Opportunities for Sustainable Materials Management and Zero Waste in Detroit

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Date: April 18, 2017

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Abstract

Zero waste and sustainable materials management (SMM) are two ways of reframing the process of waste management, by envisioning waste as potentially useful material. Detroit has taken a step towards SMM, implementing a city-wide curbside recycling program in 2014. While only 6.6% of the city's waste is currently recycled or composted, the other 93.4% is combusted in Detroit's waste-to-energy facility (WTEF) or sent to landfills. Like other post-industrial cities with long-standing WTEFs, Detroit's WTEF is located in a predominately non-white and low-income community, and the facility has faced alleged odor and emissions violations. For Detroit to move forward with sustainable and just waste reduction and diversion strategies, it is necessary to understand its successes and challenges within waste management.

This report for the East Michigan Environmental Action Council and the Global Alliance for Incinerator Alternatives characterized Detroit's waste management system using stakeholder interviews, policy review, Sankey diagrams, and environmental justice spatial analysis to analyze opportunities for enhancing SMM in the city. We selected two case study cities that also have a WTEF, Baltimore and Minneapolis, to benchmark their progress with advancing SMM and provide best practices for Detroit. Interview participants mentioned several political, social, economic, procedural/technical, and environmental factors that can support or impede efforts to advance SMM. Based on these findings, in addition to the results of our Sankey diagrams and spatial analysis, we proposed a set of eight recommendations for Detroit to consider when adopting an SMM framework in the future. Ultimately, our project recommends the following actions for Detroit: (1) Collect more data on the city's waste stream; (2) continue community engagement efforts; (3) market waste as a material resource; (4) encourage the State of Michigan to enact more SMM legislation; (5) create a method of addressing continued air emissions violations in waste management facilities; (6) centralize sustainability efforts in Detroit's new Office of Sustainability; (7) conduct a feasibility study regarding a differentiated waste management pricing structure; and (8) sustain long-term planning for SMM in Detroit. Despite our focus on Detroit, our findings also have policy implications and practical recommendations for other cities like Detroit that are struggling to advance a more sustainable and just waste management system.

Acknowledgements

This project could not have been possible without the contributions of multiple stakeholders in Ann Arbor, Detroit, Minneapolis, and Baltimore. First and foremost, we would like to thank our advisors, Dr. Gregory Keoleian, and Dr. Tony Reames, and our client and partner client contacts, William Copeland (EMEAC) and Ahmina Maxey (GAIA), for their continued collaboration, communication, and patience throughout the project. We were grateful to have the financial support of the University of Michigan School of Natural Resources and Environment, enabling us to travel and connect in person with our colleagues in Detroit and Minneapolis-St. Paul. Thanks also to the Doris Duke Conservation Scholars, Marvin Bell and Giovanni Santiago who helped us during the summer of 2016.

Thanks to individuals from Wayne County who helped us acquire Detroit waste data, and to members of Detroit's Zero Waste Subcommittee for support throughout this project. Many thanks especially to the 14 individuals who allowed us to interview them and publish their words in this report. To those with whom we spoke but did not interview, we sincerely appreciate your help with locating data, reaching out to interviewees, answering questions, and in general serving as a supportive network during our project.

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List of Acronyms & Abbreviations

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
ATSDR	Agency for Toxic Substances and Disease Registry
BRESCO	Baltimore Refuse Energy Systems Company (Refers to Baltimore's waste-to-energy facility, also known as Wheelabrator Baltimore)
CAPHE	Community Action to Promote Healthy Environments
CFR	Code of Federal Regulations
CO_2	Carbon dioxide
DALY	Disability Adjusted Life Year
DPW	Department of Public Works
DRP	Detroit Renewable Power (Detroit's waste-to-energy facility)
EIA	U.S. Energy Information Administration
EISA	2007 Energy Independence and Security Act
EJ	Environmental justice
EMEAC	East Michigan Environmental Action Council
EPR	Extended producer responsibility
ESL	Eastern Sanitary Landfill Solid Waste Management Facility
GAIA	Global Alliance for Incinerator Alternatives
GDRRA	Greater Detroit Resource Recovery Authority
GFL	Green for Life Environmental
GHG	Greenhouse gas
HAP	Hazardous air pollutants
HERC	Hennepin Energy Recovery Center (Minneapolis' waste-to-energy facility)
IRB	Institutional Review Board
ISWA	International Solid Waste Association
LFG	Landfill Gas
MDE	Maryland Department of the Environment
MDEQ	Michigan Department of Environmental Quality
MHRRD	Minnesota House of Representatives Research Department
MPCA	Minnesota Pollution Control Agency
MRF	Materials recovery facility (for recycling)
MSWM	Municipal solid waste management
MSW	Municipal solid waste
MW	Megawatt
MWh	Megawatt-hour
NOx	Nitrogen oxides
PCB	Polychlorinated biphenyl
PM	Particulate matter
PM2.5	Particulate matter 2.5
RCRA	Resource Conservation and Recovery Act of 1976
RPS	Renewable portfolio standards
SO2	Sulfur dioxide

TCMA	Twin Cities Metropolitan Area
TRI	Toxic Release Inventory
TRSW	Total Residential Solid Waste
TSDF	Transfer, storage and disposal facilities
WTEF	Waste-to-energy facility
WTE	Waste-to-energy (process of waste reduction and/or resource recovery)
ZWIA	Zero Waste International Alliance

Terminology

Combustion	"Confined and controlled burning" of municipal solid waste inside a waste-to-energy facility (U.S. EPA, n.d.a). This term is used interchangeably in this report with "WTE technology" and "incineration" with energy capture.
Compost	Organic material including food waste, yard waste, and products designed to be compostable that undergo the natural process of decomposition and may ultimately be used as a soil fertilizer. Organics, defined below, are the material such as food scraps that can be broken down and composted. This report may use compost interchangeably with organics.
Composting	The collection, storage, and treatment of compost in a way that enables aerobic digestion of biological materials to occur to later be used as fertilizer for plants (U.S. EPA, 2016c)
Contamination	In recycling or composting streams, contamination refers to materials discarded in incorrect receptacles. Recycling contamination is non-recyclable waste thrown into recycling bins, and composting or organics contamination is non-compostable waste thrown into organics collection bins.
Incineration	"A treatment technology involving destruction of waste by controlled burning at high temperatures; e.g., burning sludge to remove the water and reduce the remaining residues to a safe, non-burnable ash that can be disposed of safely on land, in some waters, or in underground locations" (U.S. EPA, n.d.a). In this report, we use this term interchangeably with waste-to-energy (WTE) combustion or WTE incineration.
Landfill	A contained segment of land where waste is discarded and systematically buried with soil. Landfills are carefully planned containment areas that utilize linings and other pollution reduction strategies to prevent leaching of potentially toxic liquids into the ground (U.S. EPA, 2016c). Note that many landfills are designed to capture landfill gas, including methane, and use it as energy.
Materials Recovery Facility (MRF)	"A facility that receives commingled materials and then uses a combination of equipment and manual labor to separate and densify materials in preparation for shipment downstream to recyclers of particular materials recovered" (LeBlanc, 2016). After collection, waste haulers take recyclables to a MRF to be processed.

Municipal solid waste (MSW)	Waste collected from residential and commercial areas within city and/or county limits. Excludes liquid waste, sewage, hazardous material, medical waste, and construction and demolition waste. MSW comprises materials that are disposed of daily, including food waste, plastics, metals, paper, bulky items such as mattresses, and electronics (U.S. EPA, 2016c). Note that our scope for this report is limited to MSW and not other types of waste, such as hazardous waste.
Municipal solid waste management (MSWM)	The process of managing the disposal and/or reuse of MSW. In this report, we also consider waste collection to be part of this process. Note that we refer to the process as both MSWM and waste management interchangeably in this report.
Organics	Compostable material including food waste and yard waste that decomposes naturally, ultimately used as a soil fertilizer. Organics are the material that comprise compost; in this report organics and compost may be used interchangeably to refer to material that is able to be composted.
Recycling	The act of diverting certain types of materials from the waste stream including metal, paper, glass, and plastic to recover and/or reprocess into new products. This method of diverting materials from landfills or WTEFs/incinerators extends the life cycle of products or provides materials for new products, thereby decreasing the need for virgin raw materials (U.S. EPA, 2016c).
Recycling participation rate	A measure of the number of residents who recycle in relation to all residents in a geographic location. Note that this only considers the number of residents who have a recycling bin or cart at their disposal, and it does not measure the amount they actually recycle.
Recycling rate	A measure of the amount of material that is recycled in relation to all material that is discarded. Note that the recycling rate does not refer to the amount of material recycled in relation to all *recyclable* materials, but rather to all types of materials.
Resource recovery	The reuse, recycling, or composting/organics collection methods that involve reuse and/or refurbishment of materials rather than disposal directly in landfills or WTEFs, effectively lengthening products' life cycles. Some organizations and public departments define WTE technology as a form of recovery since WTE recovers energy from waste. In this report, we do not consider it a form of recovery and rather define it as a form of disposal.

Source reduction	Methods of reducing waste at various points in the life cycle of a product: from product design to the end usage of a product, also known as upstream and downstream, making any residual waste less waste less toxic. Source reduction encompasses packaging and design on the manufacturing side down to a change of practices, decisions, habit, and mindset on the consumer side (U.S. EPA, 2016c). In this report, we consider source reduction specifically as consumers' waste reduction habits. If we refer to upstream material design decisions, we label them as such in context.
Sustainable Materials Management (SMM)	An approach to waste management that focuses on the entire life cycle of materials, heavily incorporating waste reduction, reuse and recycling rather than focusing on incineration or landfill disposal (U.S. EPA, 2016c). See the "Waste Management History" section for more information.
Tipping fee	Monetary fee for disposing of MSW in a recycling MRF, WTEF, or landfill, typically calculated by tonnage. Tipping fees vary based on regulations set by states and local governments, or any other jurisdiction that regulates MSW, as well as by the type of disposal facility.
Transfer station	"Facilities where municipal solid waste is unloaded from collection vehicles and briefly held while it is reloaded onto larger, long-distance transport vehicles for shipment to landfills or other treatment or disposal facilities" (U.S. EPA, 2016c). Not all municipalities or jurisdictions that regulate MSW utilize transfer stations.
Waste diversion	Diversion of waste or discarded materials from landfills and WTEFs/incineration. This term is typically used to emphasize or prioritize the usage of other waste management methods such as source reduction and reuse, recycling, and composting. In this report, we specify when other organizations or entities use a different definition of "diversion" (for example, diversion from landfills only or diversion from WTEFs only).
Waste management	The process of collecting and managing discarded materials (also known as trash or waste) through source reduction and reuse, recycling, or disposal with energy generation in a WTEF, disposal with methane reclamation in a landfill, or treatment and disposal in a landfill or incinerator that does not create energy (U.S. EPA, 2016e). Note that in this report, the term waste management does not refer to nor is it affiliated with the company Waste Management, Inc.

Waste management hierarchy	A system of prioritizing waste management methods such as source reduction and reuse, recycling, composting, and incineration and landfilling with or without energy reclamation. These methods are prioritized from most to least preferable with regards to environmental impacts such as greenhouse gas (GHG) emissions or land use change. See the "Waste Management History in the United States" section for a more detailed description of this hierarchy.
Waste reduction	Reducing the amount of waste that is discarded in the waste stream, whether the waste would have been disposed through WTE, landfilling, or recycling, because in all cases, energy and resources go into each process. If waste is reduced in the first place, the amount of energy and resources that is used is eliminated. The waste reduction process often involves changing mindsets and habits, consuming less, and becoming more aware of one's own impact on the waste stream. In some cases, waste reduction is brought on through policy interventions and market incentives.
Waste-to-energy (WTE)	The process of containing and combusting MSW in a waste-to-energy facility to reduce the volume of waste sent to landfills and to produce energy in the form of electricity and/or steam.
Waste-to-energy facilities (WTEFs) /incineration plants	Facilities that utilize WTE technologies and processes. Historically, when many were built in the 1980s, several WTEFs began as incinerators without energy-producing capabilities. Many of these facilities have since been retrofitted to produce energy. Throughout this report, we refer to these processing facilities interchangeably as WTEFs or incinerators.
Zero waste	A philosophy for addressing waste reduction and waste diversion through long-term lifestyle changes. The term first coined in the 1970s by a chemist, gaining more traction with municipalities and organizations around the world in the late 1990s (Zaman, 2014). See the "Zero Waste" section for a more detailed description.

Executive Summary

Project Context

Management of municipal solid waste (MSW) is a constant challenge in the United States and around the world. Landfilling is the main waste management technique used to manage discarded materials, followed by recycling, combustion in a waste-to-energy facility (WTEF) and composting. Both disposal in landfills and WTEFs pose environmental problems for land and air, in addition to raising environmental justice (EJ) concerns regarding the siting of such facilities near low-income communities and communities of color. There have also been questions raised regarding community health around these facilities. More recently, the U.S. EPA has embraced a sustainable materials management (SMM) framework to prioritize waste management methods that extend the use of products and reduce the toxicity of discarded materials. At the same time, cities throughout the U.S. have adopted goals and targets to achieve zero waste before the turn of the century. Other cities are now moving towards instituting practices that align with SMM and zero waste goals.

The City of Detroit has relied heavily on its WTEF as its main waste management method since 1989. From that time, residents have raised concerns regarding the proximity of EJ communities to the WTEF and recent violations of emissions standards and clean air laws. Although the city initiated a citywide recycling program in 2014, high landfill capacity in the southeast Michigan region and low tipping fees across the state likely prevent the city from moving towards implementing more SMM practices. Therefore, our project analyzes the past, present, and future of waste management in Detroit to generate a set of specific recommendations for implementing SMM practices in the city. We selected the City of Baltimore and City of Minneapolis as case study sites to benchmark their progress towards SMM and provide insight for stakeholders in Detroit's municipal solid waste management (MSWM) system. This report for the East Michigan Environmental Action Council and the Global Alliance for Incinerator Alternatives investigates MSWM in the three cities, focusing on WTEFs, zero waste, and reframing waste management as SMM in Detroit.

Methods

Our project approach involved first selecting two case study cities that are similar to Detroit. We then analyzed the social and environmental context, reviewed relevant policy documents, created a Sankey diagram characterizing waste management flow, and performed a spatial analysis of the demographic characteristics around the WTEF in each case study city and Detroit. Additionally, we conducted 14 semi-structured interviews with stakeholders in the public, private, and nonprofit sectors to understand how each city developed and implemented their current waste management practices. All interviews were coded using NVivo through open and axial coding methods. Data from the case studies were used to develop a set of eight recommendations for Detroit to consider when moving forward with SMM practices.

Case Study Findings

Each city we examined implemented different waste management practices besides landfilling at different points in time over the past few decades. **Figure 1** presents a timeline comparing the dates that each city established these methods, including WTEFs, recycling, and organics collection. Generally, even though each city uses WTE incineration, Minneapolis is leading the path for using more SMM practices. Moreover, while Detroit and Baltimore are more similar with respect to racial and socioeconomic characteristics, Detroit lags behind both Baltimore and Minneapolis with respect to their initiation of a curbside recycling program. **Table 1** summarizes the demographics in each city and provides a general understanding of their waste management trajectory.

