	108	176	217	74	1751
Grand Total	1468	165	232	290	97	2252

Figure 49: Top 50% by Generator Category and Borough, LDW Methodology

LDW Top 50% by Generator Category and Borough (Percentage)						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Man. Bev	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Retail Food	1.0%	0.0%	0.0%	1.0%	0.0%	3.0%
Wholesalers, Nondurable Goods	0.0%	1.0%	0.0%	0.0%	0.0%	2.0%
Health Care & Social Services	1.0%	1.0%	1.0%	1.0%	0.0%	4.0%
Accommodation	10.0%	0.0%	1.0%	1.0%	0.0%	12.0%
Food Service	52.0%	5.0%	8.0%	10.0%	3.0%	78.0%
Grand Total	65.0%	7.0%	10.0%	13.0%	4.0%	100.0%

Figure 50: Percentages of Top 50% by Generator Category and Borough, LDW Methodology

In ArcGIS, the food waste generators that generated more than those values of food waste were visualized spatially. This illustrated the impact of the implementation of a citywide food waste diversion mandate at those specified thresholds. Using the spatial location of these top generators, it was possible to use a similar geoprocessing strategy to create the heat maps of the impacts of the diversion of food waste from the top generators. Using the field calculator in ArcGIS, this new field would contain the values for how much food waste was being diverted under the mandate. In order to calculate this, the formula that was used was “Total Food Waste – Diversion Rate.” This value is indicative of the total amount of commercial food waste that will be diverted for each individual data point within that top 25 percent and top 50 percent layers for both methodologies.