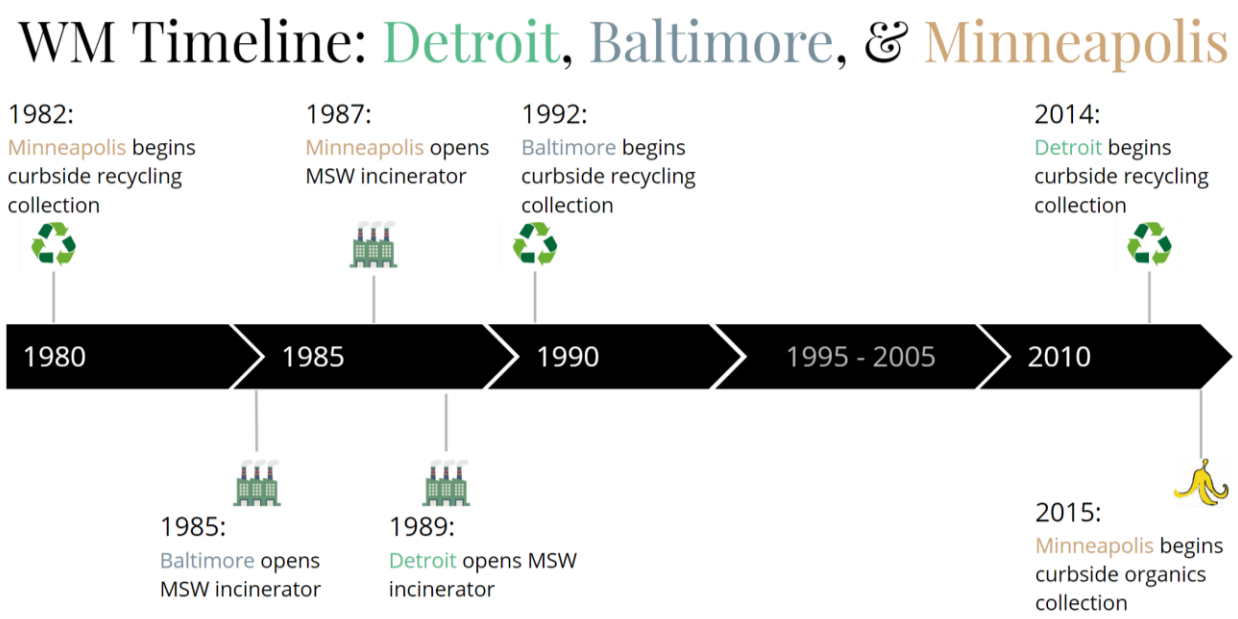

Figure 1: *Waste Management History of Detroit, Baltimore, and Minneapolis, 1982-2015*

Table 1: *Waste Management Practices and Policies and Demographic Characteristics in Detroit, Baltimore, and Minneapolis*

Snapshot	Detroit	Baltimore	Minneapolis
Race/Ethnicity (% nonwhite)	89.4%	70.4%	36.2%
Density (pop/mi^2)	4,994.94	City: 6,742.25 County: 1,180.39	6,550.99
Median HH Income	$25,764	$42,241	$51,480
Public/Private waste collection	Private	Public/Private Partnership	Public/Private Partnership
Date WTEF began operation	1989	1985	1987
WTEF ownership	Private	Public	Public
WTEF operating company	Detroit Renewable Power	Wheelabrator Technologies	Covanta Energy Corporation
Date residential recycling collection began	2014	1992	1982
Date organics collection began	N/A	N/A	2015
Hazardous waste TRI (Toxic Release Inventory) facility within 3 km of WTEF?	Yes	Yes	No
Region	Midwest	Northeast	Midwest
State Waste Diversion or Recycling Target	By 2016: 30% residential recycling rate[1, 2]	By 2040: 85% overall waste diversion, 80% overall recycling goal[3, 4]	By 2030: 75% recycling by weight of total solid waste generation for metropolitan counties, 35% by weight of total solid waste generation for non-metropolitan counties[5]

[1] This is a statewide goal (MDEQ, 2014).

[2] It is unclear if this goal has since been achieved.

[3] Diversion in this case refers to diversion of waste from landfills.

[4] Source: (Maryland Department of Environment, 2014)

[5] Source: (State of Minnesota, 2016)

Waste Management Flow

We characterized each city's waste management flow using a Sankey diagram. As shown in **Figure 2**, over 70% of Detroit's waste in 2015 went to its WTEF, while 75% of the waste accepted at the facility was from outside of the county. Only 6.6% of Detroit's waste was recycled and composted during that same year. Similarly, most of Baltimore's waste was sent to its WTEF in 2013, and just under 4% was sent to its landfill (see **Figure 3**). Baltimore's landfill also accepted residual ash from the WTEF, which constitutes 36.62% of total waste accepted. Other waste in Baltimore was either recycled or exported outside of the city. In Minneapolis, like Baltimore, about 60% of its waste was combusted in its WTEF. Compared to the other two cities, Minneapolis is more advanced with regards to recycling and composting practices. As shown in **Figure 4**, waste that was not incinerated was either recycled or composted (36.8%). None of the waste from Minneapolis was sent to a landfill in 2016.

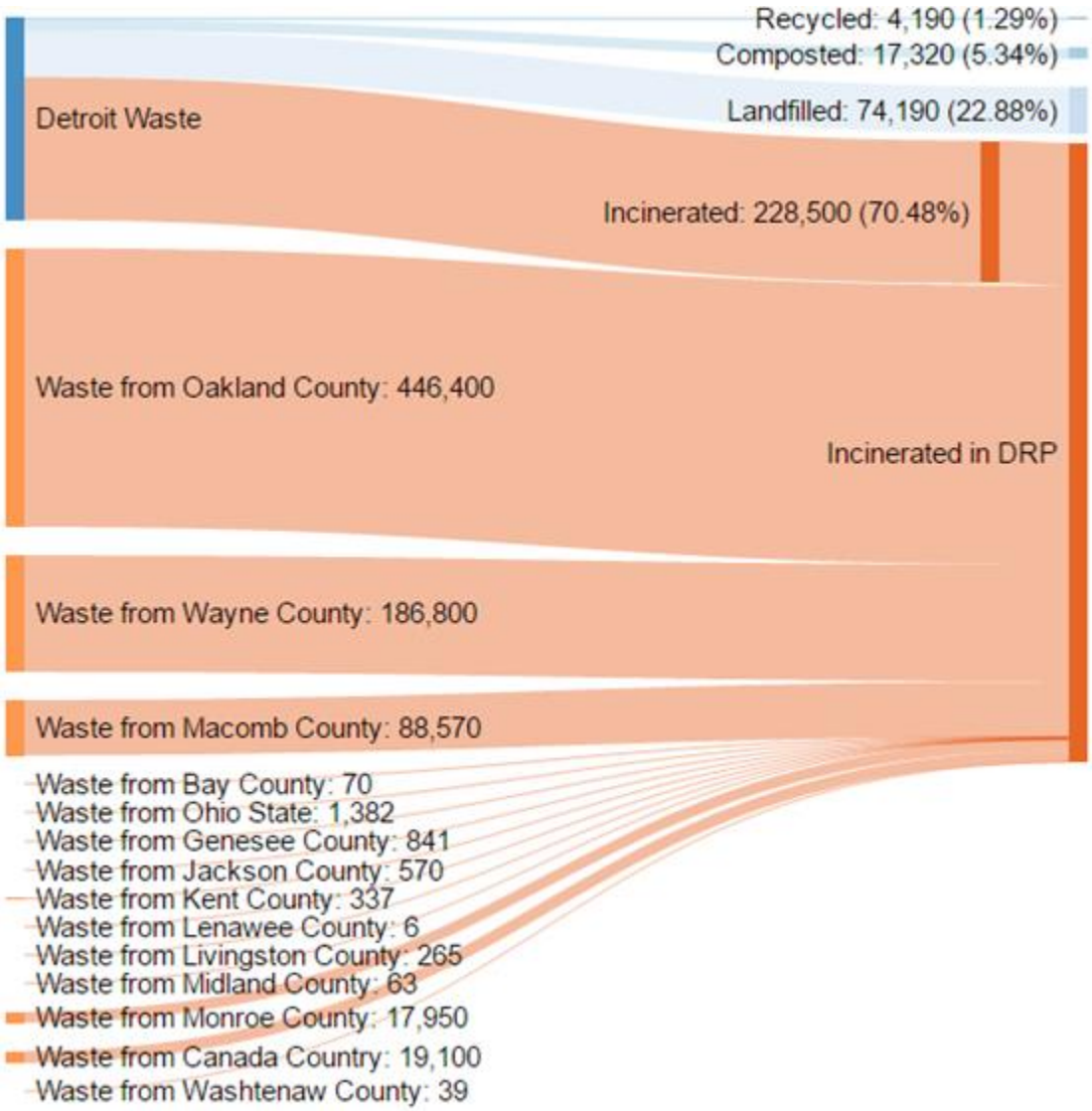

Figure 2: *Detroit Municipal Solid Waste Sankey Diagram*

This diagram shows the location of all waste disposed in Detroit Renewable Power (DRP), Detroit's WTEF, in 2015, along with some other Detroit waste data that is landfilled, recycled, or composted. The numbers shown represent tonnage. Data from Wayne County, 2016.

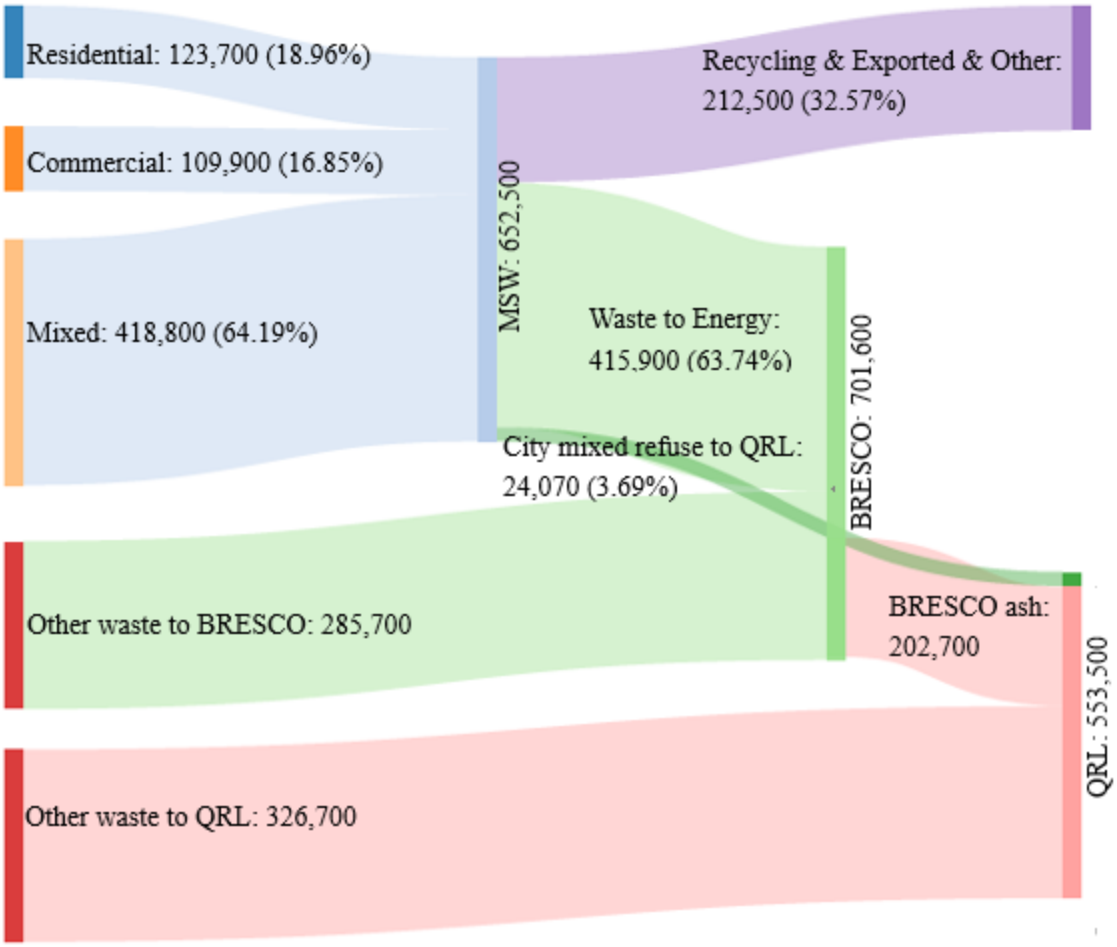

Figure 3: *Baltimore Municipal Solid Waste Sankey Diagram*

This diagram shows the waste flows in Baltimore. The numbers shown represent tonnage. Note: BRESCO represents Baltimore Refuse Energy Systems Company, Baltimore's WTEF; QRL represents Quarantine Road Landfill. Data from the City of Baltimore DPW, 2013.

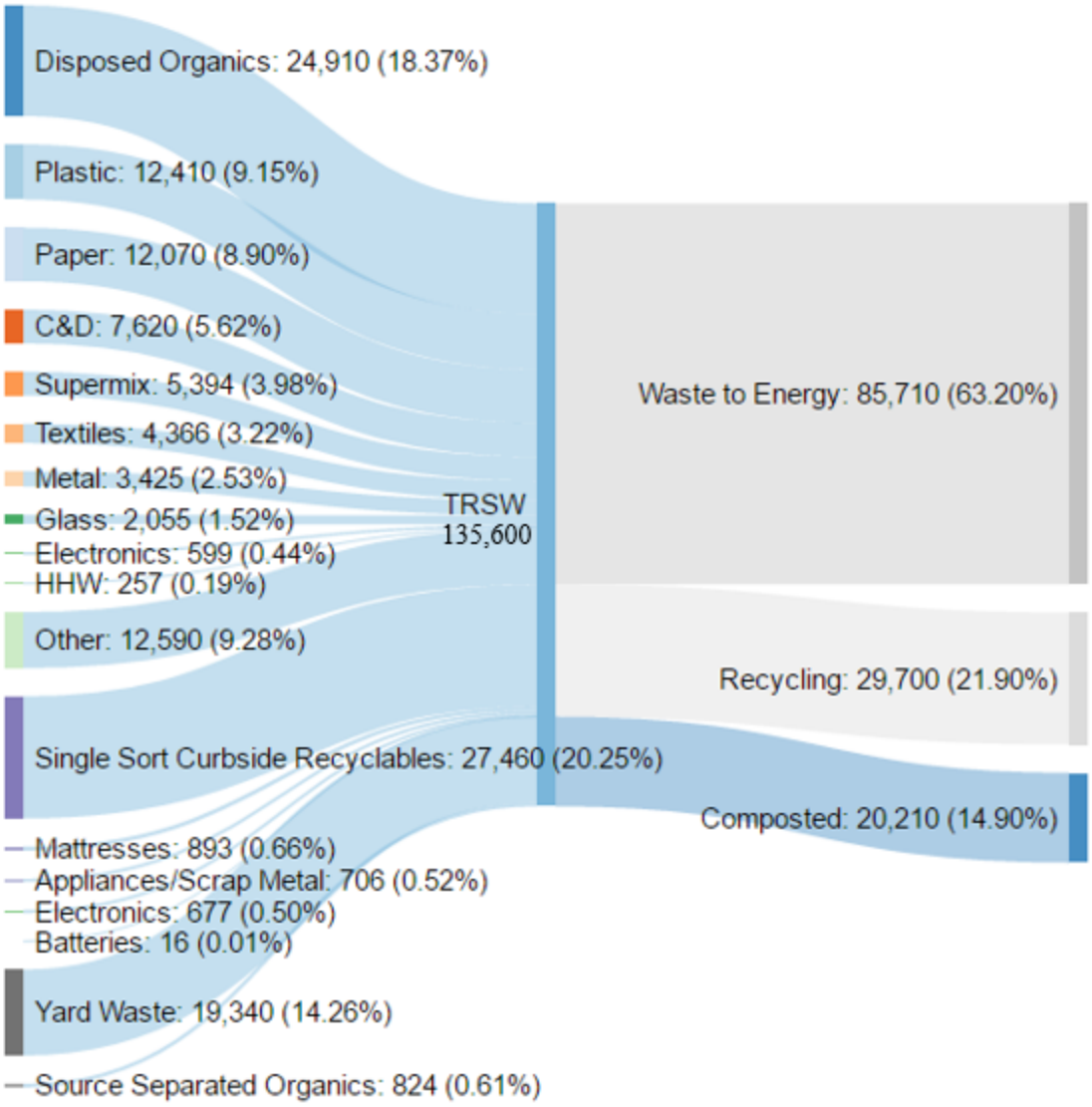

Figure 4: *Minneapolis Residential Solid Waste Sankey Diagram*

This diagram shows the type of waste flows that occur in the city. The numbers shown represent tonnage. Note: TRSW represents Total Residential Solid Waste. Data from MSW Consultants, 2016.

Spatial Analysis

We used GIS to examine the demographic characteristics of Census tracts within three-kilometer buffers around the WTEF in each city to explore demographic shifts pre- and post-WTEF construction. Data from the 1970 and 2000 censuses show an increase in percentages of non-white populations, households living in poverty, and lower median housing values in the neighborhoods around the WTEFs in each city. **Table 2** illustrates the results of this analysis, excluding median housing values. However, our analysis generated mixed results with regards to racial and socioeconomic disparities around the WTEFs when compared to the makeup of the city at large due to macro shifts in urban demographics between 1970 and 2000.

Table 2: *Demographic & Socioeconomic Changes around WTEFs (3 km) in Detroit, Baltimore, and Minneapolis between 1970 and 2000*

City	Time period	Percent White	Percent Minority	Percent Poverty
Detroit	1970	35%	65%	23%
	2000	18%	74%	34%
Baltimore	1970	45%	55%	24%
	2000	38%	59%	31%
Minneapolis	1970	90%	10%	13%
	2000	56%	30%	25%

Results: Interview Themes

Interviewees in Detroit, Baltimore and Minneapolis provided insights into five themes that can both promote and hinder efforts to move towards SMM practices: (1) political; (2) social; (3) economic; (4) procedural/technical; and (5) environmental. Within the political context, interviewees stressed the importance of collaboration between departments and sectors, the need for effective planning and policy decisions in waste management, the strong leadership of local champions, and finding the right balance between policies and infrastructure. Interviewees also expressed the concern that lobbying interests often prohibit states' commitment to SMM.

Within the social, community engagement, and SMM education context, the recognition that underlying EJ issues exist that unjustly overburden low-income and minority populations with pollution from MSW facilities. Interviewees concluded that reframing waste management as SMM through education efforts can have a lasting impression on future waste management practices in cities.

In the economic context, cities often struggle to find adequate funding for waste management. Certain funding structures, such as having lower tipping fees for landfills over materials recycling facilities, can serve as a disincentive for transitioning from traditional waste management to SMM. One way to move forward is to highlight the opportunity for job creation through SMM or zero waste initiatives. In the procedural and technical context, there is a need to collect consistent waste management data, to streamline the waste and recycling collection process, to acknowledge the entire material life cycle, and to lower contamination in recycling and composting facilities. In general, a more efficient process overall may lead to lower costs down the line. In the environmental context, it is necessary to address emissions and pollution from waste management processes and facilities and to hold polluting entities accountable through environmental regulations and reporting requirements.

Recommendations

Waste management is a complicated issue that involves a variety of political, social, economic, technical, and environmental factors. Based on our analysis of Detroit's waste management practices and a comparison with Baltimore and Minneapolis, we encourage Detroit to consider the following recommendations to adopt an SMM perspective: (1) begin collecting waste data to measure the city's progress; (2) focus city efforts on community engagement; (3) reframe waste management as SMM; (4) push for more statewide legislation that encourages SMM; (5) strengthen environmental monitoring and enforcement of air emissions for MSW facilities; (6) centralize SMM in the Office of Sustainability; (7) investigate the possibility of a differentiated pricing model; and (8) incorporate SMM into long-term planning efforts. **Table 3** assigns each recommendation to the most relevant theme.

Table 3: *Eight Recommendations for Enhancing SMM Practices in Detroit*

#	**Recommendation**	**Theme**
1	Collect waste stream data in a continuous, consistent, and publicly available manner.	**Procedural/ technical**
2	Advance efforts to engage the community in SMM practices.	**Social**
3	Change the framing of waste management and instead refer to the process as materials management.	**Social**
4	Encourage the State of Michigan to enact or initiate more legislation that furthers SMM.	**Political**
5	Strengthen monitoring and enforcement to hold MSW facilities more accountable and reduce air emissions violations.	**Environmental & Political**
6	Make Detroit's Office of Sustainability a hub for SMM initiatives and collaboration.	**Procedural/ technical & Political**
7	Conduct a pilot feasibility study to determine if the city can adopt differentiated pricing for city-owned and commercial buildings.	**Economic**
8	Incorporate SMM strategies in long-term planning efforts (i.e. develop an SMM roadmap).	**Political**

Introduction

Purpose of Study and Significance

Municipal Solid Waste Management (MSWM) is a set of activities related to solid waste, including collection, transportation, treatment, and disposal (Henry et al., 2006). MSWM should serve to protect public health, improve environmental quality, and even support the economy. The U.S. Environmental Protection Agency's (EPA) hierarchy of waste management methods ranks source reduction and reuse, recycling and composting, energy recovery, and treatment and disposal from most to least environmentally preferred (U.S. EPA, 2016e). However, even when following the hierarchy, waste management still consumes natural resources and energy, contributes pollution to the environment, and costs money. Zero waste is an ideal goal where any waste generated is diverted[6] from landfills and waste-to-energy facilities (WTEFs)[7]. This position on waste management can alleviate impacts on landfills and the land around them, avoid potential air pollutants from WTEFs, evade negative public health impacts, and serve as positive long-term sustainable community practices, thereby reducing the overall impact on the environment (Schneider and Scarr, 2013).

Recently, the EPA has embraced the concept of Sustainable Materials Management (SMM) that follows similar strategies as zero waste. SMM focuses on reduction, reuse, and recycling of waste as the highest priorities, lowering the need for combustion in WTEFs and disposal in landfills (U.S. EPA, 2016a). To move forward with zero waste and SMM, significant improvements are still needed for the City of Detroit. While many cities, like San Francisco, California; Seattle, Washington; and Austin, Texas are farther along with their waste reduction goals, the City of Detroit is not at that point yet as it implemented a formal recycling program only three years ago (Ferretti, 2016). The city is currently working to improve its recycling participation rate. Another challenge for Detroit is that most of its waste is sent to the city's WTEF, Detroit Renewable Power (DRP), which is the country's second-largest WTEF (Energy Justice Network, n.d.a).

In addition to exploring Detroit's waste management strategies, this project examined those of Minneapolis, Minnesota and Baltimore, Maryland as case study cities to understand waste management practices in two locations that also rely on WTEFs. Interviews with key

[6] The term "diversion" in waste management can have numerous meanings, depending on the defining agency or context. It could refer to a diversion from landfills (where all waste is recycled, composted, or combusted in a WTEF); diversion from WTEFs (where all waste is recycled, composted, or sent to a landfill); or it could refer to diversion from the entire waste stream (where all waste is reduced, recycled, or composted and no waste is sent to landfills or WTEFs). In this report, we define "diversion" as the third definition, diverting waste from both landfills and WTEFs.

[7] Many entities, specifically environmental justice organizations, refer to WTEFs as incinerators because when a majority of them were built in the 1980s, they began as incinerators with no energy production capabilities. In this report, we refer to these facilities interchangeably as incinerators or WTEFs.

stakeholders in the public, private, and nonprofit sectors provided a comprehensive picture of the varying MSWM strategies across each city. Additionally, we created Sankey diagrams and mapped community demographics with ArcGIS to visualize waste management flows in each city and give sociodemographic context. Local history exploration through stakeholder interviews, news articles, and policy documents provided details on the development of waste management practices in each city. We reviewed policy and planning documents at federal, state, and city levels to identify the challenges and opportunities for implementing sustainable waste management programs. Ultimately, according to these analyses, the project provided a set of best practices for the City of Detroit to develop a more effective, just, and sustainable waste management system.

Rationale for Detroit

Detroit is an ideal case for this type of analysis for several reasons. Firstly, the city has an extensive land use history that is interlaced with socioeconomic tension, low population density, and industrial pollution and related environmental health issues. Secondly, Detroit has been sending its MSW to a WTEF since 1989. In fact, the facility was the largest in the country until recently, and it imports 75% of its waste from outside of Wayne County (Energy Justice Network, n.d.a; Wayne County, 2016). Both the WTEF's presence and Detroit's financial struggles in recent years may have contributed to its lack of a curbside recycling collection program, which began around 2014 (Ferretti, 2016). The WTEF and the city's collection services are operated by private companies, with two private waste haulers collecting waste and recycled materials in different parts of the city. WTE and landfill disposal represent the main MSWM strategies used in the city (Wayne County, 2016). Finally, the WTEF presents environmental justice (EJ) concerns since it has violated air emissions standards, and it is located in a predominately low-income community of color (Felton, 2016; Lawrence, 2014).

Goals & Objectives

General Purpose Statement

The purpose of this study is to analyze Detroit's waste management practices, history, and trajectory, along with those of Baltimore and Minneapolis as case studies, to develop a set of tailored recommendations for advancing sustainable materials management in Detroit.

Objectives

1. Explore past, present, and future waste management strategies in three cities that rely heavily on WTEFs as a multiple-case-study analysis.
2. Review waste management policy and planning documents in each city.
3. Perform an environmental justice spatial analysis of the communities around the WTEFs between 1970 and 2000.
4. Characterize each city's waste flow using Sankey diagrams.
5. Identify challenges and opportunities and propose a set of recommendations for advancing a more sustainable and just waste ("materials") management system for Detroit.

Clients

Our project clients are East Michigan Environmental Action Council (EMEAC) and Global Alliance for Incinerator Alternatives (GAIA). EMEAC is exploring zero waste options to improve Detroit's waste management system. It is a non-governmental organization that was launched in the 1960s and has focused on a plethora of social and EJ topics (EMEAC, n.d.). The organization's main pillars are economy, justice, and youth leadership initiatives. As stated on their website, EMEAC's mission is: "To empower the Detroit community to protect, preserve and value the land, air, and water. We build community power through environmental justice education, youth development and collaborative relationship building" (EMEAC, n.d.).

EMEAC has a vital network of partners within Detroit and across the country. These entities include the Climate Justice Alliance, the People's Movement Assembly, and Cass Corridor Commons (EMEAC, n.d.). As a result, our group was able to probe these connections to reach out to potential interviewees.

The project's partner client is GAIA, or Global Alliance for Incinerator Alternatives. GAIA is an advocacy group that rallies from the bottom up against WTEFs, shedding light on their environmental emissions. It also promotes alternatives for incineration that include a variety of zero waste practices (GAIA, n.d.). As its name suggests, it is an international entity with members in more than 90 countries (GAIA, n.d.). Specifically, we are partnering with GAIA's U.S. and Canada sector to focus on the introduction of creative, economical, and promising zero waste policies for Detroit. Note that our approach to the project is from a research and academic standpoint.

Background

Municipal solid waste (MSW) continues to pose a problem around the world. In the United States, total MSW generation rose between 1960 and 2014, though per-capita waste generation has leveled off and even decreased slightly between 1990 and 2014 (U.S. EPA, 2016a). While 34.6% of U.S. MSW was recovered in 2014, either through recycling or composting, more than half of these materials (52.6%) were sent to landfills and the rest were combusted for energy recovery (12.8%) resulting in steam or electricity (U.S. EPA, 2016a). As some municipalities send their MSW to landfills outside of their county or state (Louis, 2004), they simultaneously need to contend with rising greenhouse gas (GHG) emissions generated from waste management practices. The U.S. EPA reported that 42% of U.S. GHG emissions in 2006 were linked to materials management, with the provision of goods and the provision of food accounting for 29% and 13%, respectively (U.S. EPA, 2009). Emissions from materials management are related to the extraction or harvest of materials, production and transportation, and the disposal of goods and food – in other words, nearly each stage in the life cycle of a product.

Figure 5 shows the national trends in waste management disposal methods from 1960-2014. From 1960 to about 1990, recycling, composting, and WTE combustion rates increased and landfill disposal decreased. Landfill disposal decreased precipitously from 1980 through 2000, from 88.6% to 57.6% (U.S. EPA, 2015a). Reasons for the decline in landfills are explained further in this report. Data from the U.S. EPA confirms that WTE combustion increased drastically from 1.8% in 1980 to 14.2% in 1990, with a slight decrease to 13.9% in 2000 (U.S. EPA, 2015a). However, beginning around the new millennium, the usage of all four waste disposal methods remain steady around the nation. From 2011 to 2014, the recycling rate decreased from 26.5% to 25.7%, while the composting rate slightly increased by 0.7%. WTE combustion has wavered around the 12.8% mark from 2011 through 2014 (U.S. EPA, 2015a). In general, the U.S. is gradually shifting away from landfilling to incorporate more recycling and composting.

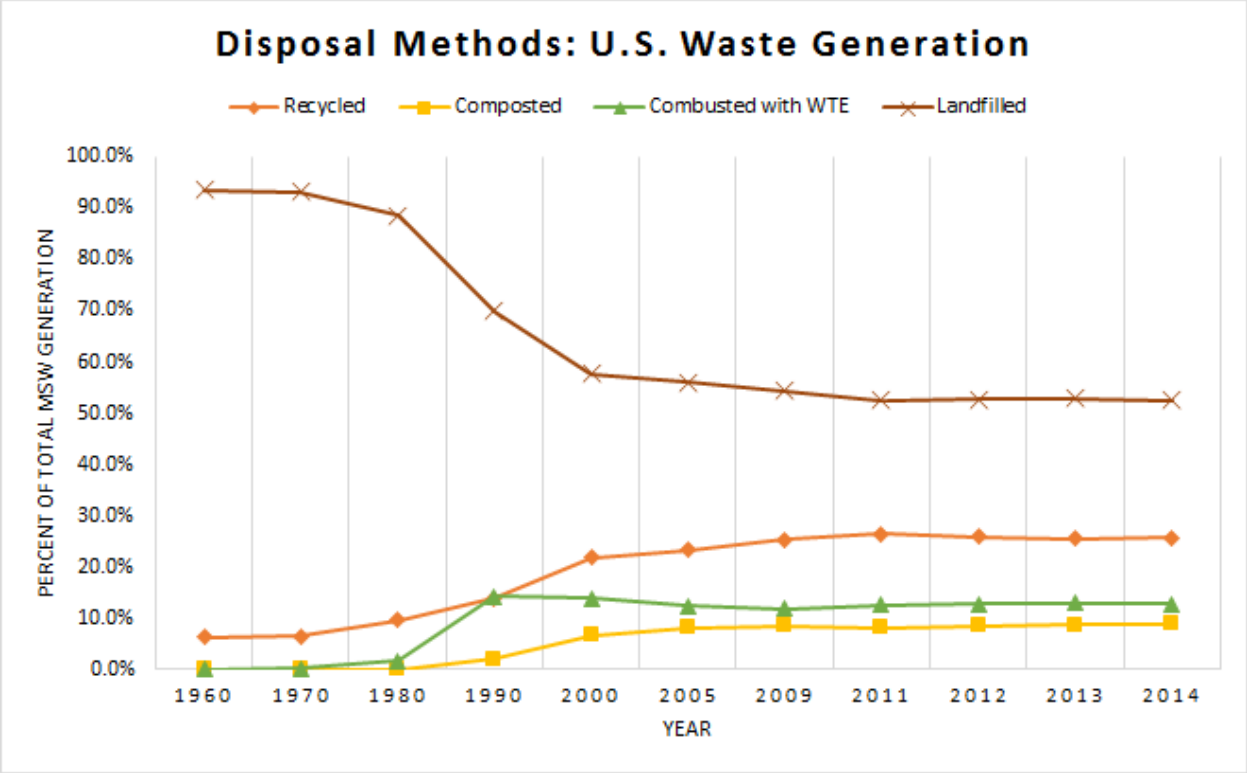

Figure 5: *National Waste Disposal Trends, 1960-2014*

This graph shows the percentage of waste in the U.S. that is disposed in four ways: through recycling, composting, WTE combustion, and landfill disposal (U.S. EPA, 2015a). Despite the significant decrease since 1960, landfill disposal still accounts for over 50% of the country's waste disposal.

Due to the social, environmental, and economic impacts of MSW, cities need to consider how to make their MSWM systems more sustainable and equitable with regards to local and regional impacts. Cities such as San Francisco, California; Seattle, Washington; and Los Angeles, California have adopted more aggressive policies that aim to divert waste from landfills with the intent of eventually achieving zero waste (Ferry, 2011). These types of practices appear to hold promise for reducing the generation of MSW and minimizing impacts on communities. At the same time, MSWM must take into consideration the EJ implications of polluting waste facilities in communities of color and low-income neighborhoods. WM systems must also be mindful that these communities should be able to meaningfully participate in decision-making around zero waste or resource recovery policies and programs. To better understand how MSWM practices can integrate both sustainability and equity, we reviewed the literature on zero waste and EJ.

Studies Comparing Waste Disposal Methods

Authors in previous studies have asked the question, which waste disposal method (landfill disposal, WTE, recycling, or composting) is the most preferred? Various researchers have conducted in-depth analyses regarding the most optimal of the four main waste disposal methods across locations including the U.S., Canada, and Sweden (Morris et al., 2012; Sound Resource

Management Group, 2009; Holmgren and Henning, 2004). Generally, these studies found that recovery through either recycling or composting is preferable to disposal through WTEFs or landfills, although one study listed landfilling as more environmentally desirable to WTE combustion (Sound Resource Management Group, 2009). The following quotations illustrate specific study findings when it comes to environmental and energy concerns:

> *The study findings show that disposal options (landfilling and waste-to-energy) are unfavourable compared to recycling where environmental impacts are concerned. These findings also show that disposing MSW in landfills is more favourable than waste-to-energy in all three environmental impact areas, particularly once organics are removed from the waste stream. Given these findings, disposal options should be seen only as interim solutions necessary to bridge the gap between the present situation and a zero waste objective achieved within a 20-30 year time horizon* (Sound Resource Management Group, 2009, pg. 41).

> *In terms of just climate impacts, the LCAs [life cycle assessments] provided enough data to conclude that aerobic composting and anaerobic digestion are preferable to waste-to-energy and to landfilling with captured methane used for energy generation* (Morris et al., 2012, pg. 550).

> *Recycling of metals saves a lot of energy, whereas glass saves less. These fractions do not give a heat contribution when incinerated... The study shows that [in terms of energy efficiency] even if there is a district heating system able to utilise the heat, paper and HDPE plastics should be material recycled whereas cardboard and biodegradable waste is more suited for energy recovery through waste incineration* (Holmgren and Henning, 2004, pg. 70-71).