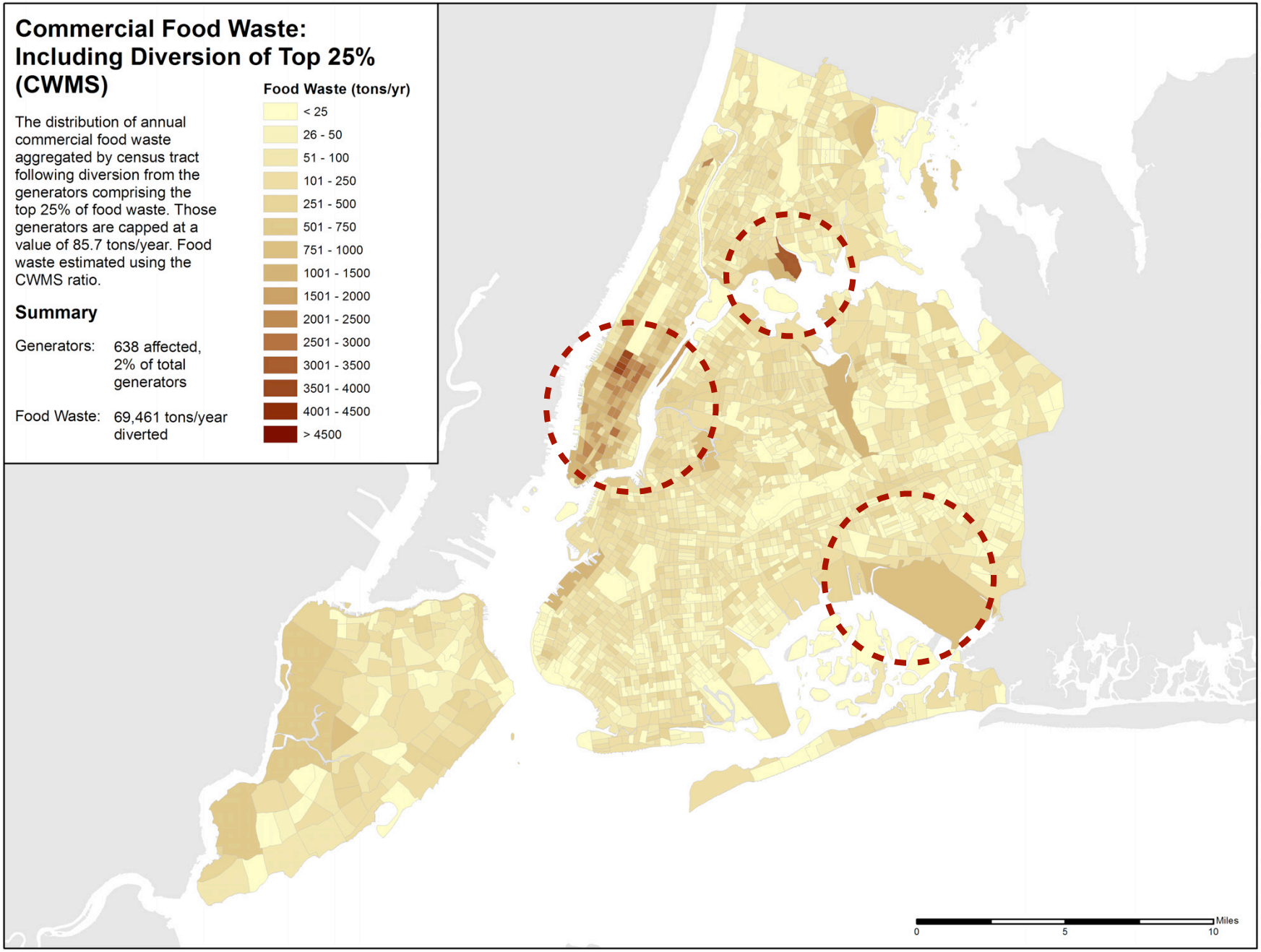


Figure 51: Visualizing the Impact of the 25% Diversion Mandate, CWMS Methodology

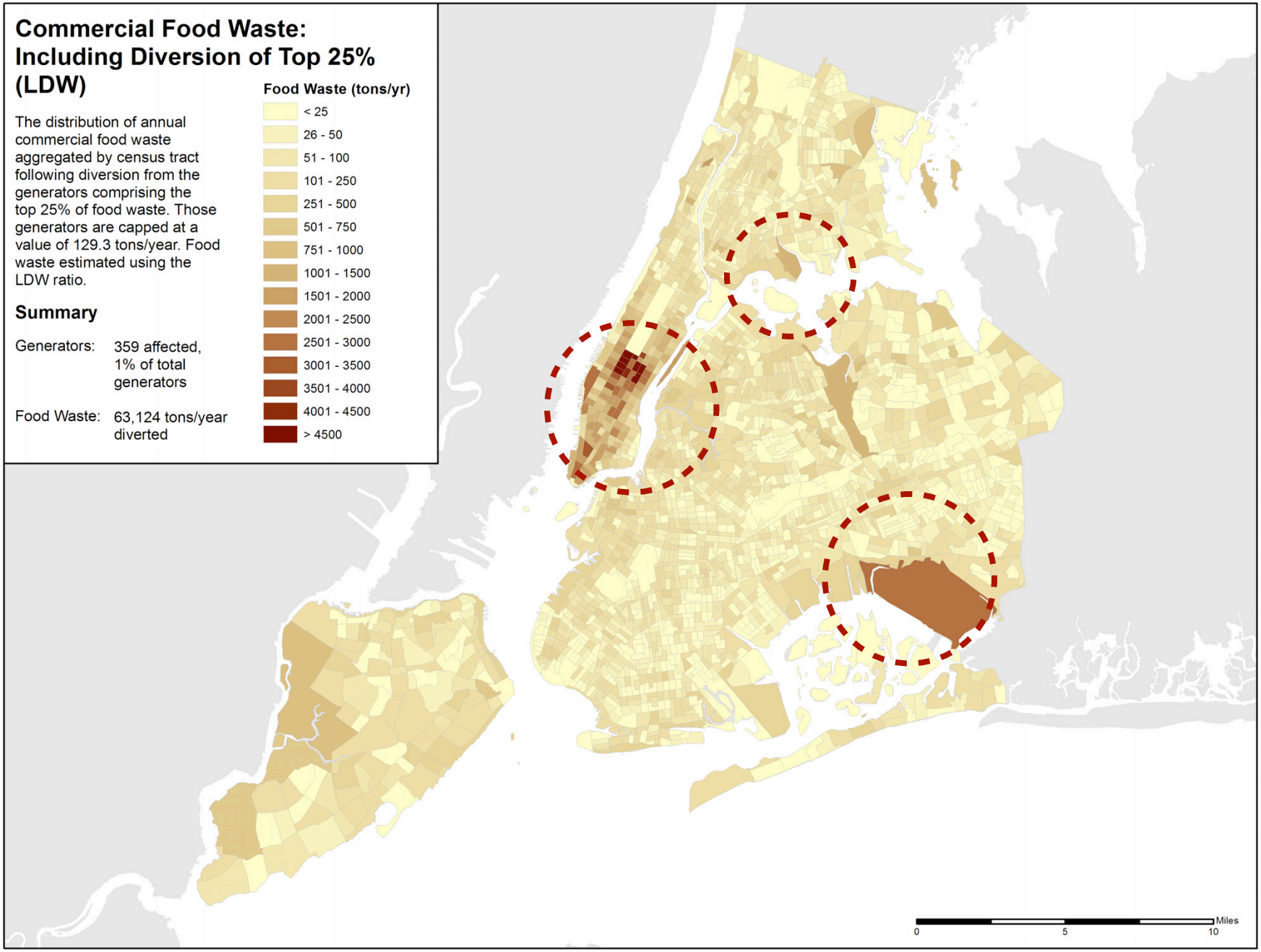


Figure 52: Visualizing the Impact of the 25% Diversion Mandate, LDW Methodology

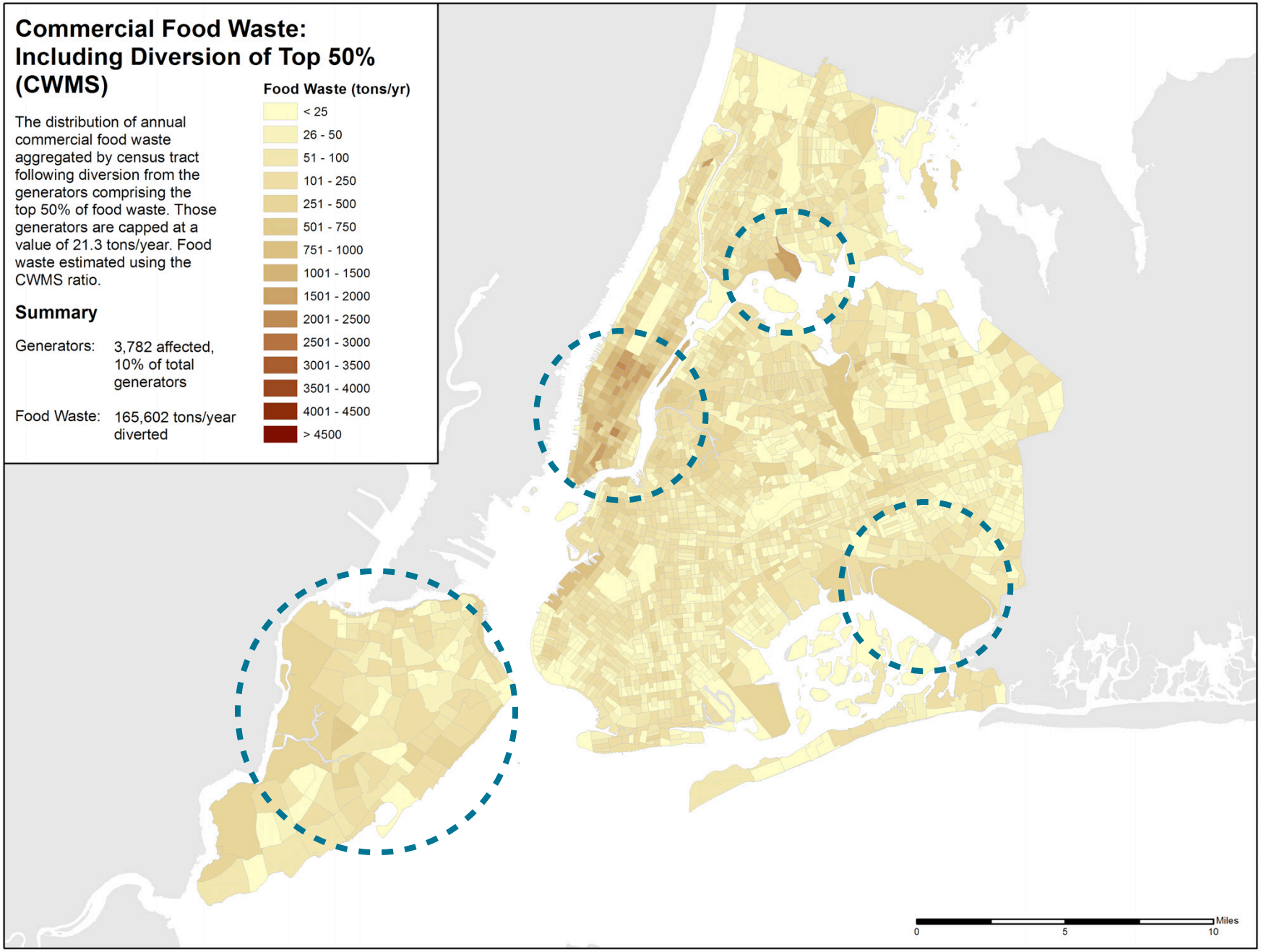


Figure 53: Visualizing the Impact of the 50% Diversion Mandate, CMWS Methodology

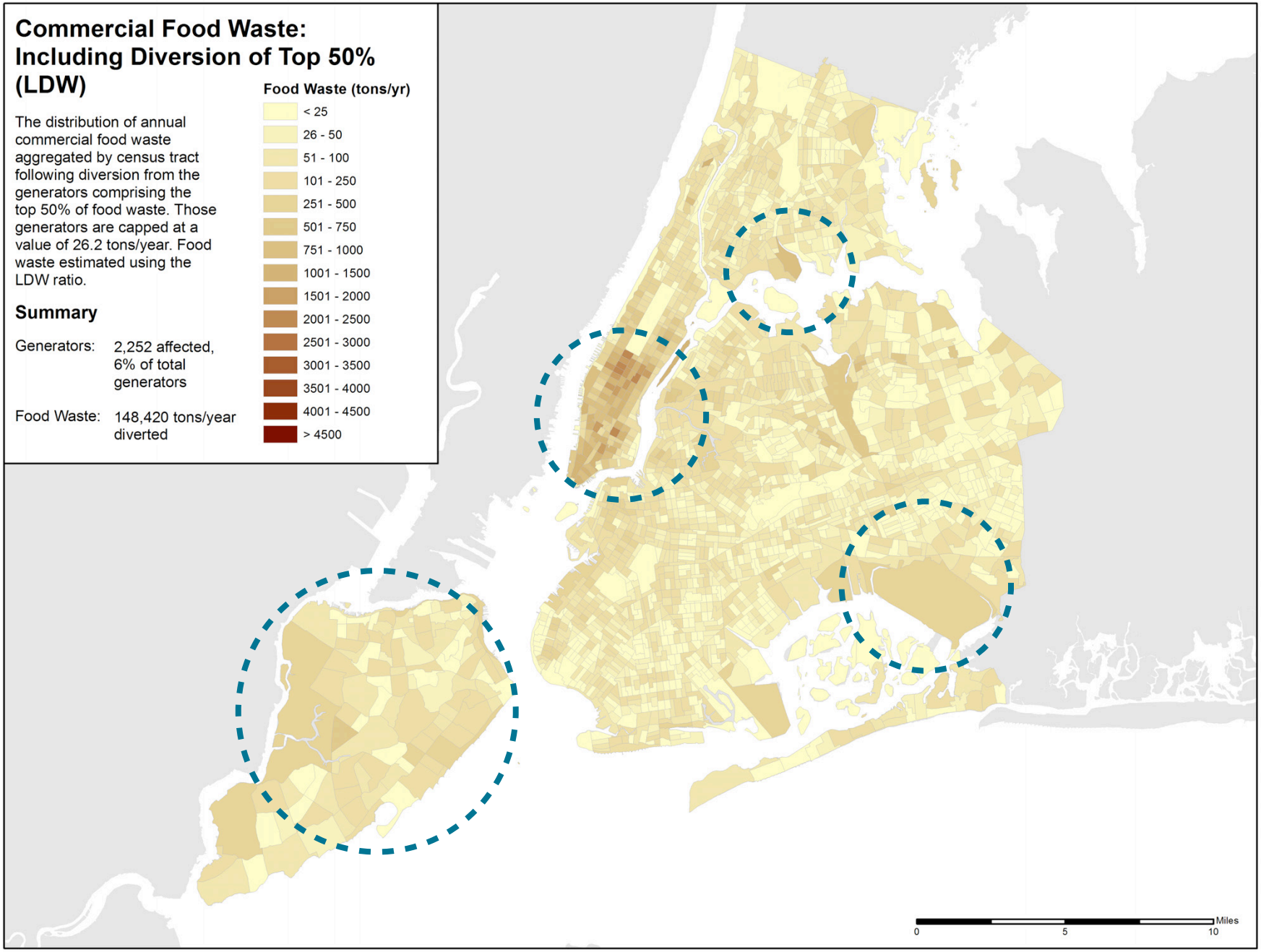


Figure 54: Visualizing the Impact of the 50% Diversion Mandate, LDW Methodology

A 10% Pilot Program

A feasible alternative in the next 12-18 months is to implement a pilot program with the top 10 percent of food waste generators, less than 100 businesses generating more than 280 tons of food waste per year (or roughly more than 5 tons of food waste per week). A pilot program will serve two purposes: 1. Test the political will of all of the stakeholders for a more formal mandate and 2. Assess the immediate projects that need to be implemented in order to scale up the City's food waste recovery infrastructure. According to the CWMS estimates, the 10 percent target would divert approximately 50,000 tons of food waste per year, which is an ideal amount if the City were also to do the pilot project in parallel with siting an AD or composting facility (typical volume required for AD or large scale composting is between 40,000 – 60,000 tons of food waste per year). Below is a summary of the boroughs and business categories that according to the CWMS methodology would be impacted by a 10 percent diversion pilot program.