Waste Management History in the United States

Before the 1880s, most American cities lacked organized waste collection and removal processes, leading to recurrent epidemics and diseases. These sanitation issues drew a need to improve public health and the environment (Louis, 2004). Unlike some European countries, the pressure from the sanitation problems was alleviated by an abundance of land and natural resources in the U.S. (Melosi, 1981). Since there was limited funding for regional infrastructure at the time, many localities took on the responsibility of developing their own MSWM systems that centered on nearby municipal dumps. In the U.S., modern MSWM practice originated from the sanitary reforms in the 1890s conducted by George Waring, Commissioner of the New York City Sanitation Department (Louis, 2004). The main component of this reform was the introduction of a unit operations approach, which involves waste generation control, collection, transportation, processing (e.g. recycling), incineration with or without energy recovery, and

landfilling (Kollikkathara et al., 2009). From the 1920s to the 1950s, these practices evolved into a general management model that is still utilized today (Louis, 2004).

A combination of socioeconomic, political, legal, administrative, and technical drivers resulted in significant changes within MSWM in the U.S. after the 1960s. With the passage of the Resource Conservation and Recovery Act of 1976 (RCRA)[8] and its subsequent reauthorizations, the U.S. government set stricter national standards for non-hazardous solid waste landfills and required more regional MSWM planning efforts (Louis, 2004). In the backdrop of this regulatory landscape, the recycling movement that emerged out of the late 1970s and 1980s advocated for the use of more resource recovery strategies at the local level, such as community drop-off sites and curbside recycling collection programs (MacBride, 2012). By the mid-1980s, a handful of states, including Michigan, New York, and California, passed bottle bills (also known as container deposit laws) to require that consumers pay a small deposit on plastic, metal, and glass containers at the time of purchase to be able to recycle these containers at businesses and receive their deposit back (MacBride, 2012). However, the regulatory framework set up by the RCRA and other federal laws also led to the closure of several open-air landfills throughout the country in the late 1980s and 1990s, resulting in a "garbage crisis" for municipalities (Louis, 2004). The rising costs of developing sanitary landfills caused many municipalities to rapidly institute other MSWM practices such as incineration and composting (Rootes and Leonard, 2009). The level of technical expertise that these laws required, as well as the legal mechanisms which permitted waste to be transferred across state and international boundaries, caused a shift from municipal control over waste management collection and facilities to a reliance on private waste management services (Louis, 2004).

While local practices may vary from city to city, the U.S. and other countries have embraced a wider perspective on MSWM to incorporate a materials life cycle perspective (Silva et al., 2016). The agency now formally promotes a "sustainable materials management" (SMM) framework that recognizes the different dimensions of waste related to both society and the environment (U.S. EPA, 2016d). The U.S. EPA defines SMM as follows:

> *Sustainable materials management (SMM) is a systemic approach to using and reusing materials more productively over their entire life cycles.* ***It represents a change in how our society thinks about the use of natural resources and environmental protection****. By examining how materials are used throughout their life cycle, an SMM approach seeks to: (1) Use materials in the most productive way with an emphasis on using less; (2) Reduce toxic chemicals and environmental impacts throughout the material life cycle; [and] (3) Assure we have sufficient resources to meet today's needs and those of the future* (U.S. EPA, 2016d).[9]

[8] See Current U.S. Federal Policies section for more detail about the RCRA.

[9] Numbering and emphasis added by authors.

Within this framework, the U.S. EPA proposes their own waste management hierarchy to avoid promoting a 'one-size-fits-all' approach to MSWM. **Figure 6** summarizes how the agency's waste management hierarchy ranks management strategies in terms of environmental preference. In this inverse pyramid, the U.S. EPA advocates for more source reduction and reuse strategies for both consumers and businesses. These practices are followed by recycling and composting, energy recovery (including WTEFs), and finally, treatment and disposal (including landfilling with or without methane gas capture and incineration without energy capture) (U.S. EPA, 2016c).

Figure 6: *The U.S. EPA's Waste Management Hierarchy*

The EPA's waste management hierarchy shows the most preferred method at the top and the least preferred one at the bottom. WTEFs and landfills with gas recapture technology fall in the Energy Recovery category while non-energy producing incinerators and landfills are categorized under Treatment & Disposal. Diagram taken from the EPA (2016d).

Zero Waste

While the U.S. EPA has advanced their SMM framework, several U.S. municipalities are also considering the life cycle of materials through the adoption of zero waste plans and policies. The Zero Waste International Alliance (ZWIA) provides the following definition of zero waste:

> *[Zero waste is] a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use. Zero waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them* (ZWIA, 2015).

Similar to the SMM hierarchy, zero waste management systems advocate for greater use of sustainable product designs and encourage more communities to embrace sustainable consumption practices. Strategies for achieving these goals include waste diversion and reduction methods such as recycling programs, composting programs, and other reuse practices. Also included among these strategies are extended producer responsibility (EPR) policies, which require manufacturers to consider how to extend the life cycle of their products (Zaman, 2014).

Although the U.S. has adopted an SMM framework, the main federal regulations that govern MSWM have not established specific waste reduction or diversion goals (Murphy and Pincetl, 2013). In contrast, some states and local governments have enacted policies to mitigate the impacts of waste generation as well as GHG emissions (Ferry, 2011). Over 40 states have adopted recycling goals, while California and Vermont are using EPR policies to target source reduction of materials (Murphy & Pincetl, 2013). At the local level, cities such as Los Angeles, California; Austin, Texas; and New York, New York have adopted plans that aim to divert waste from landfills within the next decade (Bodamer, 2015).

Few academic studies or policy reports provide a comprehensive account of zero waste strategies being used in U.S. municipalities. Though Zaman's (2014) review of zero waste studies focused on zero waste development at the global level, he generated a set of guiding principles for a holistic zero waste management system. He presented a model to implement these principles through four phases: (1) design and production, (2) sustainable consumption, (3) management and treatment, and (4) regulatory policies and assessments. In contrast, a report produced by the Partnership for Working Families (PWF), a national advocacy coalition, provided several case studies on sustainable recycling efforts in the 37 largest U.S. metropolitan statistical areas (PWF, 2013). At the time of the report, cities with greater than 50% recycling rates included Chicago, Los Angeles, Oakland, Portland, Riverside (California), Sacramento, San Francisco, San Jose, and Seattle. Those with lower than 10% recycling rates mainly consisted of post-industrial cities such as Cleveland, Detroit, and St. Louis, yet Denver and Tampa also fell under this category. Although some cities have instituted more direct strategies, such as mandatory recycling ordinances or material bans, most cities mainly offer curbside recycling programs for single-family and multi-family residential units (PWF, 2013). Even fewer cities had programs or policies that collect food scraps or construction and demolition debris.

Although SMM and zero waste share similar goals, these two frameworks slightly differ on their approach to achieving more sustainable waste management strategies (Silva et al., 2016). These differences appear in the U.S. EPA's waste management hierarchy and the ZWIA definition of zero waste. While the term 'zero waste' encourages a holistic, circular approach to sustainable consumption and materials management without use of landfilling and incineration, the EPA's hierarchy advocates for similar ideals while still placing a lower value on energy recovery through WTEFs and landfills. Silva et al. (2016) expand on these differences by stating that zero waste has become a policy label for waste prevention and reduction, while SMM has become a policy label for materials cycles. Moreover, these policy labels are adopted by

stakeholders at different scales as each approach tends to emphasize certain methods for addressing waste generation. While the zero waste label has gained the most traction among stakeholders that operate from a centralized and localized governance structure (e.g. businesses, cities, and universities), the SMM label is more popular among larger, more complex governance structures such as the United Nations Environmental Programme and the Organization for Economic Co-Operation and Development. Despite the differences between these two frameworks, Silva et al. (2016) suggest that both approaches are useful for reframing policies, strategies, and paradigms to "move [waste management] from its current wasteful focus on end-of-pipe solutions to the provision of sustainable consumption and production material flow and waste utilisation" (pg. 235).

Barriers to Zero Waste

Despite the promises of reducing emissions and increasing jobs, zero waste policy goals can be difficult to achieve. According to Zaman and Lehmann (2011), some of the challenges for zero waste include "short term thinking of producers and consumers, lack of consistency in legislation across the states, procurement versus sustainability, the attitude that the cheapest offers get commissioned and lack of community willingness to pay" (pg. 77). One study on waste management in Los Angeles found that while the city's exclusive franchise system with waste haulers would help with reporting commercial waste, policies and programs might be limited if materials are not further disaggregated by physical location and type (i.e. residential, commercial) (Murphy & Pincetl, 2013). A case study in Seattle on the response to a proposed plastic and paper bag fee in 2006 revealed how some zero waste policies might face backlash from voters, though City Council did eventually pass the fee in 2008 (Murdoch, 2010). In San Francisco, residents' concerns over odors from composting food scraps serve as a minor, but added barrier to fully achieving zero waste goals (SF Environment, n.d.).

Some have pointed out concerns over labor conditions within waste and recycling collection. One the one hand, Pellow (2002) reported how workers in materials recycling facilities (MRFs) in Chicago faced health and safety threats and that these facilities contributed to increased levels of noise and pollution in EJ communities. Moreover, an article in *The Nation* reported that open-permit systems in New York City, which hire out collection services from multiple haulers, are troubled by poor labor conditions and increased environmental burdens in comparison to city-owned waste management systems (Chen, 2015). On the other hand, a report produced by the Blue Green Alliance found that diverting 75% of U.S. municipal solid waste and construction and demolition (C&D) debris by 2030 would create about 1.1 million new jobs (Tellus Institute & Sound Resource Management, 2013). Another report from the Local Institute for Self-Reliance found that "on a per-dollar-capital investment basis, for every $10 million invested, composting facilities in Maryland support twice as many jobs as landfills and 17 more jobs than incinerators" (ISLR, 2013). Therefore, it is imperative that municipalities consider both the barriers and opportunities within zero waste policies to ensure that economic, social, and equity concerns are met.

Overview on Waste-to-Energy (WTE)

At this point, zero waste is an aspirational goal, and while many cities are working towards it, they must dispose of their waste somehow before they get there. Each of the three cities we examined primarily utilize WTE technology to reduce their waste streams. In contrast to landfilling, WTEFs (also called incinerators) not only concentrate MSW into a much smaller volume and mass, but they also generate and distribute usable energy throughout a city. In this way, WTEFs can be seen as a sustainable waste management method and even defined as a renewable form of energy in some policies. However, these facilities also release large amounts of gaseous emissions during the combustion process, and nearby residents can be disproportionately exposed to these emissions. This section lays out the main characteristics of WTEFs.

The U.S. EPA (2017) and the Electronic Code of Federal Regulations (CFR) define certain terms related to WTEFs:

> ***Energy recovery from waste*** *is the conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolization, anaerobic digestion, and landfill gas (LFG) recovery. This process is often called waste-to-energy (WTE). Converting non-recyclable waste materials into electricity and heat generates a renewable energy source and reduces carbon emissions by offsetting the need for energy from fossil sources and reduces methane generation from landfills. After energy is recovered, approximately ten percent of the volume remains as ash, which is generally sent to a landfill* (U.S. EPA, 2017a).
>
> ***Incineration*** *means the controlled process which combustible solid, liquid, or gaseous wastes are burned and changed into noncombustible gases* (CFR, 2017).
>
> ***Incinerator*** *means a facility consisting of one or more furnaces in which wastes are burned* (CFR, 2017)[10].

Energy from Waste: The Basic Mechanics

WTEFs use MSW as a fuel source to create energy. The process begins with collecting a city's MSW in trucks and transporting it to a transfer station or directly to a WTEF. Once it arrives at the facility, MSW is combusted through WTE technology. The resulting electricity and/or heat is used in the city. WTE incineration sit towards the middle of the U.S. EPA's waste management hierarchy within the Energy Recovery section, as shown in **Figure 6** (U.S. EPA, 2016e).

Not all incinerators serve as WTEFs (there are few MSW incinerators in the U.S. that do not create energy), but those that do generate energy create different types of energy outputs. One production type results solely in electricity, the other in only heat (in the form of steam), and the third generates a combined heat and power method, also known as cogeneration

[10] Formatting and emphasis added by authors.

(Papageorgiou et al., 2009; Pavlas et al., 2011). WTEFs with steam outputs are the most efficient[11] out of the three methods, more than double that of electricity-only producing plants, while cogeneration plants are in the middle in terms of efficiency (Pavlas et al., 2011). All three WTEFs referenced in this study, in Detroit, Baltimore, and Minneapolis, are cogeneration plants (DRP, n.d.; Wheelabrator Technologies, n.d.; Hennepin County, n.d.). The number of WTEFs in the nation has decreased in the past several years; there were 97 standing WTEFs in 2001, and there were 84[12, 13] in 2014 (Michaels, 2014).

In the context of energy-generating facilities, WTEFs tend to be smaller, less efficient, and less energy-producing than traditional fossil fuel energy-producing facilities (Bianchi et al, 2014; Pavlas et al., 2011; Singh et al., 2010). Therefore, while WTEFs cannot be the sole alternative to fossil fuels, they have potential to serve as a partial offset (Tan et al., 2015).

Waste-to-Energy Environmental & Public Health Effects

In terms of harmful environmental impacts, some emissions from WTEFs are comparable to their electricity-producing fossil fuel counterparts:

> *Burning MSW in WTE plants produces comparatively high carbon dioxide emissions, a contributor to global climate change. …These [WTE] plants produce comparatively high rates of nitrogen oxide emissions. The on-site land use impacts are generally equal to those of coal or oil fueled plants* (Power Scorecard, 2003).

The main pollutant emitted from WTEFs is 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), which results from incomplete combustion (U.S. EPA, 1999). The numbers in this chemical refer to the location and position of the chlorine atoms on the dioxin molecule. This dioxin is one of the more toxic ones for mammals, and according to the Agency for Toxic Substances and Disease Registry (ATSDR), "2,3,7,8-TCDD is not usually found in rural or urban air, but it is found in air near urban waste incinerators" (ATSDR, 1998, pg. 6).

Despite the toxicity of dioxins, pollution from WTEFs has significantly decreased over the years as technological improvements have been made in the industry (U.S. EPA, 2016b). Total emissions from MSW plants have decreased by 96% from 1990 to 2005 (see **Table 4**), and mercury emissions have fallen as well as described by the U.S. EPA:

[11] Pavlas et al. (2011) uses the European Union's definition of energy efficiency referring specifically to MSW incinerators, as outlined as the R1 formula in Directive 2008/98/EC. Generally, the lower the loss of energy via transformation and boiler loss, the higher the facility's efficiency (Pavlas et al., 2011).

[12] This number includes four inactive facilities.

[13] Note that the International Solid Waste Association (ISWA) offers a conflicting number, citing 86 U.S. WTEFs in 2012. Since Michaels' report was published more recently, in 2014, we used this source instead of ISWA.

> *In 1990, three industry sectors made up approximately **two-thirds** of total U.S. mercury emissions: medical waste incinerators, municipal waste combustors, and power plants. The first two of these sectors have been subject to emissions standards for years and as a result have reduced their mercury emissions by more than **95 percent*** (U.S. EPA, 2016b).

Ultimately, while this is an impressive and positive environmental step forward for WTEFs, continuous monitoring and technological advances in pollution controls are still necessary to further reduce emissions and address EJ concerns.

Table 4: *Sources of Mercury Emissions in the U.S.*

Industrial Category	1990 Emissions tons per year (tpy)	2005 Emissions (tpy)	Percent Reduction
Power Plants	59	53	10%
Municipal Waste Combustors	**57**	**2**	**96%**
Medical Waste Incinerators	51	1	98%

This chart shows the drastic decrease in mercury emissions in U.S. plants from 1990 to 2005. WTEFs are shown in the middle-right at 96%. Data taken from the EPA (2016b).

Environmental Justice (EJ)

The EJ movement emerged in the late 1980s after Black residents in Warren County, North Carolina protested the placement of polychlorinated biphenyls (PCBs), chlorine compounds that were shown to have negative health effects (Mohai, Pellow, and Roberts, 2009). After the event catapulted residents' concerns over toxic substances into national news outlets, the movement gained momentum in getting policymakers and academic researchers to recognize that these concerns are not isolated incidents. The 1987 *Toxic Wastes and Race in the United States* report showed a correlation between the placement of hazardous waste sites and communities of color or low-income neighborhoods (UCCRJ, 1987). Several subsequent research studies confirm the prevalence of racial and socioeconomic disparities in the distribution of environmental hazards in the U.S. (Mohai and Saha, 2015a; Mohai and Saha, 2009a; Bell and Ebisu, 2012; Miranda et al., 2011; Bullard, 2000). Thus, communities of color and low income communities continue to face overexposure to harmful pollutants that may result in adverse health impacts.