Adjusted CWMS Top 10% by Generator Category and Borough > 283 t/y						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	1	0	4	2	0	7
Man. Bev	0	2	0	0	0	2
Retail Food	9	1	3	5	3	21
Wholesalers, Nondurable Goods	2	3	1	1	0	7
Health Care & Social	5	3	3	0	0	11
Accommodation	36	0	0	0	0	36
Food Service	22	1	0	5	1	29
Grand Total	75	10	11	13	4	113

Figure 55: Top 10% by Generator Category and Borough, CWMS Methodology

Adjusted CWMS Top 10% by Generator Category and Borough > 283 t/y (Percentage)						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	1.0%	0.0%	4.0%	2.0%	0.0%	7.0%
Man. Bev	0.0%	2.0%	0.0%	0.0%	0.0%	2.0%
Retail Food	8.0%	1.0%	3.0%	4.0%	3.0%	19.0%
Wholesalers, Nondurable Goods	2.0%	3.0%	1.0%	1.0%	0.0%	7.0%
Health Care & Social	4.0%	3.0%	0.0%	0.0%	0.0%	7.0%
Accommodation	32.0%	0.0%	0.0%	0.0%	0.0%	32.0%
Food Service	19.0%	1.0%	0.0%	4.0%	1.0%	25.0%
Grand Total	66.0%	9.0%	10.0%	12.0%	4.0%	100.0%

Figure 56: Percentages of Top 10% by Generator Category and Borough, CWMS Methodology

LDW Top 10% by Generator Category and Borough > 522.24 t/y						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	0	0	0	0	0	0
Man. Bev	0	0	0	0	0	0
Retail Food	0	0	0	0	0	0
Wholesalers, Nondurable Goods	0	0	0	0	0	0
Health Care & Social	1	2	0	0	0	3
Accommodation	34	0	0	0	0	34
Food Service	6	0	0	8	5	19
Grand Total	41	2	0	8	5	56

Figure 57: Top 10% by Generator Category and Borough, LDW Methodology

LDw Top 10% by Generator Category and Borough (Percentage) > 522.24 t/y						
Generator Type	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Total
Man. Food	0%	0%	0%	0%	0%	0%
Man. Bev	0%	0%	0%	0%	0%	0%
Retail Food	0%	0%	0%	0%	0%	0%
Wholesalers, Nondurable Goods	0%	0%	0%	0%	0%	0%
Health Care & Social	2%	4%	0%	0%	0%	5%
Accommodation	61%	0%	0%	0%	0%	61%
Food Service	11%	0%	0%	14%	9%	34%
Grand Total	73%	4%	0%	14%	9%	100%

Figure 58: Percentages of Top 10% by Generator Category and Borough, LDW Methodology

Scope of Compliance Entities: Waste Generators and Haulers

During the above analysis of waste diversion mandates under different generation threshold levels, the target is the commercial waste generator. However, a generator's responsibility to achieve compliance would only extend to properly sorting food waste in separate bins. Therefore, in order to divert food waste from landfills, a waste diversion mandate must also be enforced on the private haulers responsible for collecting and removing the food waste. In the following section, 5.2.2 "Replace Open Market System with Multiple Exclusive Franchise," alternative regulatory frameworks are evaluated to determine policy tools that other cities have employed to enforce and incentivize haulers comply with a food waste diversion mandate.

4.2.2 Replace Open Market System with Multiple Exclusive Franchise

Current Waste Removal System: The Rate Cap, Open Market, and Recycling

The waste trade industry in New York City is structured as an open market system in which private carters negotiate with commercial waste generators to determine a price for waste removal services.

As mentioned above, BIC is the regulatory agency that monitors private carters for committing illicit activities and sets the cap on the rate that private carters can charge commercial generators for collecting and hauling their waste. Private carters can charge either based on volume at $15.89 per cubic yard of loose refuse or based on weight at $10.42 per 100 pounds of refuse (BIC, “Frequently Asked Questions).

Regarding recycling, BIC enforces legislation that mandates the recycling of glass or metal, plastic bottles and jugs, aluminum foil and aluminum foil products, and cardboard (BIC, “Recycling”). However, the current system has no enforcement mechanism in place to require food waste diversion.

Political and Economic Challenges to Lowering the Disposal Rate for Food Waste

New York City attempted to increase food waste diversion in 2010 through a food waste composting bill, which would have authorized BIC to reduce the rate cap for compostable waste in order to incentivize commercial generators to properly sort food waste. However, BIC needs to address several competing interests of carters, generators, and regulatory oversight in order to lower the rate cap for food waste:

- Require carters divert food waste to alternative processing facilities, but address the growing operational costs involved with food waste disposal.

- Offer a lower disposal rate to incentivize generators to sort their food waste, but compensate carters for setting rates that are not cost effective.
- Achieve the above goals, while maintaining strict oversight of carters for setting unreasonably high disposal rates .

Statistics on annual violations committed by carters demonstrate that BIC has a responsibility to protect generators from carters committing illegal activities, including overcharging customers. Over the past four years, 200 private carters have committed between 1,200 and 1,600 violations per year (NYC Mayor's Office of Operations" 44). Although this data from the 2012 Mayor's Management Report does not identify the exact number of violations for setting prices above the rate cap, it highlights the continued need for BIC to ensure that the disposal rate for not only food waste, but all waste is priced at a reasonable rate for commercial waste generators.

Recommendation: Institute a Multiple Exclusive Franchise System

The following is an explanation of the three alternative systems to an open market:

- **Multiple Exclusive Franchise**: DSNY awards contracts to haulers for commercial waste removal based on geographic zones and includes pricing and food waste diversion requirements in each contract (HF&H Consultants 12).
- **Single Exclusive Franchise:** The same structure as the multiple exclusive franchise, except only one hauler wins a waste removal contract for the entire city (HF&H Consultants 11)
- **Non-exclusive Franchise**: DSNY bids out contracts with diversion requirements but prices are negotiated between the hauler and customer (HF&H Consultants 11).

BIC should adopt the multiple exclusive franchise system because it provides the highest level of flexibility in program design in order to reform the

rate cap to underprice food waste, while still maintaining oversight of illicit pricing by haulers.

Under all three franchise systems, a waste removal contract between New York City and the hauler empowers the city to incorporate food waste diversion requirements directly into waste removal contracts, but only a single and multiple exclusive franchise would enable the City to mandate all haulers collect food waste at a lower rate than other types of waste (HF&H Consultant 16). Key examples that illustrate this point include:

- **Seattle, WA:** Offers an exclusive franchise system that includes more than one hauler, and requires all sorted food waste be charged 32 percent below other types of waste (City of Seattle).
- **Pomona, Pasadena, and five other communities in Los Angeles County, CA**: Among the seven communities in Los Angeles County that have non-exclusive franchises, none regulate waste disposal rates (HF&H Consultants 18).

In turn, a single or multiple exclusive franchise system would enable BIC to incorporate a reformed rate cap that incentivizes generators to sort their food waste, so carters are not burdened with the cost of doing so. However, as mentioned above, NSWMA has actively lobbied against lower disposal rates for food waste because of rising operational costs to export refuse. Therefore, BIC must design a dynamic disposal rate for food and other types of waste by emulating efforts of cities that have considered or implemented exclusive franchise systems:

- **Chicago, IL**: Considered adopting an inflation adjusted rate cap, in which either the Consumer Price Index or a fuel index would be used to increase waste disposal rates each year (City of Chicago 13).
- **Los Angeles and San Jose, CA:** In order to subsidize a lower disposal rate, large carters pay a fee for earning a waste removal contract. In Los Angeles, this fee is used to provide a tax revenue base to rebate those haulers that collect heavier food waste and have higher operational costs, currently at $55 per ton (City of Los Angeles

Department of Sanitation, “Food Waste Diversion”), while haulers moving less than 1,000 tons per year are exempt from the fee to limit impact on smaller haulers (City of Los Angeles Department of Public Works 97).

For New York City, a multiple exclusive franchise system could incorporate Chicago’s proposed inflation based indicator and Los Angeles’ rebate incentive program to address growing costs for waste removal services, while accounting for underpriced food waste disposal rates by imposing a fee on large haulers that can afford such a fee. Equally important, BIC could continue to ensure a reformed rate cap is in place in order to deter haulers from overpricing commercial generators.

The primary cost associated with single exclusive and multiple exclusive franchise systems is that small haulers are unable to compete in the market for waste contracts (HF&H Consultants 24). Past precedent suggests that this is inherent in any attempt to design a franchise model, as demonstrated by San Francisco with one hauler, Seattle with two, and Chicago considering only one as well. In New York City, designing a geographically zoned exclusive franchise system faces the prospect of additional backlash from NSWMA and the entire waste hauling industry because the current open market system has made it cost effective for smaller haulers to operate and compete. With 200 haulers competing for only a select number of geographical zones, it is important to consider other cities’ efforts to address this challenge, such as Los Angeles:

- **LA’s Zoning System:** With 19 of the 45 haulers collecting less than 1,000 tons per year, Los Angeles is considering designing a geographically zoned franchise system, and setting aside one district for small scale haulers to compete for contracts (Carrol 2).

While the opportunities for small scale carting would be impacted in New York City under a multiple exclusive franchise, assigning a zoned area to only small haulers would be a valuable compromise to maintain competitiveness for preexisting haulers in the City.

4.2.3 Private Developers to Increase Food Waste Processing Capacity

Stakeholder Insight

As discussed in the introduction, only approximately 12,000 tons of food waste per year in the city is currently sent to commercial processing facilities for composting and resource recovery. Therefore, to divert the 124,122 tons per year at the 25 percent threshold level, the city together with private investors and partnerships, needs to increase the processing capacity for organics recovery by tenfold.

Based on an interview with the CEO of Action Carting Ron Bergamini, although Action is only hauling 35-tons per day of food waste, disposal has high operational costs, specifically with respect to transportation to the Peninsula Composting site, which is 125 miles away from New York City. Action's capital investment in the specially designed trucks to transport food waste is in the hundreds of thousands of dollars in addition to the labor costs for two full time drivers that take the food waste to Peninsula every day. These high operational costs highlight the importance of identifying opportunities to expand the food recycling capacity to make hauling food waste a sustainable model for private carting businesses.

An ideal solution is to site an anaerobic digestion (AD) or composting facility within at least a twenty-mile radius of New York City to mitigate transportation costs. A potential intermediate solution, as the volume of commercial food waste diversion increases, is for transfer stations to offer a competitive pricing scheme to haulers to tip food waste in order to increase daily tonnage collected.

Increasing the tonnage of food waste collected in a 24-hour period at the transfer stations will decrease transportation costs significantly because the food waste can be consolidated into a long-haul truck to be transported to Peninsula. In fact, according to a study by Global Green, Shipping food waste to Peninsula

using a 'long-haul' truck would be using an asset that costs half the price of a garbage food truck and that is built for driving long distances (de la Houssaye and White). This intermediate solution will not only provide additional economic incentives for both the carters, by lowering tipping fees for food waste, and tipping stations, by increasing tipping fees in terms of volume, but it will also allow private carters to mitigate the operational costs of food waste disposal. The following analysis further evaluates the key challenges and solutions to increasing food waste processing capacity.

Current Economic Competitiveness of Food Waste Processing Facilities

There are three key factors that impact the economic competitiveness of large scale food waste processing facilities in New York City:

- Tipping fee of AD and composting facilities relative to proximate waste transfer stations
- Upfront capital costs for project development of facilities
- Proximity of facilities for carters to tip their waste

When a private hauler carts food waste and seeks to tip its product at a transfer station or processing facility, a large scale food processor must offer a tipping fee that is competitive, and ideally, lower than waste transfer stations (NYCEDC 7-4). According to the NSWMA, tipping fees at New York City transfer stations have increased between 50 percent and 60 percent from 1997 through 2007, which is equivalent to double the inflation rate during this ten-year period (R.W. Beck 7-4). As a result, in 2009, New York City tipping fees ranged between $78 and $90.97 per ton, while the average New Jersey tipping in 2009 reached $81 per ton (R.W. Beck 7-5). In turn, food waste processing facilities must offer tipping fees equivalent to this range in order to compete with waste transfer stations.

Adequate policy incentives must also be in place in order to minimize upfront capital costs for developing AD and composting facilities. It is important to note that amidst high upfront capital costs, BIC can impact the economic competitiveness of these processing facilities if it developed an inflation adjusted rate cap, similar to the proposal considered by Chicago (City of Chicago 13).

While not a politically feasible option given continued illegal pricing activities committed by private haulers, if BIC removed the rate cap entirely, the New York City Economic Development Corporation (NYCEDC) claims, "it is possible that tipping fees would rise at transfer stations once the carters have more ability to charge higher rates and pay increased tipping fees (R.W. Beck 7-6)." However, it is uncertain to what extent a rising and tiered rate cap for food and other waste would impact tipping fees at transfer stations.

Since many haulers travel an additional hour or more to tip their waste at composting facilities, the chairman of NSWMA argues that added fuel and other transportation related costs outweigh the lower tipping fees at currently operating facilities located far away from New York City (Biderman 1). Therefore, it is important for policy incentives to be in place for AD and composting project developers to site in or near New York City in order to minimize transportation costs for haulers.

Available Public Financing Options

Currently, private developers of food waste processing facilities can take advantage of two state level policy incentives to alleviate project development costs:

NYSERDA Incentive: Maximum $1 million for AD facilities

The New York State Energy Research and Development Authority (NYSERDA) has allocated $57 million to finance the construction and operation of anaerobic digester facilities in New York through its "Renewable Portfolio Standard Customer Sited Tier Anaerobic Digester Gas To Electricity Program" (NYSERDA 1). Through this program, an AD project developer can obtain two payments

based on its facility's capacity and expected performance equal to no more than $1 million through 2015. The "Capacity Incentive" is equal to $1,000 per kilowatt (kW), but cannot exceed the lesser of $850,000 or expected capital expenses (NYSERDA 3). Next, the "Performance Incentive" is calculated by multiplying the kW capacity by 8,760 hours per year by 3 years by $0.10 per kWh by a 75 percent capacity factor (NYSERDA 3). If this approach for calculating the performance incentive leads to the two payments collectively exceeding $1 million, the other method to calculating this portion of the incentive is to receive a payment equal to $1 million minus the capacity incentive (NYSERDA 3).

NY DEC Grant: Maximum $2 million for composting and AD facilities

The NY Department of Environmental Conservation (DEC) has a grant scheme called the Municipal Waste Reduction and Recycling Program, in which both materials recovery and composting facilities are eligible for state assistance (DEC, "State Assistance Programs for Waste Reduction, Recycling and Household Hazardous Waste Programs"). Specifically, developers of composting and AD facilities can receive a 50 percent rebate for all capital costs associated with the purchase of equipment and the construction of the facility (DEC, "State Assistance Programs for Waste Reduction, Recycling and Household Hazardous Waste Programs"), with the grant capped at $2 million per site (DEC, "Environmental Notice Bulletin - Statewide Notices").

Given the above incentives already available, an AD or composting project developer could obtain at most $3 million offset for project development costs. If DSNY aims to incentivize large scale processing facilities to site in New York City or the surrounding area, additional strategies need to be implemented because the relative impact on upfront project development costs is minimal. For example, according to the NYCEDC, the siting and construction of an AD facility that received 60,000 tons of food waste per year and produced electricity, digestate, and biogas would cost between $22 and $47 million (R.W. Beck 7-9). For that reason, DSNY should consider additional strategies that other states and cities have implemented to alleviate upfront project development costs for AD and composting facilities.

Alternative Financing Tools

One option that BIC should consider is an innovative public-private financing strategy employed at the state level in California called the "Pollution Control Tax Exempt Bond Financing Program." Under this approach, the California Pollution Control Financing Authority (CPCFA) is authorized to issue tax-exempt bonds with lower coupon payments than traditional financing strategies for private developers of waste recovery and composting facilities (CPCFA, "Tax Exempt Bond Financing Program"). This public financing tool has enabled cities in California to attract large scale AD and composting project developers, including:

- **Zero Waste Energy:** This private developer secured a $32,390,000 bond from the CPCFA to construct a joint AD and composting facility (Royce Printing 1), which has a processing capacity of 270,000 tons of food waste per year (Zero Waste Energy, "San Jose Anaerobic Digestion/Composting Plant.").

Tax exempt bond financing serves as an effective approach to scale up private AD and composting development in NYC because of the city's role in such a financing arrangement. In California, the CPCFA functions as a "conduit issuer" of tax exempt bonds (CFCPA, "Overview"). As explained by the California Bureau of State Audits, a public agency acting as a conduit issuer does not hold any responsibility for paying the bond investors back, but rather its only responsibility in the transaction is to connect borrowers, or the project developers, to investors (California State Auditor 1). In turn, since the private developer pays the face value and coupon payments of the bond, the city can facilitate increased financing of AD and composting facilities without directly bearing the risk of financing these capital intensive projects.

In addition, certain cities and states have consolidated the regulatory permitting process to lower environmental compliance costs for AD and composting facilities. One key example includes:

- **Indiana**: Removed its mandatory solid waste permitting fee for yard waste composting facilities seeking to accept food waste, and inserted key performance requirements from this permit into another marketing and distribution permit (Freeman and Skumatz 42). The consolidation of the permitting process enabled owners of composting facilities to avoid the $12,000 fee incurred for obtaining a solid waste permit (Freeman and Skumatz 42).

Given that state rebate and grant programs already exist for AD and composting facilities, BIC should adopt the permit consolidation and bond financing strategies rather than allocate additional state or local revenue to fund new incentive programs. Moreover, BIC could collaborate with the New York City Department of Finance, New York City's Mayor's Office of Long Term Planning and Sustainability and the New York State Department of Taxation and Finance to design a tax exempt bond financing mechanism similar to the California program. Working with these key actors, BIC would provide valuable tools to complement the preexisting grants and rebates in place to scale up food waste processing capacity as commercial generators are mandated to divert an increasing amount of food waste.

4.3 Technology Innovations

4.3.1 Large Scale Composting

Compost has many physical, chemical and biological benefits. Physical benefits include, improving the physical structure of soil to reduce erosion and to improve the soil's ability to retain moisture. Some of the chemical benefits include the considerable amount of macro and micro nutrients contained in the compost, such as nitrogen, phosphorous, and potassium, which are essential for plant growth (National Composting Council, "USCC Factsheet: Compost and Its

Benefits"). Additional important benefits of compost from a sustainability standpoint, include:

- **Bind Contaminants** – bind heavy metals and other contaminants to reduce leachability and absorption by plants. Contaminated sites with various pollutants can be improved by amending the native soil with compost (National Composting Council, "USCC Factsheet: Compost and Its Benefits")
- **Wetland Restoration** – compost and soil/compost blends can simulate the characteristics of wetland soils, thereby encouraging the reestablishment of native plant species (National Composting Council, "USCC Factsheet: Compost and Its Benefits").
- **Erosion Control** – coarser composts have been used with great success as mulch for erosion control and have been successfully used on sites where conventional erosion control methods have not performed well (National Composting Council, "USCC Factsheet: Compost and Its Benefits").