Debates over "People vs. Pollution" and Implications of Regional Variations

More recent studies within the EJ literature shed light on the processes that create polluted communities. Mohai and Saha (2015a, 2015b) made two important contributions to the EJ field by addressing the long-standing question of whether people or pollution came first. In other words, were facilities disproportionately sited in communities of color and low income communities, or did these residents move in after the facilities had been sited? In one study, the researchers maintained that under the disparate siting of facilities hypothesis, environmental

disparities may be a result of market functions, industrial practices that target communities based on the "path of least resistance" principle, and/or various policies and regulations that intentionally or unintentionally segregated communities of color near industrial facilities (Mohai and Saha, 2015a). As for the post-siting demographic change hypothesis, environmental disparities may have occurred due to reductions in property values and increased affordable housing after "white flight," barriers that prevent meaningful civic engagement in communities, and/or discriminatory housing practices that affect where people of color have lived or can live. Mohai and Saha (2015a) found that most EJ studies using distance-based methods confirm the disparate siting hypothesis, thereby suggesting that communities of color tended to attract more TSDFs (transfer, storage and disposal facilities) in a particular region over time.

In their companion study, Mohai and Saha (2015b) used different spatial analysis methods[14] to determine whether the disparate siting of facilities hypothesis, post-siting demographic change hypothesis, or both have resulted in present-day environmental disparities. The researchers found that racial disparities existed throughout each time period examined (1966-1995) when using distance-based methods as opposed to unit-hazard coincidence methods, yet these were due to both disparate siting and post-siting demographic changes (Mohai and Saha, 2015b). They concluded that demographic changes were *already occurring* in communities at the time of siting, which then tended to "attract" TSDF facilities. Both studies purport that in the debate on "people versus pollution," disparate siting is primarily responsible for the prevalence of environmental disparities rather than post-siting demographic change (Mohai and Saha, 2015a; Mohai and Saha, 2015b).

Racial disparities in proximity to facilities and exposure to pollutants also differ regionally within the U.S. (Zwickl et al., 2014; Morello-Frosch et al., 2002). Zwickl et al.'s (2014) analysis of environmental inequalities in air pollution cited the significance of regional examination. Since U.S. EPA regions loosely align with historical environmental and economic trends, Zwickl et al. (2014) believe that national-level studies may not fully capture these regional differences. According to their results, the Midwest, South Central, and Mid-Atlantic regions all have the highest median exposures to air pollution. Additionally, Zwickl et al. noted that Blacks and Latinos in the Midwest have consistently higher exposures than Whites across a range of incomes (2014). Another study presented similar findings (Mohai et al., 2009). In their analysis of racial and socioeconomic disparities in the spatial distributions of polluting facilities, Mohai et al. (2009) found that survey respondents in metropolitan areas of the Northeast, Midwest, and West had a statistically significantly greater chance of residing within one mile of a TSDF facility in comparison to those residing in rural areas. In particular, the Midwest had higher racial disparities between whites and Blacks in comparison to other regions (Mohai et al. 2009). Therefore, the Midwest appears to present a unique set of EJ challenges due to seemingly higher racial disparities.

[14] See Mohai and Saha (2006) for a discussion on the use of 50% containment and areal apportionment methods over unit-hazards coincidence methods.

EMEAC, GAIA, and other EJ organizations across the U.S. take a stance against incineration as a waste management strategy due to a history of EJ concerns. Incinerators, which were not always energy-creating facilities, have been shrouded in conflict and public condemnation in the U.S. ever since the 1980s, roughly a decade after the federal government placed stricter requirements on incinerator emissions (Walsh et al., 1997). As a result, community rallies, local protests, and public unrest led to the creation of anti-incineration coalitions (see **Figure 7**). Walsh et al. (1997) captured the concerns presented by these coalitions by stating that "opposition forces focused upon three general areas: the fairness of the original siting decisions, health and safety issues associated with the technology, and the recycling alternative to burning" (pg. xvi).

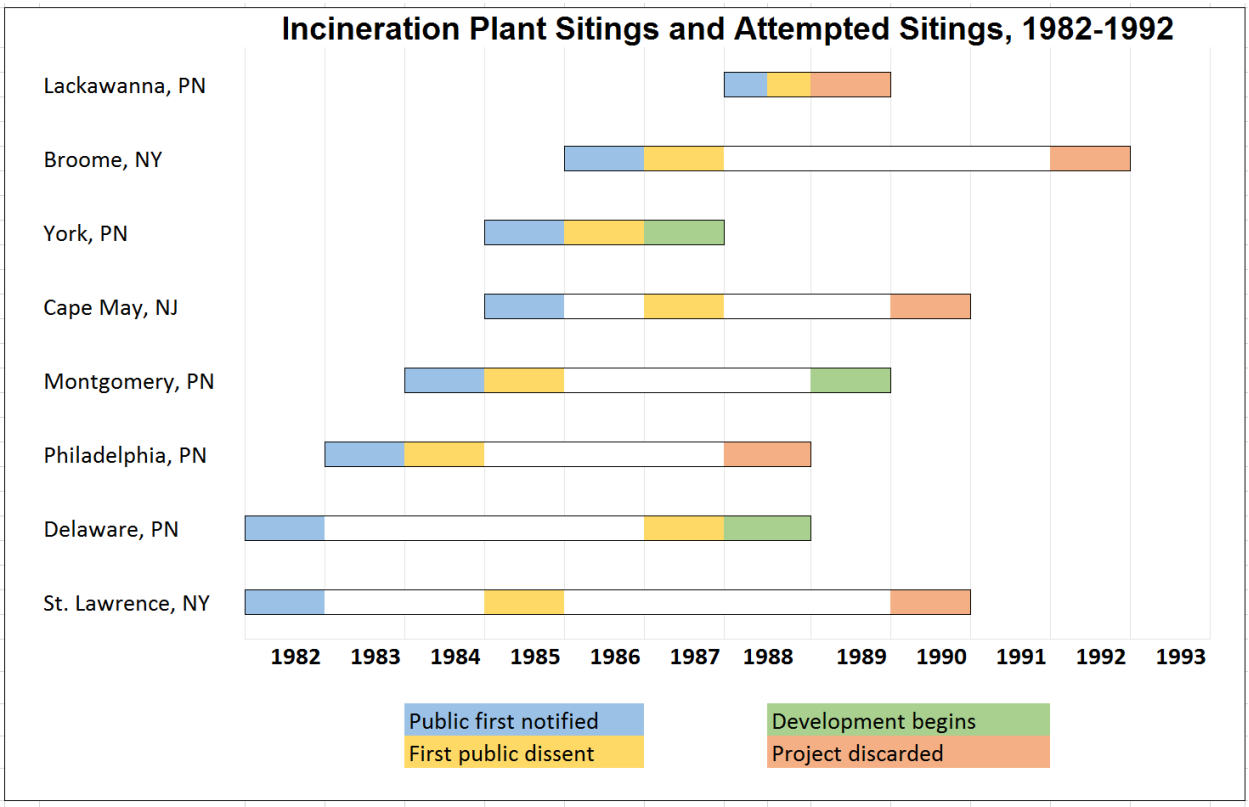

Figure 7: *Incinerator Siting Cases in the 1980s and 1990s*

This chart illustrates the timelines of eight different WTEF siting processes (five of which ended up falling through) based on public unrest. Walsh et al. highlighted each of these locations as a case study in their 1997 book (pg. 245).

Moreover, Rootes and Leonard (2009) found that public campaigns against incinerators in the U.S. emerged from the EJ movement as well as grassroots recycling organizing efforts. They mentioned that while campaigners raised concerns over air emissions of dioxins and particulate matter (PM), they also brought attention to the fact that ash generated from incineration can still create toxic residuals that must be sent to landfills. Other anti-incineration

advocates reported in *Think Progress* that WTEFs tend to be predominantly located in communities of color and low-income communities, and that they can lack adequate pollution controls in some cities (Pereira, 2016). When combined with EJ concerns presented in the previous section, the issues raised by anti-incineration campaigns demonstrate the need for MSWM stakeholders to fully consider the social and environmental implications of WTE.

Current U.S. Federal Policies

The Resource Conservation and Recovery Act: RCRA Subtitle D

The Resource Conservation and Recovery Act (RCRA), enacted in 1976, provides the framework and guidelines for environmentally responsible management of solid waste at the federal level. One goal of the RCRA is to "ensure that wastes are managed in environmentally sound manner" (U.S. EPA, 2014b).

RCRA has 10 subtitles, A through J. Among these subtitles, Subtitle D regulates the management of MSW through federal technical standards. Under Subtitle D, the EPA develops federal regulation and guidance for Municipal Solid Waste Landfills and other solid waste disposal facilities. Subtitle D also establishes the framework for the solid waste program. In the RCRA nonhazardous solid waste program, MSW is defined as "durable goods (e.g., appliances, tires, batteries), nondurable goods (e.g., newspapers, books, magazines), containers and packaging, food wastes, yard trimmings, commercial, and industrial nonprocessed sources" (U.S. EPA, 2014b).

The U.S. EPA also developed initiatives that focus on the economic and environmental benefits associated with source reduction and recycling. Examples of these initiatives include Recycling Market Development, Materials and Waste Exchanges, Pay-As-You-Throw, Full Cost Accounting for Municipal Solid Waste, Tools for Local Government Recycling Programs, and Industrial Ecology (U.S. EPA, 2014b).

Code of Federal Regulations: *40 CFR Part 239 through 258*

The Code of Federal Regulations (CFR) codifies the general and permanent rules published in the Federal Register. Title 40, Chapter I, established by the EPA, assures environmental protection (CFR, 2017). There are 15 subchapters in Chapter I: A through J, N, O, Q, R, and U. Among these sections, Subchapter I includes the requirements and guidelines for storage, collection, treatment, and disposal of solid waste (CFR, 2017). See **Table 5** for details.

Table 5: *Breakdown of CFR Parts, Headings, and Descriptions.*

Part	Table of Contents	Headings	Descriptions
239	239.1 to 239.13	REQUIREMENTS FOR STATE PERMIT PROGRAM DETERMINATION OF ADEQUACY	This specifies the requirements for adequacy of state RCRA Subtitle D permit programs and the determination procedures EPA will follow.
240	240.100 to 240.211 - 3	GUIDELINES FOR THE THERMAL PROCESSING OF SOLID WASTES	This applies to thermal processing facilities designed to process 50 tons or more per day of municipal-type solid waste. The requirement sections establish the criteria for solid waste accepted, site selection, design, operation, and records. All water discharged should be treated to meet applicable water quality standards under provisions of the Federal Water Pollution Control, and emissions should meet the standards under the authority of the Clean Air Act.
241	241.1 to 241.4	SOLID WASTES USED AS FUELS OR INGREDIENTS IN COMBUSTION UNITS	This provides the standards and procedures for the identification of solid wastes used as fuels or ingredients in combustion units. It identifies that scrap tires are not solid wastes when used as a fuel in a combustion unit.
243	243.100 to 243.204-2	GUIDELINES FOR THE STORAGE AND COLLECTION OF RESIDENTIAL, COMMERCIAL, AND INSTITUTIONAL SOLID WASTE	This identifies requirements and recommended procedures for storage and collection of solid waste. Solid wastes containing organics are required to be collected at a minimum of once during each week and bulky waste at least once every three months.
246	246.100 to 246.203	SOURCE SEPARATION FOR MATERIALS RECOVERY GUIDELINES	This identifies requirements and recommended procedures for source separation of residential, commercial, and institutional solid waste. High-grade paper, used newspaper, and corrugated containers are the focus.
255	255.1 to 255.41	IDENTIFICATION OF REGIONS AND AGENCIES FOR SOLID WASTE MANAGEMENT	This establishes guidelines for the identification of areas with common MSWM problems and appropriate units for planning regional solid waste management services.
256	256.01 to 256.65	GUIDELINES FOR DEVELOPMENT AND IMPLEMENTATION OF STATE SOLID WASTE MANAGEMENT PLANS	This provides guidelines for development and implementation of state solid waste management plans. It identifies responsibilities of state and substate authorities and describes the distribution of funding. It requires the that the state plan shall provide for (1) The establishment of state regulatory powers; (2) a policy and strategy to encourage resource recovery; (3) adequate resource conservation, recovery, storage,

			treatment and disposal facilities; and (4) practices for proper usage and disposal of solid waste. The plan shall identify means for coordinating regional planning and implementation.
257	257.1 to 257.107	CRITERIA FOR CLASSIFICATION OF SOLID WASTE DISPOSAL FACILITIES AND PRACTICES	This part establishes the criteria used in determining whether a solid waste disposal facility or practice poses a reasonable probability of adverse health or environmental effects.
258	258.1 to 257.107	CRITERIA FOR MUNICIPAL SOLID WASTE LANDFILLS	This part sets the minimum national criteria for all municipal solid waste landfills including location restrictions, operation criteria, design requirements, closure and post-closure care, and financial assurance criteria.

U.S. Clean Power Plan

The Clean Power Plan was established by the U.S. EPA to provide guidelines for reducing GHG emissions from existing power plants (U.S. EPA, 2015). The plan advocates for cutting carbon pollution by advancing clean energy innovation and development, creating the foundation for long-term planning efforts to address climate change (U.S. EPA, n.d.b). More specifically, the plan refers to emissions from landfills and WTEFs. Regarding landfill methane gas, a few refinements are proposed including the use of updated information on cost and potential of renewable energy and revision of the loss of renewable energy technologies that can exclude landfill gas. The primary standard is adopted in terms of flaring of landfill methane gas captured.

While the Clean Power Plan states that MSW can be directly incinerated in WTEFs as an alternative to landfill disposal, concerns also are expressed that increasing demand for electricity from WTEFs might work against waste reduction, composting, and recycling programs. Therefore, the plan emphasizes the importance of other strategies in the waste management hierarchy. At the same time, it is required that state plans that implement the best system of emission reduction should discuss potentially negative impacts of WTE practices on promoting waste reduction, recycling, and composting and measures to minimize these impacts. Additionally, only electricity generated from WTEFs using the biogenic portion of MSW is regarded as renewable energy. If a state plans to use WTE incineration to adjust a carbon dioxide (CO_2) emission rate, the state plan must assess the capacity to improve existing or develop new recycling, composting, waste reduction, and reuse programs and also include "a method for determining the proportion of total MWh generation from a waste-to-energy facility that is eligible for use in adjusting a CO_2 emission rate" (U.S. EPA, 2015).

Waste-to-Energy Terminology & Policy

Understanding WTE policy implications is as messy as the MSW that enters these facilities. This section will address the following questions: Is the energy produced by WTEFs considered

renewable? Is MSW, the fuel that goes into WTEFs, defined as renewable? These definitions, in a policy context, could ultimately create monetary and social repercussions based on how WTEFs are regulated by the government and how they are funded (Bracmort, 2015). This section will outline how U.S. federal policy classifies MSW as renewable and on the other hand, how U.S. states vary in their categorization of MSW as renewable.

U.S. Federal Waste-to-Energy Policies

The U.S. federal government has not held a consistent position with regards to whether MSW constitutes a renewable form of energy in WTEFs. Different policy documents frame and define both WTE and MSW in different ways. The 2007 Energy Independence and Security Act (EISA) pushed the U.S. to be more energy-independent by intensifying domestic renewable energy production and increasing product and system efficiency. Interestingly, neither MSW nor WTEFs were mentioned in this report. The U.S. Energy Policy Act of 2005 required that 7.5% of all electric power must be derived from renewables from the year 2013 onward. Here, the act defines MSW as a form of renewable energy (U.S. Energy Policy Act, 2005). The U.S. Energy Information Administration (EIA) also considers MSW as both a form of renewable energy and a form of biomass (2015).

However, the U.S. EPA's 2015 Carbon Pollution Emission Guidelines document outlines further requirements on renewable energy for WTEFs. WTE is listed under the biomass section, which was a cause of concern for commenters on that document who cited the heterogeneity of the materials that are combusted inside facilities (U.S. EPA, 2015). As a result, the following sentence clarified the issue: "Only electric generation related to the **biogenic**[15] fraction of MSW at a waste-to-energy facility added after 2012 is eligible for use in adjusting a CO_2 emission rate[16]" (U.S. EPA, 2015, pg. 64900). As defined in EPA's 2014 Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources, "Biogenic CO_2 emissions are defined as CO_2 emissions related to the natural carbon cycle, as well as those resulting from the production, harvest, combustion, digestion, fermentation, decomposition, and processing of biologically based materials" (U.S. EPA, 2014a, pg. ii). While MSW combusted in a WTEF does contain organic material, it also contains metal, plastics, and other materials that are mixed together. As a result, the renewable energy designation only refers to organic MSW (U.S. EPA, 2015; U.S. EPA, 2014a).