There are about eight different kinds of composting methods and technologies for large scale or industrial-scale composting. Determining which technology to use for composting depends on the materials being composted. For food organics, higher technology composting systems and greater management are required because food waste materials has been traditionally more difficult to process in typical composting systems due to their nigh nutrient content (Recycled Organics Unit, "On-site Composting").

Composting Facilities

The different kinds of composting technologies lead to having different types of composting facilities. Some facilities are aerated or unaerated and they could also be covered or not covered (Recycled Organics Unit, “On Site Composting”). Some facilities may be small scale and others may be large scale or industrial scale facilities. Depending on the type of technology used, equipment requirements vary at each facility. The following table explains the different types of facilities available.

Composting Method	Facility Information
Passive Piles	Facility where materials are stacked in piles and allowing them to decompose over a long time with little management required.
Windrow Composting	Facility where mixed materials are placed in long, narrow piles and turning or agitating them regularly. This method requires having room for the windrows that are typically 3 to 12 feet high, 10 to 12 feet wide, and hundreds of feet long.
Static Piles	Facility where there is a passively aerated system that has no need for turning like in the windrow composting system, because air is supplied through perforated pipes embedded in the piles or windrows. The open ends of the pipes allow air to be drawn in and circulated through the piles or windrows through a chimney effect created by rising hot gases.
In-vessel Composting	A facility where the composting process is confined within an area and a combination of forced aeration and mechanical turning is required to speed up the composting process.

Figure 59: Composting Facilities

In-vessel composting system is one method that is appropriate for composting food waste because it is supplied with odor control equipment and has the capacity to compost hard-to-manage materials like food waste (Recycled Organics Unit).

In-vessel Aerobic Composting Systems

Although more costly, In-vessel aerobic composting offer better odor control, better aeration, shorter processing time, and require less land area than windrow systems (US EPA, "Food Scrap Recycling"). The type and the volume of organic materials to be processed will determine the size of the vessels. While vertical vessels (e.g., silos) allow larger quantities of organic materials to be processed in smaller land areas, horizontal vessels (e.g., rotating drums, containers, or enclosed tunnels or channels) require a larger land area than silo systems. Also, in-vessel systems require less overall land area to process similar volumes of material than windrow systems due to the lower retention time required. During the active composting phase, the organic materials are aerated either by forcing air through the vessel or by mechanically agitating the material. Agitated systems (e.g., rotary drums, agitated beds, augers) break up the organic materials providing microorganisms with better access to the nutrients needed for digestion. Liquid is added as needed to maintain the moisture content in the organic materials (US EPA, "Food Scrap Recycling").

Key Factors for In-vessel Aerobic Composting Systems

Land Area Requirements

- 3 to 6 acres and additional land space needed for composting US EPA, "Food Scrap Recycling")
- The following steps are recommended for site development (NC State University, "Large Scale Organic Materials Composting")
  - Grade the site to a 2 to 4 percent slope
  - Slope the site toward a collection pond
  - Add minimal paving under the compost (for sludge and municipal solid waste)
  - Build berms around the perimeter to control run-off and run-on
  - Plan areas for raw materials storage, processing, composting
  - Curing, storage, and blending of end product

- Set up equipment in locations convenient to the process
- Construct retainer walls for storage piles
- Develop a screen around the site (fencing/plants/shrubs/trees)

Waste Stream

- Yard trimmings and food scrap plus bulking agent
- Food scrap volume will be limited by the mixture of waste streams to achieve control parameters. Typically processes higher food scrap ratios than windrows – 30 percent to 40 percent of organic materials are food scrap (US EPA, "Food Scrap Recycling").

Cost and Labor

- $80/ton to $110/ton (higher capital costs, lower labor costs)
- Heavy equipment operators, laborers, maintenance personnel, and instrumentation/computer operators (US EPA, "Food Scrap Recycling").

Composting at Peninsula

The Peninsula Compost facility in Wilmington, Delaware is the largest composting facility in the Northeastern United States with a capacity of 550 tons per day of organic waste and current processing of approximately 400 tons per day. Peninsula is a fully operational and permitted in-vessel organics-processing center. Haulers report to access the facility in two different ways: either by using first a transfer station where food is consolidated into a long-haul truck and then transported to the facility; or by sending the waste to the Peninsula facility in a garbage truck. A report published by Global Green indicates that multiple haulers stated that food waste is often sent on a 260-mile round trip to the Peninsula Compost facility in the same truck that collected the material, and that doing this decreases the lifespan of these trucks (de la Houssaye and White).

In order to indicate the overall project cost of a 10,000-ton per year composting facility, a study conducted by Duke University, indicates that the cost of composting a ton of waste over the lifecycle of the facility (without

assuming any revenues from carbon offsets nor compost) is $45.97, which is in line with Peninsula's tipping fees (Wangerman, Kaufmann and Tang).

Regulatory Requirements

Federal, state and/or local regulatory requirements have to be considered for siting a large scale-composting site, including permitting processes also at the local level, state regulators. Typical permits and regulatory requirements that may be encountered during construction and operation include (US EPA, "Food Scrap Recycling"):

- Solid waste management requirements and permits
- Water quality requirements and permits
- National Pollution Discharge Elimination Systems (NPDES) construction stormwater requirements and permits
- Stormwater pollution prevention plan requirements
- Waste/water discharge requirements
- Air permits
- Local zoning requirements
- Local construction/building permits
- Grading and erosion control requirements
- Composting regulations and permits
- Facility Siting and Development

In New York State Article 27, Title 7: Solid Waste Management and Resource Recovery Facilities governs siting and operations of landfills and composting facilities. For composting sites in particular, Article 27 establishes standards to "minimize contamination and odor generation, eliminate pathogens, and produce a mature product (DSNY, "NY State Composting Facilities and Processing Law").

4.3.2 Anaerobic Digestion

Overview of Anaerobic Digestion Process

Anaerobic digestion (AD) involves four key processes in which bacteria break down carbon intensive materials in a deoxygenated environment (Ostrem 5). The four chemical reactions include hydrolysis, acidogenesis, acetogenesis, and methane fermentation. During these phases, an anaerobic digestion system will decompose food waste from a soluble to an insoluble organic substance and then a methane gas (Ostrem 6-8). Although these four stages of decomposition remain the same for various AD systems, different approaches exist regarding the pretreatment of food waste, heating of the waste, timing for each chemical process, and the final stage of methane fermentation.

Regarding pretreatment, food waste can either be shredded into smaller pieces or exposed to chemicals such as sodium hydroxide in order to be directly broken down into a soluble organic compound (Ostrem 16). Next, the digestion process can take place under temperatures between 85° to 95° F, referred to as mesophilic digestion, or at temperatures greater than 13 that 0° F, referred to as thermophilic digestion (US EPA, “Food Scrap Recycling”). The latter process serves as a more effective approach in that a higher temperature applied to decomposition yields increased amounts of methane gas (US EPA, “Food Scrap Recycling”).

For the timing of decomposition, a digester can be designed with a single chamber in which all four types of bacteria for each process exist in the same location, or in four separate chambers for the food waste to pass through (Ostrem 17-18). Essentially, a single stage scenario means that all four chemical processes happen at the same time, whereas under a multichamber scenario, each process happens in distinct locations. Lastly, two methane fermentation processes exist to generate moisture for the bacteria to survive and turn the food waste into methane gas, including wet and dry fermentation (US EPA, “Food Recycling”). Wet fermentation requires higher levels of moisture and may need additional moisture to then be added to the food waste, whereas dry

fermentation necessitates less moisture and may require yard waste to decrease the moisture content (US EPA, “Food Scrap Recycling”).

Key Benefits of Anaerobic Digestion

The AD process produces two valuable outputs, methane biogas and digestate. Both of these benefits of AD are further explained below:

Methane Biogas: Heat and Electricity Generation

Following the methane fermentation phase, the AD process creates a biogas that consists of 60 percent to 70 percent methane, 30 percent to 40 percent carbon dioxide, and minimal amounts of several other substances such as vapor and hydrogen sulfide (US EPA, “Food Scrap Recycling”). The methane biogas can then be used to generate heat, electricity capable of being connected to a grid, or natural gas (US EPA, “Food Scrap Recycling”).

Digestate: An Input for AD or Composting

Along with biogas, AD produces a waste output called digestate, which is a viscous material that remains at the end of the digestion process. Ultimately, the moisture content and other attributes of the feedstock along with the specific digestion techniques used will determine to what extent methane biogas and digestate are produced (R.W. Beck 3-1). Through a process referred to as “dewatering,” the thick digestate can be recycled into the digestion process to increase the moisture content or be turned into a liquid fertilizer (US EPA, “Food Scrap Recycling”). In order to become a fertilizer, the digestate requires substantial amounts of water be transported to the AD facility, thereby reducing the cost effectiveness for the process to take place on site (Ostrem 14). Nevertheless, the digestate can serve as a valuable commodity to be sold offsite to companies in need of digestate to develop their fertilizer products.

Factors for Anaerobic Digestion

Land Area Requirements

Assuming 40,000 tons of food waste per year as feedstock, the EPA projects that AD facilities require 3 to 6 acres of land (US EPA, "Food Scrap Recycling"). Estimates from other studies on land use requirements suggest that the land use requirements vary depending on the digestion techniques used along with permitting requirements (Alternative Resources, "New York City Evaluation of New and Emerging Waste Management and Recycling Technologies").

Waste Stream

An AD facility can receive food waste alone to generate biogas and digestate, while animal waste and organic waste from wastewater treatment plants can be used instead (Arsova 24). As mentioned above, yard waste may serve as an important input for food waste if the moisture content of the food waste is insufficient (US EPA, "Food Scrap Recycling").

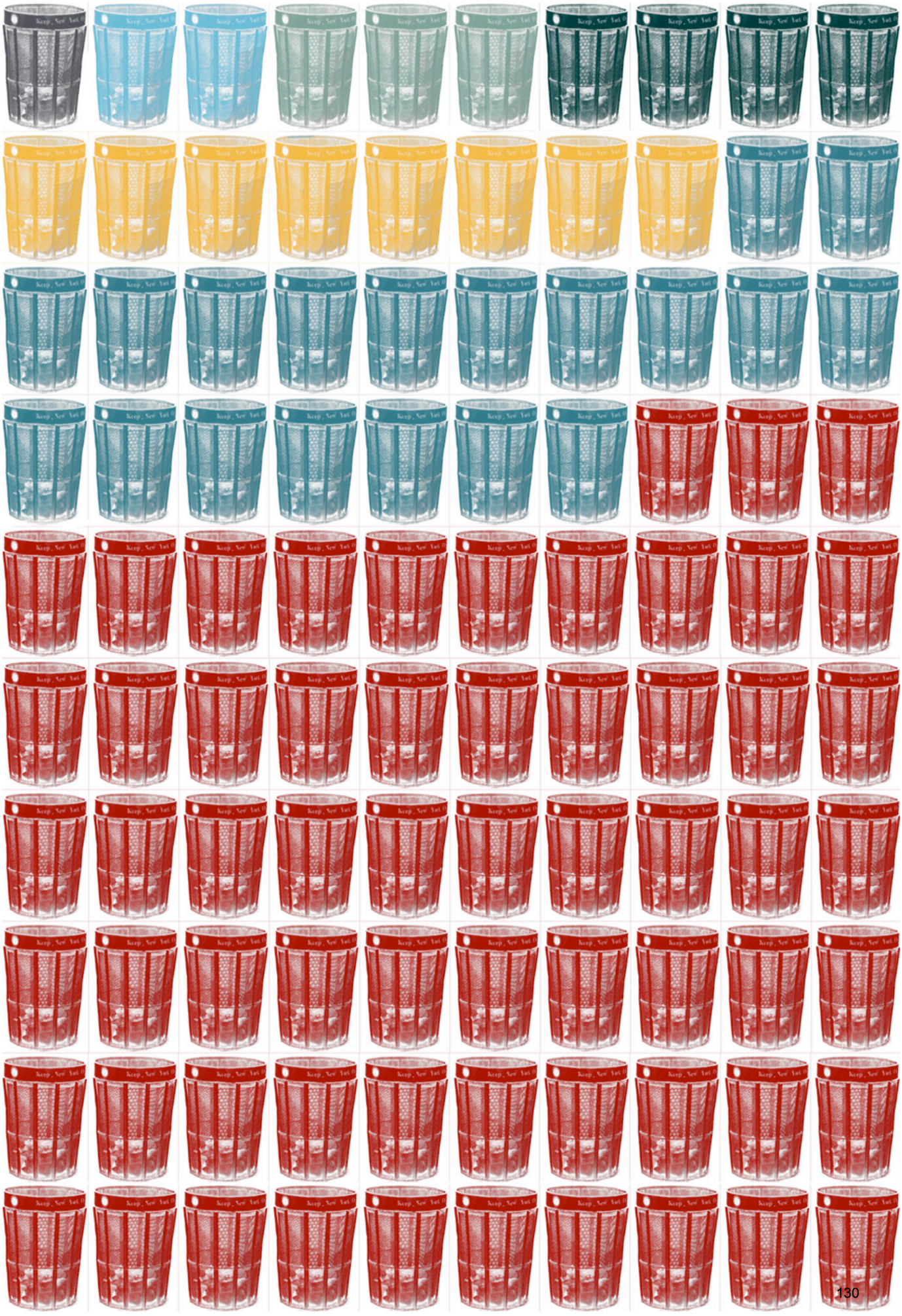
Costs/Labor

Under the 40,000 tons of food waste per week assumption, capital costs related to construction and operation equal to $110 to $150 per ton of food waste (US EPA, "Food Scrap Recycling"). However, such costs can vary depending on the study and reference AD facilities evaluated. A study conducted by the New York City Economic Development Corporation performed a more detailed cost accounting for construction, permitting, and connection to an electricity grid. This report indicated that costs could range from $841.66 to $903.33 per ton of food waste.

Regulatory Requirements

Federal, state and/or local regulatory requirements have to be considered for siting an AD facility. If an AD facility were to be cited in New York City, the following permits and regulatory requirements would need to be considered (R.W. Beck, “Hunts Point Anaerobic Digestion Feasibility Study”):

- Zoning: Manufacturing zone (M3)
- State or City Environmental Quality Review
- Part 360 Solid Waste Permit
- Air Pollution Control
- Noise Mitigation Plan
- Sewer Certification and Connection Permit
- Stormwater Pollution Prevention Plan
- Permit for Stormwater Discharges Associated with Industrial Activities
- Public Participation Plan (if cited as environmental justice area)



5. Conclusion

5.1 Summary

This report was designed to provide the New York City Department of Sanitation with a spatial analysis of the main commercial food waste generators, an estimate of citywide commercial food waste generation and a framework for increasing commercial food waste diversion from landfills. This study also offers DSNY a high level analysis of potential strategies and technological solutions to increase the diversion rate and reduce the total amount of commercial food waste that is currently landfilled in New York State and other neighboring states.

Business Category	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Grand Total
Manufacturing Food	4,494.74	2,018.21	6,215.92	3,955.77	403.25	17,087.89
Manufacturing Beverage	231.13	972.71	273.42	124.91	119.01	1,721.18
Wholesale Non Durable Goods	3,447.52	6,791.22	6,726.33	4,348.33	563.41	21,876.80
Retail Food	32,095.11	12,057.31	23,677.03	18,776.98	4,300.34	90,906.77
Health Care & Social Services	3,755.24	2,716.48	2,869.07	1,677.89	830.11	11,848.79
Accommodation	32,548.23	374.84	1,143.39	2,160.99	367.92	36,595.37
Food Service	168,631.66	23,733.19	53,495.27	49,701.58	11,559.68	307,121.37
Grand Total	245,203.63	48,663.95	94,400.43	80,746.44	18,143.71	487,158.17

Figure 60: Characterization of Commercial Food Waste Generation

Business Category	Manhattan	The Bronx	Brooklyn	Queens	Staten Island	Grand Total
Manufacturing Food	432	170	513	366	51	1,532
Manufacturing Beverage	17	5	16	6	2	46
Wholesale Non Durable Goods	242	418	626	376	73	1,735
Retail Food	2,413	1,573	3,143	1,787	268	9,184
Health Care & Social Services	303	237	352	257	106	1,255
Accommodation	650	38	129	133	17	967
Food Service	9,406	2,431	5,424	4,455	950	22,666
Grand Total	13,463	4,872	10,203	7,380	1,467	37,385

Figure 61: Characterization of Commercial Food Waste Generators

This report analyzed previous work completed by independent consultants for DSNY and it used a commercial dataset, as well as specific food waste production ratios to spatially determine the generation of food waste within New York City at a census tract resolution. The waste generator categories identified were determined through the use of two main sources: InfoUSA's North American

Industry Classification System and the 2004 Commercial Waste Management Study's Standard Industrial Classification codes. The ratios applied to the data were based on previous studies that analyzed the combined waste production across the five boroughs. These ratios were adjusted accordingly to reflect this report's focus on generation of food waste.

The analysis indicated that more than 80 percent of total Commercial Food Waste is currently generated by three specific business categories: Food Service (63 percent of total waste and 60 percent of total businesses), Retail Food (18 percent of total waste and 24.5 percent of total businesses) and Accommodation (7 percent of total waste and 2.5 percent of total businesses).

Although over 50 percent of food waste is generated in Manhattan, it is noteworthy that geographical differences (among boroughs) exist within business categories: for instance it was noted that two thirds of the Wholesale Non-Durable Good category is generated in the Bronx and Brooklyn.

Finally, the overall analysis fed directly into a GIS analysis to spatially locate and identify the food waste that is currently landfilled as well as potential diversion solutions and their impact in a best case scenario hypothesis. The following tables provide a recap of the commercial food waste currently generated by the top five categories (NAICS 2 level: Manufacturing, Wholesale, Retail Food, Healthcare & Social Service, Accommodation & Food Services) and the total number of businesses included in the analysis.

Similarly to what other states and cities such as Massachusetts, Connecticut and San Francisco have done, the first policy recommendation for DSNY is to implement a tiered approach to mandate commercial food waste diversion and to target the top generators of food waste in New York City. The recommendation is to introduce a mandate to target the largest generators of commercial food waste to divert 25 percent of the current food waste generation. Specifically, this mandate would impact generators that produce more than approximately 85 tons of food waste per year. The mandate would impact approximately 2 percent of the total generators identified, or roughly 650 businesses. This would avoid the emissions of approximately 85,000 $MTCO_2e$.