Further, there was also concern regarding the location of WTE incineration on EPA's waste management hierarchy. Since reduction, reuse, and recycling are preferred over WTE, the Carbon Pollution Emission Guidelines document also specified a need for these waste reduction tactics to be prioritized:

[15] Emphasis added by authors.

[16] In this case, "adjusting a CO2 emission rate" refers to its inclusion in state renewable portfolio standards (RPS).

> *When developing their plans, states planning to use waste-to-energy as an option for the adjustment of a CO2 emission rate should assess both their capacity to strengthen existing or implement new waste reduction, reuse, recycling and composting programs, and measures to minimize any potential negative impacts of waste-to-energy operations on such programs. States must include that information in their plan submissions. The EPA will reject as qualified biomass any proposed waste-to-energy component of state plans if states do not include information on their efforts to strengthen existing or implement new waste reduction as well as reuse, recycling and composting programs, and measures to minimize any potential negative impacts of waste-to-energy operations on such programs.* (U.S. EPA, 2015, pg. 64900).

Additionally, the EPA also addressed environmental issues regarding WTEFs and emissions. The agency defined a rule to reduce GHG emissions in existing power plants as part of the Carbon Pollution Emission Guidelines document. That report mandated the reduction of mainly CO_2 in relation to facilities that produce energy, including WTEFs. In turn, the document states that by reducing GHG emissions there will be other ripple effects:

> *Conventional pollutants emitted by power plants, such as particulate matter (PM), SO2 [sulfur dioxide], hazardous air pollutants (HAP), and nitrogen oxides (NOx), will also be reduced as the plants reduce their carbon emissions. These pollutants can have significant adverse local and regional health impacts* (U.S. EPA, 2015, pg. 64670).

Ultimately, U.S. federal documents generally define biomass and biogenic material as renewable, but the designation of WTE is not as straightforward since it combusts a myriad of assorted materials. In general, it is up to the states to create their own designations when it comes to renewable portfolio standards (RPS) and WTEFs.

Variation in State-level U.S. Waste-to-Energy Policy

In the context of WTEFs, MSW is often cited as a renewable resource or potential to be a renewable resource (Pavlas et al., 2011; Tan et al., 2015; Tan et al., 2014; Ren et al., 2016). However, state policy definitions regarding renewable energy and WTEFs vary (see **Figure 8**). Twenty-two states have functioning WTEFs, and 31 states[17] define WTEFs as renewable energy resources (Michaels, 2014). These renewable designations are listed in state RPS policy or other energy laws and regulations (Michaels, 2014). Pace University lays out both sides of the renewable/nonrenewable WTEF issue in its Power Scorecard, which is a tool for consumers to compare varying energy resources:

[17] Includes Washington, D.C. and two U.S. territories.

The Power Scorecard does not consider MSW a renewable energy source, because the waste stream includes materials made from fossil resources; the sources of the plant material based content (e.g., paper and wood[18]) are unpredictable; and the waste stream would be greatly reduced with environmentally preferable waste reduction and management practices. The EPA and the federal government and some state governments classify MSW as a renewable energy source because MSW is abundant and contains significant amounts of biomass (Power Scorecard, 2003).

[18] The U.S. EPA notes that paper comprised 27% of nationwide MSW waste stream in 2013 and wood comprised 6.2%, all of which constituted 33.2% of the total material (U.S. EPA, 2015).

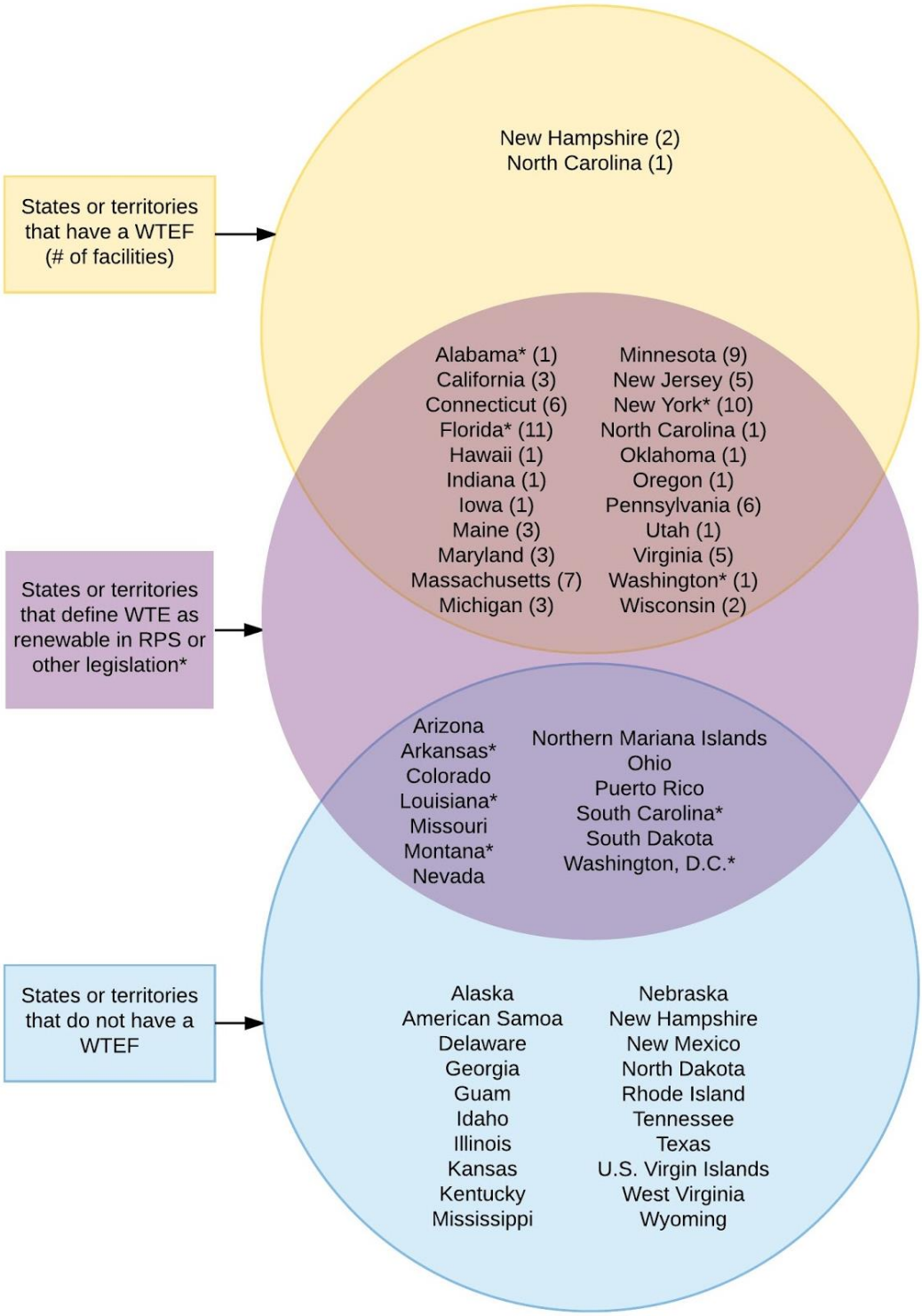

Figure 8: *Venn Diagram of U.S. States & Territories that Define WTE as Renewable*

This graphic shows the states that have a WTEF but do not designate MSW as renewable energy in their state policy (yellow area), states that have a WTEF and define it as renewable in their renewable portfolio standards (RPS) or otherwise* (purple-yellow area), states that do not have a WTEF but still designate WTE as renewable (purple-blue area), and states that neither have a WTEF nor designate the technology as renewable (blue area). Parenthesis show the number of WTEFs. Data from Michaels (2014, pg. 6).

Tabasova et al. (2012) reported that the "waste industry is one of the most developed areas in the EU" (pg. 146). The European Union (EU) recognizes that in order for the waste management process to be more efficient and environmentally conscious, data collection at "different points of the waste-stream generation, collection, recovery, and disposal" is critical (Regulation (EC) No 2150/2002, Note 3). By collecting consistent data throughout the entire waste stream, the EU creates a strong baseline and ideal waste management standard.

While Regulation (EC) No 2150/2002[19] does not specifically mention WTEFs, other documents discuss WTE more in depth. For instance, the EU's Directive 2000/76/EC solely encompasses waste incineration:

> *The European Union imposes strict operating conditions and technical requirements on waste incineration plants and waste co-incineration plants*[20] *to prevent or reduce air, water and soil pollution caused by the incineration or co-incineration of waste. The directive requires a permit for incineration and co-incineration plants, and emission limits are introduced for certain pollutants released to air or to water* (Municipal Waste Europe, 2016).

In 2015, the European Commission released *Closing the loop – An EU action plan for the circular economy* (EU, 2015). This action plan focuses on "the circular economy," the life cycle of materials, and the transition to a more sustainable business model. From this perspective, the plan formulates a long-term strategy of increasing source reduction and recycling, changing mindsets around how waste is discarded, and increasing efficiency in the overall waste management system. Recently, the European Commission published *The role of waste-to-energy in the circular economy,* which highlights the waste management hierarchy and the most efficient and effective waste management strategies (EU, 2017). Like the U.S. EPA's waste hierarchy, the EU also ranks recycling and recovery high on their own inverted pyramid, after prevention and reuse, and they call for more deliberate, higher recycling rates (EU, 2017). As for WTE technology:

> *The communication also examines how the role of waste-to-energy processes can be optimised to play a part in meeting the objectives set out in the Energy Union Strategy and in the Paris Agreement. At the same time, by highlighting proven energy-efficient technology the approach to waste-to-energy set out here is meant to provide incentives for innovation and help create high-quality jobs* (EU, 2017).

[19] A note about EU terminology: "A 'regulation' is a binding legislative act. It must be applied in its entirety across the EU," in contrast to a directive, which "is a legislative act that sets out a goal that all EU countries must achieve. However, it is up to the individual countries to devise their own laws on how to reach these goals" (EU, 2016).

[20] As defined by EU's Directive 2000/76/EC, a co-incineration plant refers to "any stationary or mobile plant whose main purpose is the generation of energy or production of material products… this definition covers the site and the entire plant including all co-incineration lines, waste reception, storage," etc.

Zero Waste Europe, an organization aimed at redesigning how European nations manage and think about waste, praised the European Commission for releasing these reports that focus on reframing waste in Europe and view the larger picture when it comes to materials management (Zero Waste Europe, 2017).

It is worth noting that the EU is an authoritative body for the entire European region, unlike the U.S. government that develops regulations for only one country. Some countries stand out the most when it comes to WTE policy. For example, Denmark "has developed the most efficient waste management system in Europe" due to its "visionary environmental and energy policies combined with coherent public planning" (Power Magazine, 2010). Though this report will not delve into Denmark, other studies focus more on their WTE practices (Brinck et al., 2011).

Figure 9 shows the number of WTEFs in 20 European nations in comparison to the number of U.S. plants. Only France, with 120 plants, has more than the U.S.; however, as seen in **Table 6**, the number of WTEFs per square mile in Europe is almost double that of the U.S. Additionally, although the population in Europe[21] is higher than that of the U.S., the per-capita number of WTEFs per person is more than three times higher in Europe. As a result, WTEFs are more common in Europe when population and land area are taken into account.

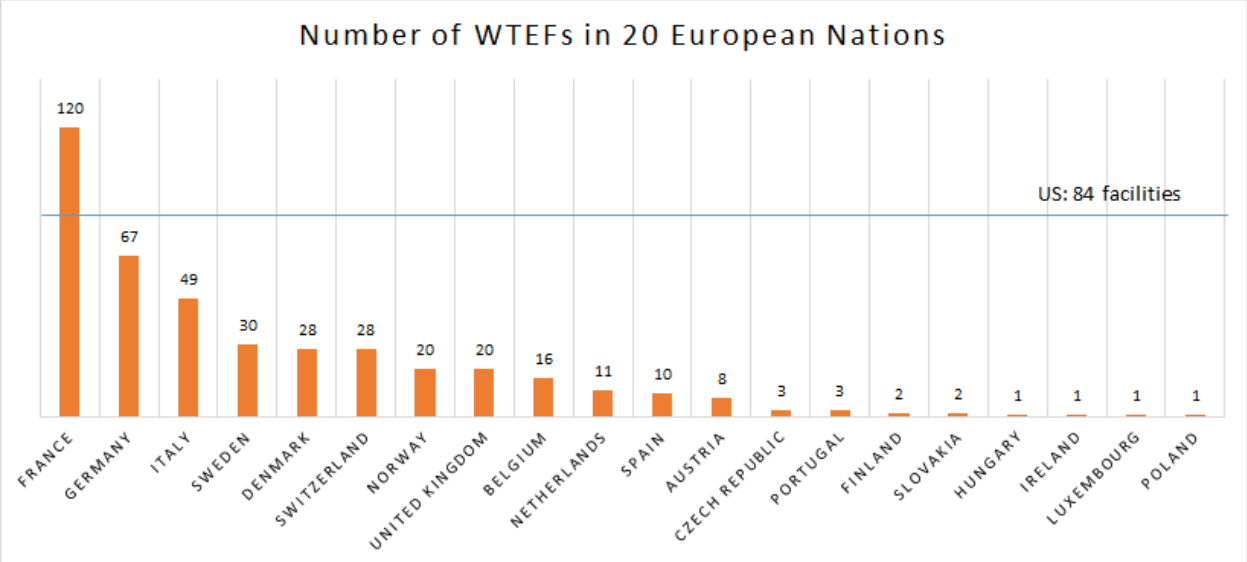

Figure 9: *List of European WTEFs*

This chart shows the numbers of WTEFs in 20 European countries in comparison to the number in the U.S. Data taken from Rogoff & Screve (2011, pg. 5) and ISWA (2012, pg. 100).

[21] In this context, we define "Europe" as the 20 nations that Rogoff and Screve (2011) and the ISWA (2012) highlighted in their publications as having WTEFs.

Table 6: *Ratio of WTEFs in the U.S. versus in Europe, Based on Land Area and Population*

	Number of WTEFs	Land area (square miles)	WTEFs per square mile	Population	WTEFs per capita
United States	84	5,683,943	1.48E-05	321,418,820	2.61341E-07
Europe*	421	1,514,507	2.78E-04	471,153,895	8.93551E-07

*In this case, "Europe" is defined as the 20 listed countries in **Figure 9**.
This chart shows the number of WTEFs in the U.S. and in Europe. Europe has more WTEFs per square mile and more WTEFs per capita than the U.S. Land area and population data taken from the World Bank (2015).

The U.S. EPA (n.d.) explains that the reason incineration is more prevalent in Europe is due to a combination of factors in the U.S.: higher land area, priority for short-term waste management solutions, backlash from the public about siting and emissions, and increased upfront costs of building a WTEF:

> *As the United States encompasses a large amount of land, space limitations have not been as important a factor in the adoption of combustion with energy recovery. Landfilling in the United States is often considered a more viable option, especially in the short term, due to the low economic cost of building an MSW landfill verses [sic] an MSW combustion facility.*
>
> *Another factor in the slow growth rate of MSW combustion in the United States is public opposition to the facilities. These facilities have not always had air emission control equipment, thus gaining a reputation as high polluting. In addition, many communities do not want the increased traffic from trucks or to be adjacent to any facility handling municipal waste.*
>
> *Additionally, the upfront money needed to build an MSW combustion facility can be significant and economic benefits may take several years to be fully realized.* ***A new [WTE] plant typically requires at least 100 million dollars to finance the construction; larger plants may require double to triple that amount***[22] (U.S. EPA, n.d.a).

[22] Emphasis added by authors.

Methodology

This section outlines our process of selecting our two case study cities. Further, we describe the interview process from creating the interview guide and receiving University of Michigan Institutional Review Board (IRB) exemption status to recruiting and interviewing the 14 stakeholders. We then provide information on the type of participants which whom we interviewed to give an understanding of their role in the waste management process in each city. Next, we explain our process of coding the interviews using qualitative data analysis methodologies. Finally, the last two subsections outline our process of spatial analysis and developing Sankey diagrams.

City Selection Process

We included other cities as case studies within this project to learn from existing waste management practices, including successes, challenges, and future opportunities that may be relevant to Detroit. In collaboration with our client, we discussed the types of cities that would contribute the most to the overall project. Initially, we wished to include about five to seven other case studies, including both cities with well-established zero waste practices and cities that are closer to Detroit's history and experiences with waste management. However, we ultimately chose to further research two other cities and remove the highest-achieving model cities to gain a more comprehensive understanding of issues that can be most transferrable and pertinent to Detroit's context.