This recommendation could be taken a step further to increase the diversion rate to reduce the food waste currently landfilled by half. Under this scenario, the mandate would impact the top 10 percent of total generators, or generators that produce approximately 25 tons of food waste per year.

For comparison purposes, the Massachusetts and Connecticut food waste reports were analyzed against these recommendations. Based on the Massachusetts food diversion mandate threshold of 104 tons per year, the New York City equivalent would be to create a threshold to divert the 23 percent of food waste, which would affect 506 businesses for about 111,555 tons of waste per year diverted. Based on the Connecticut food diversion mandate threshold of 52 tons per year, the New York City equivalent would be to create a threshold to divert 34 percent of food waste generated, which would affect 1,257 businesses for about 164,924 tons of waste per year diverted. While these examples provide valuable insight regarding best practices for designing a mandate, an appropriate generation threshold level should be primarily informed by the data analysis of New York City's food waste, which reveals the type, location, and total number of generators impacted at varying threshold levels.

The second recommendation for BIC is to replace the open market system with a multiple exclusive franchise model. Currently, carters and generators negotiate disposal rates within the boundary of a rate cap and no enforcement

mechanism is in place to ensure carters divert sorted food waste to alternative processing facilities. The exclusive franchise model would enable BIC to award waste removal contracts to carters for different geographical zones and include food waste diversion requirements in each contract. In tandem with an exclusive franchise should be a dynamic and tiered rate cap that is responsive to carters' concerns about growing waste removal costs, but incentivizes commercial generators to sort food waste that carters receive.

Other cities that have considered or adopted an exclusive franchise provide valuable best practices to design a system that addresses the competing interests of a city in need of strict oversight of carter activities, but also incentives for generators to properly sort food waste and carters to then divert food waste to alternative processing facilities. Cities such as San Francisco and Seattle have the authority to impose a financial penalty on generators for not meeting diversion requirements and the ability to mandate lower disposal rates for food waste. This creates an economic incentive for generators to sort their food waste. Large waste haulers in cities such as San Jose pay a franchise fee for earning a waste removal contract, which is used as a tax revenue base to rebate carters for hauling heavier food waste with higher waste removal costs.

Moreover, while the City controls pricing for all service zones to keep it fair and uniform, Chicago's proposal reveals that rates can correspond to inflation and rising export costs by annually adjusting them in response to the Consumer Price Index or a fuel index. Through an exclusive franchise system, winning contract haulers will have enough customers in proximity and with sufficient economies of scale for food waste removal due to collection, routing, and processing efficiencies. While small scale carters will be unable to compete for as many contracts, the City of Los Angeles has proposed to designate a geographic zone for smaller haulers so that opportunities remain for these businesses to remain competitive. New York City could consider identifying areas of each borough that are only for carters that haul below a certain threshold.

While policies can help provide the regulatory framework, it is acknowledged that New York City must increase its infrastructure and related processing capacity. This analysis indicates that New York City needs to increase its processing capacity tenfold to handle all of the food waste diverted at the 25 percent threshold from our previous recommendation. Outlined in this report, various technologies were explored that the city could pursue. One such technology would be an anaerobic digestion facility, which could process between 30,000 and 60,000 tons of waste per year or between 24 and 48 percent of the total food waste diverted under the recommendation for a 25 percent mandate.

New York City can pursue a variety of programs to fund AD as well as large scale composting projects. NYSERDA has made approximately $57M available to support the installation and operation of anaerobic digester gas to electricity systems in New York State through 2015. Also, the Department of Environmental Conservation in New York State is authorized to provide state assistance for projects that enhance recycling infrastructure through the Municipal Waste Reduction and Recycling Program. Other states, such as Indiana and California, provide innovative cost reduction and public financing strategies that can complement these preexisting policy incentives to scale up food waste processing capacity.

5.2 Next Steps

Based on the methodology used for this report, which has been constructed using ratios to estimate food waste generation as other states have done, it is recommended that DSNY conduct a separate ‘physical’ waste characterization study to confirm the key findings.

In particular, it is noted that the main threshold mandate proposal has been deemed an appropriate level to maximize food diversion while minimizing the number of businesses impacted. The dataset however does not indicate a "clean" break between different threshold levels (as opposed to the State of

Connecticut for instance which has mandated a 1 ton per year threshold level). It is not advised to rely on threshold levels based on Connecticut or Massachusetts because the amount of regulated generators is vastly different for these states relative to New York City. Utilizing the Connecticut threshold, for instance, would correspond to the 31-40 percent range of top generators in New York City.

A characterization study would be able to confirm that the threshold of 25 percent as an initial step is indeed adequate and corresponds to the amount of food waste diversion that has been estimated. This analysis is a snapshot in time and the numbers (both tonnage and number of businesses) are likely to change as any policy will likely have the impact of additional compliance for generators in other categories who perceive that they might also be impacted in the future.

As it relates to the processing capacity, it is recommended to conduct a more detailed feasibility analysis of the technology proposed in this report. Although various key criteria have been included in this report, like permits, siting and air pollution, a more detailed business plan and a cost-benefit analysis would be required to confirm the intended impact and anticipated return. Likewise, several onsite composting technologies have been identified but a more detailed analysis as to their cost, process, scale and long-term viability would allow the City to promote certain technologies based on a detailed comparative study.

6. Appendices

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Appendix 2: Interview List

Interviews Conducted by Client

Name	Category	Title	Company	Date
Anthony Schifano Jr.	Generator	Director of Environmental Initiatives	Mt. Sinai Medical Center	6/15/2011
Anthony Tristani	Waste Hauler	Owner & President	Five Star Carting	7/20/2011
Austin Publicover	Generator	Facilties Manager	Union Square Hospitality	6/15/2011
Bosch Ganev	Generator	Environmental Responsibility Manager	J. P. Morgan Chase	6/20/2011
Caitlin Leibert	Generator	Sustainability Coordinator	Chipotle Mexican Grill	6/27/2011
Dan Ackerman	Expert	Chef of Staff	Downtown Alliance	7/29/2011
Dan Solway	Generator	Operations Manager, Purchasing & Facilities	Union Square Hospitality	6/15/2011
David Biderman	Expert	General Counsel & Director of Safety	National Solid Waste Management Association	Electronic
Deidre Hoguet	Generator	Manager Environmental Strategy	Design Tex	
Gregg Bianco	Technology	Owner	Metropolitan Paper Company	6/20/2011
Gregg Tricola	Waste Hauler	President	Midland Carting	6/16/2011
Joe Burke	Waste Hauler	Director of Sales	Action Carting	6/20/2011
Ken Richards	Expert	Director of Management Services	Great Forest	6/23/2011
Michael Barry	Generator	Sustainability Project Maanger	Bllomberg Information	7/5/2011
Anthony Schifano Jr.	Generator	Director of Environmental Initiatives	Mt. Sinai Medical Center	6/15/2011
Anthony Tristani	Waste Hauler	Owner & President	Five Star Carting	7/20/2011
Austin Publicover	Generator	Facilties Manager	Union Square Hospitality	6/15/2011
Bosch Ganev	Generator	Environmental Responsibility Manager	J. P. Morgan Chase	6/20/2011
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Ken Richards	Expert	Director of Management Services	Great Forest	6/23/2011
Michael Barry	Generator	Sustainability Project Maanger	Bllomberg Information	7/5/2011
Naser Gjeslosi	Generator	Director of Sustainability & Training	BMS Building Maintenance Service	7/6/2011
Nelson Widell	Processor	Marketing and Sales Director, Co-Founder	Peninsula Compost Group	8/10/2011
Rich Nolan	Waste Hauler	District Manager	Atlantic Waste Disposal	6/23/2011
Sean Gilligan	Generator	Chief Operating Officer	Shred Services	
Suki Paciorek	Generator	Vice President of Corporate Sustainability	Vornado Realty Trust	6/22/2011
Susan Long	Generator	Environmental Impact Manager	Starbucks	8/18/2011
Tristam Coffin	Generator	Green Mission Specialist, Northeast Region	Whole Foods	7/23/2011

Appendix 3: Client Report Review

Commercial Waste Data	**Regulations and Policy** All carters collecting or disposing putrescible waste are required to have a license from the Business Integrity Commission, "BIC" ($5K plus $500/collection vehicle and must be renewed every 2 yrs).
	Technology Private transfer stations and commercial carters use paper based reporting while licensed commercial carters report using an electronic template provided by BIC.
	Reporting Private transfer stations and commercial carters report to DSNY quarterly (but do not include recycling weight) . Commercial carters (does not include C&D or fill) reports on all waste and recycling collected in NYC whether it is taken for disposal, processing, or transfer stations within NYC or beyond. Licensed commercial carters report twice a year through their customer registry to BIC (waste & recycling)

Source: "Commercial Waste Data", DSNY Internal briefing paper. 6 Jun 2011

Organics Proposal	**Regulations and Policy: Other states practices** San Francisco used policy levers of mandate and price incentive to implement organics collection. Seattle used price incentives implement organics collection. Conneticut enacted first state law requiring commercial organics diversion (for generation of at least 104 tons of organic waste/year or 2 tons/week). The state estimates the law will capture approx 80% of state's commercial food waste. Massachussets DEP plans to issue a similar rule if generation is above 52 tons/yr or 1 ton/week.
	Technology Closest large scale facility for source-separated organics practices is Delaware
	Waste characterization Commercial putrescible waste comprises approx 25% or 3.5M tons/yr of NYC waste stream.Organics comprise approx 18% or 0.6M tons/yr but only 2% of organics are diverted (12K tons/yr)

Source: "Commercial Organics Diversion", DSNY Internal briefing paper. N.d

Waste Reduction & Diversion Trends in the Hospitality Industry (North America)	**Consumer survey** (Source: National Restaurant Association, November 2010 Household Survey) -57% of all adults said they are more likely to visit a restaurant that offers food that was grown/raised in an organic/environmentally-friendly way -60% believe consumers want to patronize restaurants with recycling programs -51% believe consumers will pay more at a restaurant with recycling -85% agree that consumers will help with recycling like sorting -1 in 4 restaurateurs report customers asking staff about recycling **-1 out of 10 restaurant operators participate in a composting program**

Source: "Waste Reduction & Diversion Trends in the Hospitality Industry - North America", National Restaurant Association. Web 20 Oct. 2012 < www.RestaurantsRecycle.com>.