To choose our case study cities, we decided on five major criteria in comparison to Detroit: 1) demographic characteristics, 2) city density, 3) private or public waste management services, 4) presence of a WTEF, and 5) proximity to Detroit (with preference to Midwestern and/or Rust Belt cities).[23] Ideally, we wanted two cities that would be most like Detroit in all five criteria, yet we did not fully dismiss a city that deviated slightly from one or two of these criteria.

These criteria were developed for several reasons. The demographic element was the most germane because the City of Detroit is 82.7% Black (U.S. Census, 2010), and we aimed to choose other cities who also had a large nonwhite population. Additionally, Detroit is not densely populated. After the recent economic downturn, larger pockets of the city became vacant as residents moved elsewhere and the population spread out. In recent years, Detroit has switched to private waste management services, which pose a different set of challenges than publicly managed waste systems. Therefore, we preferred cities with privatized waste management like Detroit. Since WTE is such a central aspect of Detroit's waste management practices, which also present community concerns, we prioritized cities that mainly utilize WTE incineration in their waste management system. With regards to geographic location, we preferred cities in the Midwestern or Rust Belt of the U.S. due to aforementioned climate, political, and EJ issues.

[23] See Appendix A for chart of city selection process

We compiled a list of 81 cities with WTEFs at first (Energy Justice Network, n.d.a), narrowing the selection down from there by filtering each city through our other criteria. 57 cities that were drastically different from Detroit in many of the criteria were removed during this process. After consulting with our client, we further analyzed the remaining 24 cities' waste management systems and ultimately selected the City of Baltimore[24] and City of Minneapolis, both of which are considered post-industrial cities like Detroit. Baltimore has similar demographic characteristics with Detroit since 63.7% of the population is Black (U.S. Census, 2010), though the city's density is higher and its waste management system is municipally operated. While Minneapolis has a smaller Black population (18.6%) (U.S. Census, 2010), and its waste management is operated by public and private entities, its Midwestern location met one of our criteria. Another important aspect was the history of waste management and recycling in each location, all of which provided meaningful narratives for our analysis. The social, historical, and community contexts in each city were especially important to highlight, particularly within the context of EJ. These histories are presented in **Figure 10** in the "Case Studies" section.

Interview process

Interview Guide

As stated in our project purpose, the goal of this report was to explore the waste management practices, histories, and trajectories of all three cities to ultimately develop a tailored set of recommendations for Detroit. We opted for conducting semi-structured interviews to allow participants to provide more open answers and speak more candidly if they wanted to (Newing, 2011). Newing (2011) explains the merits and proper context for semi-structured interviews:

> *Semi-structured interviews are used for a range of purposes, [including] elicitation of information from a specific person with specialist or privileged knowledge … [This] is often the case when interviewing officials, staff of non-governmental organizations or the leader of a community; their institutional role means that they should have privileged knowledge and a unique perspective. In this case, a different interview guide is often needed for each informant to reflect their area of knowledge* (Newing, 2011, pg. 102).

Since Newing's (2011) description fits well with the type of information we were seeking form stakeholders, we followed this as a guide. As Newing suggested, we adjusted the interview guide by modifying the questions slightly for different stakeholders who worked in a public agency,

[24] In this report, we combined both the City of Baltimore and Baltimore County together as one entity due to data, time, and logistical constraints. While we recognize that they are different jurisdictions, their waste management issues, strategies, and programs often overlap due to their geographic proximity to one another. Throughout this report, we will refer to the area broadly as "Baltimore" unless we specify policies or programs existing in only the county or city.

nonprofit/community organization, or a private company, as each required a slight change in the interview approach. As seen in the **Appendices B-E**[25], Section 3 of the interview guide posed a set of questions for cities with a local waste diversion goal (i.e. Minneapolis) and without a local waste diversion goal (Detroit and Baltimore).

Institutional Review Board (IRB) Application Process

To ensure ethical research standards were followed, we submitted the study methods, interview methods, and interview protocol to the IRB at the University of Michigan early in the summer of 2016. We received IRB exemption status in June 2016 under Exception #2 of the 45 CFR 46.101.(b) regarding interview participants.

We ensured interviewee confidentiality, but could not guarantee their anonymity. Consequently, we have not listed the interviewees' names, only their title and the sector with which their organization is affiliated (see **Table 7**). Further, we made it clear that participation was voluntary, making sure not to place any undue influence on potential interviewees. Before each interview, we reviewed the purpose of the study and verbally asked them if they still wished to participate and may be recorded. Each interview participant agreed to being interviewed and being recorded using audio recording applications. If interviewees requested a higher level of confidentiality, then we honored their requests in this report. We specified these elements well beforehand in our IRB application, and the project was exempt on the condition that we take the aforementioned steps towards protecting interviewees' confidentiality.

Finding, Contacting, & Interviewing Stakeholders

We initially planned to interview six to seven individuals within each city in different sectors for a wide range of stakeholder perspectives. We also aimed to speak with stakeholders in different positions within each sector, including in the city, county, and/or state, to understand potential policy implications at various scales. Since our clients have extensive connections to various individuals and organizations in different cities, we first utilized their networks to recruit potential interviewees. This led us to attend a Zero Waste conference in St. Paul, Minnesota, where we connected with waste management stakeholders in the Twin Cities area. At the same time, we identified other potential interviewees by contacting individuals or agencies that were listed on policy or planning documents in each city. We employed the snowball method, asking each interviewee if they had suggestions for others we should contact. As Biernacki and Waldorf (1981) noted though, while snowball sampling is thought to sometimes "[proceed] on its own" after the initial contact, this process proved to be ongoing on the researcher's part, with constant communication among numerous stakeholders throughout the length of the project.

We attempted to contact multiple potential interviewees via email, phone, or in person at least two separate times, but no more than three times if the first communication attempt went unanswered. We set this limit so as not to overburden potential interviewees. In the contact

[25] **Appendices B-E** illustrate the interview scripts.

messages, we clarified the purpose of our project and how we were planning to use the interview content. All interviews were conducted between July and December 2016, either by phone or in person when possible. We interviewed 14 participants, with one interview that was held with two participants, which resulted in over 14 hours of audio content. Each interview ranged from 36 minutes to 107 minutes, with an average of about 65 minutes each.

Interviewee Biographies

Table 7 lists the complete set of stakeholder position descriptions (i.e. interviewees' titles, organizations, and sectors). Note that since interviewee names are kept confidential, as per the project's IRB exemption status, we have removed any attribution throughout the report for both quotations and paraphrased responses.

In Detroit, we conducted five formal interview. We also engaged with numerous other individuals involved in waste management in the city through local meetings. Through these informal networks, we were better able to identify additional interviewees. Ultimately, the five formal interviewees represented the public (i.e. county, city, and state), private, community/advocacy, and nonprofit sectors. One participant had decades of experience in community organizing and collaboration, while another participant had decades of experience in the public sector. Other interviewees had a shorter range of experience in the waste management field in Detroit. This range of experiences provided multiple perspectives on Detroit's waste management structure.

We interviewed three individuals in Baltimore. Two participants work in the public sector, with the other participant working in a nonprofit advocacy organization. Their experience ranged from a few months to over ten years in their positions or in similar positions. Unfortunately, we were not able to recruit more interviewees in Baltimore due to time limitations and a lack of face-to-face contact with stakeholders as was achieved in Minneapolis. Therefore, relying on email and phone contacts alone resulted in fewer Baltimore interviews within our timeframe. However, those who we did interview in Baltimore had diverse experiences to be able to provide us with valuable insights into the city's waste management practices.

In Minneapolis, like in Detroit, we engaged with interviewees over telecommunications and in person. We interviewed six individuals from the public sector (i.e. city and county) and nonprofit/advocacy organizations. In some cases, interviewees' experiences included more of a perspective from the City of St. Paul, as Minneapolis and St. Paul comprise the Twin Cities area. Interestingly, one interviewee was formerly employed in Detroit, offering additional insights for our project. Like some of the Detroit interviewees, one Minneapolis interviewee also had been involved in community and regional waste management projects for decades. Other Minneapolis interviewees worked in the waste management field from about three to fifteen years.

Table 7: *List of Interviewees, Code Names, Titles, and Cities*

#	**Title (at the time of interview)**	**Type of organization**	**City**
1	Convener	Community/ advocacy	Detroit
2	Interviewee preferred to omit this information	Private	Detroit
3	Program Director	Nonprofit	Detroit
4	Division Director	Public: County	Detroit
5	Recycling Specialist	Public: State	Detroit
6	Sustainability Coordinator and Acting Director	Public: City	Baltimore
7	Bureau Chief	Public: County	Baltimore
8	Environmental Justice Community Organizer	Nonprofit/ advocacy	Baltimore
9	Director of Solid Waste and Recycling	Public: City	Minneapolis
10	Recycling Coordinator & Vice Chair	Public: City Nonprofit/ advocacy & community	Minneapolis
11	Vice President of Policy and Research	Nonprofit/ advocacy	Minneapolis
12	Board Chair	Nonprofit/ advocacy	Minneapolis
13	Recycling Specialist	Public: County	Minneapolis
14	Environmental Justice Organizer	Nonprofit/ advocacy	Minneapolis

List of interviewees and their titles in all three selected cities. Note that in some cases, an interviewee's organization was located outside of our selected cities. For example, one interviewee was based in St. Paul, but spoke about Minneapolis, yet it is categorized under Minneapolis.

Qualitative Analysis: Coding Process

Existing Research on Qualitative Analysis

Strauss and Corbin (1990) explained the methodology and reason for coding qualitative data: "Coding represents the operations by which data are broken down, conceptualized, and put back together in new ways. It is the central process by which theories are built from data" (pg. 57). Similarly, Newing (2011) defines coding more from the researcher's' perspective: "At its simplest, coding is a method of indexing your data so that you can find sections on different topics easily" (pg. 246).

Coding "uses a systematic set of procedures to develop an inductively derived **grounded theory**[26] about a phenomenon" (Strauss and Corbin, pg. 24, 1990). In this way, through methodology cited in qualitative analysis documents, the themes resulting from this report's coding methods are substantiated. Strauss and Corbin (1990) described the processes of open coding and axial coding, which we used in this paper. Open coding involves systematically identifying the major concepts listed in the qualitative works via comparing and contrasting different themes to create categories (Strauss and Corbin, 1990). Axial coding is an additional step, which involves putting data "back together in new ways after open coding, by making connections between categories" (Strauss and Corbin, pg. 96, 1990).

Since we each coded interview transcripts, there was a chance for variability among the coders that could be problematic if it was excessive. To account for that variation, qualitative data analysis software has an inter-rater reliability function that analyzes the coded interview transcripts and provides a Kappa coefficient value. The Kappa coefficient, also known as Cohen's kappa, was introduced by Jacob Cohen in 1960. This coefficient is most relevant for qualitative data:

> *Cohen suggests the possibility that for at least some of the variables, none of the raters were sure what score to enter and simply made random guesses. In that case, the achieved agreement is a false agreement. Cohen's kappa was developed to account for this concern* (McHugh, 2012).

The range of values that the coding software calculates for the Kappa coefficient are 0 to 1, with 1 suggesting perfect agreement (McHugh, 2012). The software we used, NVivo 11®, suggested a value from 0.75 to 1 as favorable and anything below 0.75 as unfavorable (QSR International, n.d.).

Step-by-Step Process

Based on the suggested coding methods described by Newing (2011, pg. 247), we first created a rough set of themes and initial codes, based solely on the interview question structure we previously created. Next, we each read over one interview transcript to create rough annotations in the columns to edit our list of initial codes. We then assessed our findings and we each reviewed all interview transcripts, making further annotations and occasionally more in-depth analytic memos through the **open coding** process as noted in Strauss and Corbin (1990). We reconvened, discussed the first round of open coding, and then organized a revised set of codes that we each agreed upon into a codebook (see **Appendix F**). We then re-coded a set of interview transcripts to test the viability of each code. After finding that our codes were not applicable to each type of interviewee, we restructured the codebook by maintaining the major

[26] Emphasis added by authors.

themes while amending or merging categories. This process is considered **axial coding** (Strauss and Corbin, 1990).

We then used NVivo 11® to continue coding all interview transcripts. Since the version we used did not allow us to simultaneously code in one file at the same time, we each coded an interview transcript on separate NVivo® files that were combined in one master copy. We performed an inter-rater reliability test in this master copy to give us a Kappa coefficient[27] of 0.8, which showed that the inconsistencies among each coder were not significant enough to warrant any changes to our codebook. We then divided the remaining 12 interviews among the three of us, coding four each using our final codebook (see **Appendix F**). We developed a set of parent, child, and grandchild nodes that formed our major themes, which are outlined in the "Interview Findings: Addressing Waste Management Framework" section later in this report.

Spatial Analysis Process

We used geographic information systems to analyze demographic characteristics in the communities around WTEFs in Detroit, Baltimore, and Minneapolis before and after the facilities were constructed. Previous studies have used distance-based methods to determine the extent to which disparate siting of facilities or post-siting demographic changes result in racial and socioeconomic disparities for TSDFs (Mohai and Saha, 2015b). Thus, we replicated these methods for our report to perform an EJ spatial analysis of the communities around each city's WTEFs.

We obtained demographic information for each city from the 1970 and 2000 U.S. Decennial Censuses through Social Explorer®. We were unable to examine demographic characteristics at the census block group level since this unit of geography did not exist in the censuses prior to 1990. We obtained census shapefiles from the National Historical Geographic Information System, which provides data on historic and current census tracts (University of Minnesota, 2016). We reduced our scope of analysis to only the 1970 and 2000 census decades due to data limitations, yet the selected decades do in fact show the demographic characteristics pre- and post-WTEF in each city, as the facilities were built in the 1980s. Variables we collected from the census include race, ratio of income to poverty, and median housing values.[28] Since the U.S. Census Bureau classified race differently from 1970 to 2000, we report racial disparities within minority[29] communities in 1970 and Black and Latino communities in 2000.[30] The income-to-poverty ratio determines the level of income a family receives in comparison to the federal poverty level in each decade. We standardized these measures across time to define

[27] With an agreement percentage of 99.1% among the each of us, as another measure of inter-rater reliability.

[28] These values were not adjusted for inflation in 2015.

[29] For the purposes of our spatial analysis, we considered the "minority" population to be the sum of "Black" and "Some Other Race" populations as defined by the 1970 U.S. Decennial Census.

[30] We only reported percent Black population within the 2000 Census data for the City of Baltimore since there seemed to be a high degree of overlap in the population counts, which resulted in percent values over 100 when combining Black and Latino counts.

households living in poverty as having an income-to-poverty ratio of less than 1.00, meaning that a family is earning an income less than the federal poverty level (IRP, 2016).[31]

In addition to mapping the communities around the WTEFs, we also included facilities that were as classified under the North American Industrial Classification Codes as hazardous waste TSDFs. Locations and addresses for the WTEFs were obtained from Google Maps©. We obtained the locations and addresses of hazardous waste TSDFs from the U.S. EPA Toxic Release Inventory (TRI) Database (U.S. EPA, 2017b). Since these facilities are outside of the scope of our analysis, they are only included in our maps so that readers of this report are aware of the co-location of both WTEFs and TRI facilities within communities in each city.

Using ArcMap 10.4.1, we geocoded addresses for both WTEFs and TRI sites. We then used the centroid containment and areal apportionment methods (Mohai and Saha, 2007; Mohai and Saha, 2006) to examine the demographic characteristics of communities within three-kilometer circular buffers around each WTEF. The centroid containment method determines the segment of the population within the three-kilometer buffer for tracts that have their population centers (i.e. centroids) within the buffer, regardless of whether a tract exists completely within the buffer itself. The areal apportionment method calculates population density within each tract to analyze the population within that segment of the tract that overlays the buffer. We then compared the demographic characteristics of tracts within the three-kilometer buffer to those tracts throughout each city to assess demographic changes around the WTEFs across time and determine the level of disparities in proximities to WTEFs. The census variables and circular buffer distance of three kilometer were selected since studies have demonstrated that facilities sited within this distance can affect both property values and community health in the buffer (Mohai and Saha, 2015b).

Sankey Diagram Process

Sankey diagrams are a specific type of flow diagram that can illustrate the flow quantities with the thickness of the diagram branches (Neugebauer et al., 2011). Sankey diagrams were first introduced to visualize energy flows in the engineering field (Sankey, 1898). While it became a standard practice to use Sankey diagrams in the energy and heat industry as of 1931, Sankey diagrams started to be applied to quantity-related materials management in the mid-1930s (Schmidt, 2008). Containing quantity-based information, this use of Sankey diagrams allows a quick overview of the interrelation between the physical quantities of the studied system (Neugebauer et al., 2011).