The Green Business Challenge Guidebook	**Regulations and Policy: Other State best practices** In 2009, Chicago Mayor Richard Daley launched the Chicago Green Office Challenge to reduce the commerical (39% of the GHG's for the city). During the first year of program, 150 companies reduced GHG by 54K metric tons and saved more than $5M for participants. Cost of program $50K-$150K and 0.75-2 FTE to run the program 6 other cities have since launched the program: Arlington County, VA, Charleston, SC, Houston, TX, Saint Louis Region, MO, Port of San Diego, CA, Westchester County, NY

Source: "The Green Business Challenge Guidebook: Launching a Program to Engage Businesses in Climate Action and Energy Efficiency", ICLEI. Dec. 2010

UK organic waste recycling industry

Regulations and Policy: UK example

The UK Government made a commitment to work towards a 'zero waste' economy in the Coalition Programme for Government, published in May 2010. It is estimated that in the UK over 10 million tonnes of organic material has been going to landfill.

Currently the Northern Ireland Waste Management Strategy is under review. New policies, such as the introduction of a statutory 60% recycling target for local authority collected municipal waste and a proposal for a food waste ban, will assist in increasing the diversion of biodegradable waste from landfill.

Economics

Total compost market value is estimated at £9.2 million in 2010.

UK compost outputs in 2010: 2.tourists tonnes, 2.2% up on the 2009 survey; total composting capacity of 7.0 million tonnes, suggesting a 78% capacity utilisation; total UK employment in composting of 1,255 full time equivalents.

Source: "A survey of the UK organics recycling industry in 2010", WRAP. Aug. 2012.

Economics of New York City Commercial Municipal Source Waste Collection & Disposal

Food waste collection estimate in NYC

The three largest waste haulers in NYC are Action Environmental Group, IESI, and Royal Waste, collecting a combined 80 tons per day of commercial food waste in New York City.

To account for food waste collected by additional haulers, it is assumed that an additional 20 tons per day may be collected by other haulers, resulting in a range of 80-100 tons per day of food waste that is collected in New York City.

Over 95% of commercial food waste generated in New York City is landfilled or disposed of through a combustion process

Economics

Estimated total cost of $103-$160 per ton of putrescible waste collection in nyc. For reference, the maximum price waste haulers can charge in New York City is $208/ton.

The numbers indicate that high-end estimates for in-city collection of organics can be $20 more per ton compared to commercial putrescible waste collection .

Potential solutions

The following is a description of some of the ways increased collection efficiencies per truck route can be achieved to decrease the gap in the amount of waste collected per truck shift and thereby improve overall organics collection economics.

- Decrease Stops per Location for Various Waste Streams through Use of Split-body Trucks

- Increase Number of Location Stops per Truck Shift through Increasing Route Density

- Increase Volume of Organics Collected per Location Stop

- Decrease Collection Frequency

- Reduce Transport Distance to Processing Location (23% - 36% of the total cost of sending organic waste from New York City to Peninsula is due to long-haul transport.)

Source: de la Houssaye, Matt and White, Annie. "Economics of New York City Commercial MSW Collection & Disposal and Source-Separated Food Waste Collection & Composting: Opportunities to Reduce Costs of Food Waste Collection & Recovery", Global Green USA. N.d

Wasted: How America is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill

The Challenge:

Economic:

It is estimated that food manufacturers lose about 16% of raw materials during manufacturing - amounting to 23% of total food losses produced by manufacturing, distribution, retail ops, and households.

In-store food losses in US totaled 43 billion pounds in 2008 or 10% of the total food supply at the retail level. 2005 & 2006-annual supermarket losses averaged 11.4% for fresh fruit and 9.7% for vegetables. Industry expert estimates supermarkets discard $2300 per store worth of out of date food every day

40% of food in the US goes uneaten (Americans throw out $165B of food each year)

Sustainable:

The Nation's agriculture production accounts for 80% of consumptive water use and more than half of all land use. Food rots in the landfill accounting for 25% of US methane emissions.

Reducing food losses by just 15% would be enough food to feed more than 25M people

Food reduction solutions:

-Work with partners to improve food labels (could reduce up to 20% of waste)

-Education of composting programs

-Conduct food waste audits

-Encourage innovation of new technologies, etc

-Promote regional or local food distribution

-Buy imperfect products or incent companies or consumers to consume those

In 5 years, the UK has reduced avoidable household food waste by 18%

Source: Gunders, Dana. "Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill", NRDC Issue Paper. Aug. 2012.

The Relative Greenhouse Gas Benefits of Front-of-House Recycling and Composting in a Quick-Service Restaurant

Case Study Pret a Manger:

Based on the results of this study, Global Green undertook an analysis comparing several waste recovery scenarios to determine the relative greenhouse gas outcomes for systems that emphasize recycling versus systems that emphasize composting. The outcome of this analysis showed that packaging recycling, particularly for paper items at locations where significant paper is generated, leads to improved emissions outcomes relative to composting, even given low capture rates.

Key findings -Modeled Scenario Results for Pret a Manger

Scenario 1: Current System at 100% Capture Rates

This scenario yields a very high greenhouse gas benefit, in large part due to the emissions mitigations resulting from the recycling of paper.

Scenario 2: Compost All Packaging and Food

Not as poweful as the above from a GHG point of view: if 100% of paper and plastic can be recycled, the GHG recovery is higher than if those are compostable

Scenario 3: Observed Scenario: Pret A Manger's Four-Stream System: The observed scenario reduces greenhouse gas emissions to a 20% greater extent than the scenario where all packaging is designed to be composted

The case study shows that the inclusion of recycling in a front-of-house resource recovery system has a greater opportunity to mitigate greenhouse gas emissions accounted for in the end-of-life portion of the material's life cycle, compared to a full switch to compostable packaging and capturing all the food waste.

While every effort should be made to maximize diversion of all waste streams, successful programs that improve the capture of paper will have a strong impact on a restaurants carbon footprint relative to efforts to capture other materials in restaurants that generate a significant amount of paper.

Source: "To Sort or Not to Sort: The Relative Greenhouse Gas Benefits of Front-of-House Recycling and Composting in a Quick-Service Restaurant", Global Green USA. Sep. 2012.

Identification, Characterization, and Mapping of Food Waste and

Food Waste Generators in Massachusetts

Summary of the Study:

The study was prepared for the Massachusetts Department of Environmental Protection to provide an analysis of the the food waste generators in the state of Massachusetts. The study identified the major food waste generators categorized under these ten business categories including: food manufacturers, processors, and distributors, colleges and universities, hospitals and other healthcare institutions, resort/conference facilities, correctional facilities, restaurants, and supermarkets. The waste generated by these business categories was quantified and characterized GIS technology was usedto map the location of all identified generators.

Key Findings of the Study

- The large number of smaller generators, individually and collectively do not contribute a substantial proportion to statewide generation of food waste.

- The amount of food waste per generator is estimated by using the number of employees per establishment or by using the amount of annual sales of that establishment.

- Food waste composition varies from one business category to the other.

- Manufacturers / Processors generator category generates the largest amount of tons per year, generating approximately 56% of the total amount.

- Supermarkets are the second highest total food waste generators, they are the source of nearly 100,000 tons/year of compostable organics, and from the standpoint of organics diversion offer advantages in that they represent a consistent and predictable waste stream.

- Restaurants produce the third highest total amount of food waste, but the second highest amount per establishement.

- Some number of large manufacturers have already identified and implemented composting or other organics diversion alternatives due to the high cost of food disposal.

Source: Draper/Lennon, Inc. Identification, Characterization, and Mapping of Food Waste and. Rep. Boston: Massachusetts Department of Environmental Protection, 2002. Print.

Appendix 4: Acronyms

AD – Anaerobic Digestion

BIC - Business Integrity Commission

BWPRR- Bureau of Waste Prevention, Reuse, and Recycling

CWMS - Commercial Waste Management Study

DEC - Department of Environmental Conservation in New York State

DEP - New York State Department of Environment

DSNY - New York Department of Sanitation

EPA – Environmental Protection Agency

FAO – Food and Agriculture Organization

GHGs - Greenhouse Gases

IPCC - Intergovernmental Panel on Climate Change

NAICS - North American Industry Classification System

NRDC- Natural Resources Defense Council

NSWMA- National Solid Wastes Management Association

NYC – New York City

NYSERDA - New York State Energy Research and Development Authority

OLTPS - Office of Long-Term Planning and Sustainability

TWC – Trade Waste Commission