In this project, we utilized Sankey diagrams to show the waste information in each city. In the interview process, we asked our participants to assist us in finding and acquiring the data. The waste data for Minneapolis and Baltimore is mainly based on published work or studies on MSW in those cities (MSW Consultants, 2016; City of Baltimore DPW, 2013). We directly

[31] Since the the federal poverty level changed over the decades we examined, we created a ratio of income-to-poverty less than 1.00 category because it was the most viable method of standardizing poverty across time.

extracted most data from these two studies, while we calculated some numbers based on those studies. For example, in Baltimore, we extrapolated the amount of "other waste" sent to the WTEF from the total waste accepted by the facility and the amount of Municipal Solid Waste (MSW) combusted. The data for the City of Detroit were provided by one of our interviewees since existing data was limited (Wayne County, 2016).

After data processing, we employed SankeyMATIC to create the waste flow diagrams. SankeyMATIC is an online software that allowed us to visualize the waste flow using coding. We inputted data points into the software, including waste composition, where the waste came from, and where the waste was delivered. We created Sankey diagrams in this way representing the amount of waste. Therefore, these diagrams allow a quick overview of the basic background information of each city's waste management structure, showing which facilitates further waste management analysis and comparisons.

Case Studies

The three cities we examined, Detroit, Baltimore, and Minneapolis, serve as the focus of this report. The "Methodology" section outlined the process of choosing these cities and interviewing the stakeholders. Now, we will go further in depth about each city's waste management history, structure, policies, and political and social contexts. From there, each section will outline key findings, including city-specific opportunities and challenges, that arose in our interviews. Finally, we will present Sankey diagrams showing each case study city's waste management data, mainly the waste composition and volume flow in each city. This section will set the stage for the "Interview Findings: Addressing Waste Management Framework" section later in the report, which explores interview themes from the results of our qualitative coding analysis.

As shown in **Figure 10**, Detroit, Baltimore, and Minneapolis adopted their waste management strategies at varying times. Each city's WTEF became operational in the 1980s. Concurrently, Detroit grassroots recycling organizations began to appear to fill the city's recycling void, as a citywide recycling collection program was introduced in Minneapolis in the same decade. In the 1990s, Baltimore County partnered with community volunteer groups to open weekend recycling drop-off locations, and curbside recycling began. Since 2010, Baltimore moved to single-stream recycling, Detroit began its curbside residential recycling program, and Minneapolis implemented an organics collection program. See **Table 8** for a snapshot of facts and figures about each city's waste management structure and context. Demographic changes in the communities surrounding the WTEFs in each city is shown in **Table 9**.

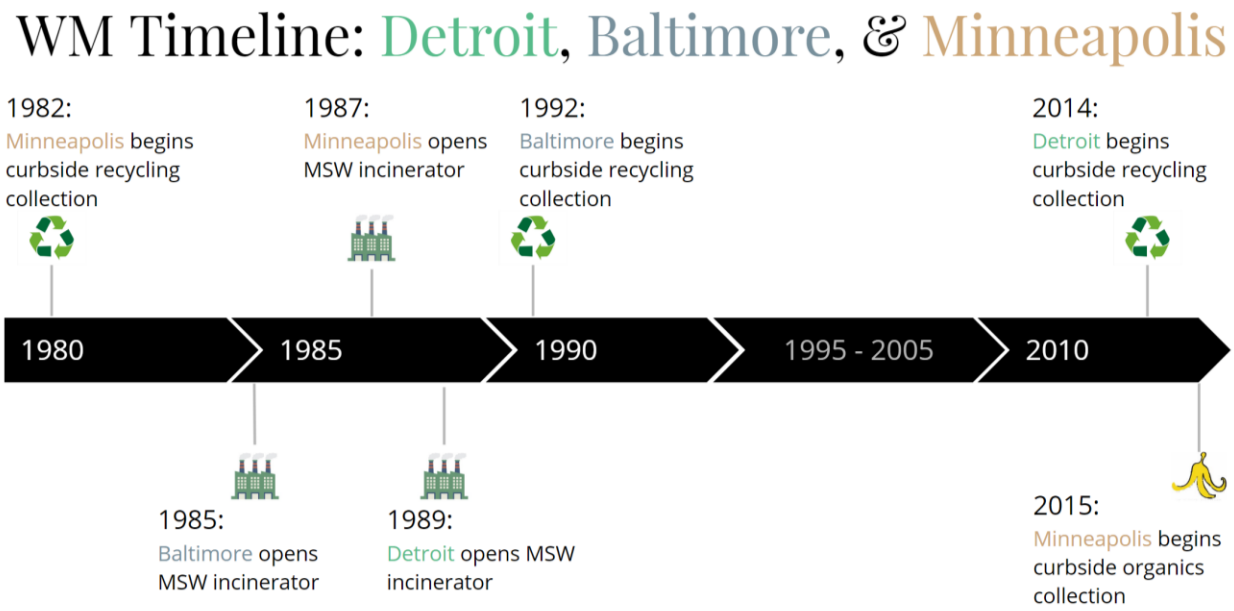

Figure 10: *Waste Management Timeline from 1982 through 2015 for Our Three Selected Cities*

From this timeline, we can see that Minneapolis began its curbside recycling the earliest out of the three cities, in 1982, while Baltimore began recycling collection ten years later in 1992, and Detroit started theirs in 2014. The WTEF in all three cities began operation in the mid- to late-1980s, and in recent years, Minneapolis has also begun collecting organics curbside.

Table 8: *Snapshot of Detroit, Baltimore, and Minneapolis' Waste Management, Geographic, Political, and Socioeconomic Context*

Snapshot	**Detroit**	**Baltimore**	**Minneapolis**
Race/Ethnicity (% nonwhite)	89.4%	70.4%	36.2%
Density (pop/mi^2)	4,994.94	City: 6,742.25 County: 1,180.39	6,550.99
Median HH Income	$25,764	$42,241	$51,480
Public/Private waste management collection	Private	Public/private partnership	Public/Private Partnership
Date WTEF began operation	1989	1985	1987
WTEF ownership	Private	Public	Public
WTEF operating company	Detroit Renewable Power	Wheelabrator Technologies	Covanta Energy Corporation
Date residential recycling collection began	2014	1992	1982
Date organics collection began	N/A	N/A	2015
Hazardous waste TRI facility within 3 km of WTEF?	Yes	Yes	No
Region	Midwest	Northeast	Midwest
State Waste Diversion or Recycling Target	By 2016: 30% residential recycling rate[32, 33]	By 2040: 85% overall waste diversion, 80% overall recycling goal[34, 35]	By 2030: 75% recycling rate for metropolitan counties, 35% for non-metropolitan counties[36]

This table shows a snapshot of the three cities' waste management, geographic, and socioeconomic context based on how we chose the locations.

[32] Michigan Department of Environmental Quality (2014).

[33] It is unclear if this goal has been achieved.

[34] Diversion in this case refers to diversion of waste from landfills.

[35] Maryland Department of Environment (2014)

[36] State of Minnesota (2016)

Table 9: *Demographic & Socioeconomic Changes around WTEFs (3 km) in Detroit, Baltimore, and Minneapolis between 1970 and 2000*

City	Time period	Percent White	Percent Minority	Percent Poverty
Detroit	1970	35%	65%	23%
	2000	18%	74%	34%
Baltimore	1970	45%	55%	24%
	2000	38%	59%	31%
Minneapolis	1970	90%	10%	13%
	2000	56%	30%	25%

Detroit

History of Waste Management: Timeline

Incineration & Waste Collection

> *Twenty-five years ago when I was just starting in this field, there was what was known as a capacity crisis in the State of Michigan. We were running out of landfill space. There was a lot of worry and concern that we didn't have enough space to dump our trash.*
> – **A Detroit interviewee**

Detroit's WTEF, now called Detroit Renewable Power (DRP), began operation in 1989 amid significant political and social discord (Zero Waste Detroit, n.d.). The question to build a MSW incinerator, the largest in the country until recently (Energy Justice Network, n.d.b), appeared on a public referendum at a time in which residents had the opportunity to vote in favor or against, according to a longtime volunteer and community collaborator. The referendum eventually passed, which meant that "citizens approved a public debt" in the form of a 20-year, $440 million bond to pay for the WTEF (Felton, 2014). The city paid off this debt in 2009, having ultimately spent over $1.9 billion (Felton, 2014).

Throughout its history, Detroit's WTEF has changed ownership numerous times. It began operation as a public entity, then it was sold shortly after:

> *Only four years later, [in the early 1990s] to avert financial catastrophe, then-Mayor Coleman Young sold [the WTEF] for $54 million to private investors, including tobacco giant Philip Morris, although the city continued having to pay tipping fees – charges for delivering a certain amount of waste – and debt costs* (Felton, 2014).

In 2009, international WTE company Covanta purchased a stake in the facility as well (Covanta Ltd, 2009). Detroit Renewable Power (DRP) stepped in to acquire the facility in 2010, yet the facility was temporarily closed later that year as "sales talks were pending" (Halcom, 2010). DRP, the result of a joint venture between Atlas Holdings LLC and Thermal Ventures II LP, purchased the plant that year at a $50 million value (Halcom, 2010). DRP continues to operate Detroit's WTEF (See **Figure 11**). The Greater Detroit Resource Recovery Authority (GDRRA)

also serves as a quasi-public entity that contracts waste for Detroit. GDDRA is authorized under Michigan's Joint Garbage and Rubbish Disposal Act (see "Policies & Goals" below).

In the midst of the city's bankruptcy filing in 2013, Detroit switched to a privatized waste collection system, contracting with two haulers, Advanced Disposal, and what used to be Rizzo Environmental Services instead of public collection (Saunders, 2016). This switch was done as a cost-saving measure.

Figure 11: *The Chimney of Detroit's WTEF, Detroit Renewable Power (DRP), on a clear day*
Photo by Gabriel Jones.

Recycling

Although curbside recycling was only recently enacted in Detroit, community-wide recycling initiatives have been ongoing since the late 1980s and 1990s. One nonprofit interviewee banded together with community groups and neighborhood coalitions to provide recycling drop-off locations in some Detroit neighborhoods. Yet, there was still hesitation to expand recycling at the time because recycling "could be perceived as competition" for community groups like Girl Scouts, Boy Scouts, and others who would host newspaper drives. Moreover, recycling was especially perceived to be competition for the WTEF. According to a nonprofit interview participant: "the city considered that the incinerator is a recycling program." By this point in time, the city had just taken on massive public debt from municipal bonds issued for the operation of its WTEF, which created a high level of waste management priority. As a result, local leaders were tied to this financial commitment to the WTEF that had been made, as

described by a nonprofit interviewee who mentioned that "everything was committed to go to the incinerator" as the main waste management strategy. Although recycling efforts in Detroit had been increasing, financial and political commitment to the WTEF remained strong.

It wasn't until 2009 when the city began a pilot recycling curbside collection program in nine areas of the city, according to an employee in a Detroit educational nonprofit. The city focused the recycling pilot in nine communities around Detroit, providing the residents with recycling bins. Around the same time as the start of the pilot program, the community organization Recycle Here! set up mobile recycling sites, in areas such as parks, around the city each Saturday. A large part of the initiation of the pilot curbside recycling program was due to forward movement from local leaders such as Mayor Ken Cockrel and organizations such as Zero Waste Detroit, Green Living Science, and Recycle Here! After a few years of testing the pilot program and adjusting logistical aspects, the city officially expanded the curbside recycling program in 2014 to all Detroit neighborhoods (Ferretti, 2016).

Education was another important element of the expansion of the pilot program. One participant mentioned that the neighborhoods that were chosen as pilot areas ultimately had the highest contamination rate because they had not received education regarding acceptable materials for recycling. Since high levels of contamination ultimately translates to low program efficiency, and therefore inefficient use of resources and money, this provided a good reason to increase recycling education efforts in the city. This is where Green Living Science, Recycle Here!, and Zero Waste Detroit stepped in to teach residents how to recycle and properly discard materials. Green Living Science and Zero Waste Detroit also educate students in Detroit schools about this issue, provide workshops for other city residents, and engage with community members through food programs and other local events.

Community & Environmental Context

Racial and socioeconomic issues have persisted in the City of Detroit over the last few decades, and they are reflected in waste management issues. Currently the city's population is made up of 82.7% African-Americans, 10.6% Whites, and less than 7% other races (U.S. Census, 2010). Twenty-one percent of the population makes less than $10,000 per year, while 61% of residents make less than $35,000 per year (U.S. Census, 2014). Thus, Detroit contains several communities of color and low income communities, which constitute the demographics in other EJ communities as described in previous sections.

Detroit's elevated asthma rates add another layer to concerns around the WTEF. Asthma rates in the city are 50% higher than Michigan's statewide rates (Wasilevich et al., 2008; Michigan Inpatient Data Base, 2013). While there is no documented causation attributing this respiratory illness solely to the DRP plant's emissions (DRP, 2014), these health issues have made the community even more wary of DRP and the plant's overall history. Two Detroit-specific studies have found connections between the city's WTEF and specific emissions, primarily ≤ 2.5 μm particulate matter ($PM_{2.5}$) (Morishita, et al., 2006; Hammond et al., 2008). Both studies listed municipal waste incineration as one of the primary sources of $PM_{2.5}$ emissions

(Morishita, et al., 2006; Hammond et al., 2008). Currently, Detroit is in non-attainment for the $PM_{2.5}$ National Ambient Air Quality Standard, and has been since 2004 (Hammond et al., 2008; MDEQ, 2016). The DRP emissions themselves, however, are considered to be within the acceptable EPA pollution limits (DRP, 2014).

Before the WTEF was planned to be built in the 1980s, making it the largest one in the country at the time (Energy Justice Network, n.d.b), residents were wary of its addition especially considering the city's standing health issues. An interview participant from a community organization tells an anecdotal account of the racial and socioeconomic tensions that went on during that time period:

> *There was a real strong coalition that was fighting against [the incinerator], called the Evergreen Alliance. Greenpeace was part of it. Sierra Club was part of it – Sierra Club powered the lawsuit. The important thing from my lived experience is [the anti-incinerator coalition] was portrayed as white environmental suburban knights against a Black urban mayor.*

This racial tension may have been part of the reason why the measure passed and the public ultimately voted in favor of building a waste incinerator. After that time, community groups centered around green initiatives and waste reduction began to meet. An interview participant explained that actively engaging a diverse range of people became a top priority in the coalition that campaigned against the incinerator and for more sustainable alternatives.

Community groups have brought awareness about odor and pollution violations from the WTEF (EMEAC, 2016; Felton, 2014; Neavling, 2014). EMEAC's website cites an October 17, 2016 press release from the Great Lakes Environmental Law Center:

> *The incinerator places a substantial environmental and public health burden on Detroit residents. Since the start of 2015, the incinerator committed 21 violations for strong odors wafting from the incinerator and 19 violations for emitting carbon monoxide, sulfur dioxide, and particulate matter above legally allowed limits. According to the EPA, 7,280 residents live within 1-mile of the incinerator, 87% being people of color* (EMEAC, 2016).

A 2016 report conducted by Community Action to Promote Healthy Environments (CAPHE) analyzed the health impacts from DRP, focusing on SO_2, $PM_{2.5}$, and NOx emissions. The report found that the combined emissions from DRP[37] accounted for 5.1 DALYs (Disability Adjusted Life Years) and 12.5 hospitalizations. The findings also attributes 14 work loss days and a monetized impact of $2.6 million.[38] The report also lists 15 other point sources of air pollutants

[37] Note that in the report DRP is identified by its former name, Greater Detroit Resource Recovery.
[38] In 2010 dollars.

for a total of 971.4 DALYs and $550.5 million[39] of monetized impact for the City of Detroit, meaning that the DRP WTEF accounts for 0.53% and 0.47% of the total impacts, respectively (CAPHE, 2016).

Current Waste Management Strategy

Today, DRP is still among the largest WTEFs in the nation. However, the facility in Chester, Pennsylvania, which has been operating since 1992, has now become the largest in the U.S. (Energy Justice Network, n.d.a; Covanta, n.d.). Chester's WTEF can process as many as 3,510 tons of MSW, while the processing capacity of DRP is 3,300 tons of MSW at most (Covanta Ltd, n.d.; DRP, n.d.; Energy Justice Network, n.d.a). DRP produces about 68 MW of electricity for sale to DTE Energy and enough steam to power over 140 buildings in midtown and downtown through Detroit Thermal (DRP, n.d.).

Over 75% of waste that the Detroit WTEF combusts comes from outside of Wayne County (Wayne County, 2016). Eleven geographic locations send their MSW to the facility. The major contributors (sending over 1,000 tons to DRP) are the State of Ohio, Canada, and Genesee, Macomb, Monroe, and Oakland counties (Wayne County, 2016). Oakland County contributes the most volume in MSW to the facility, sending about 518,000 tons to DRP in 2016, in comparison to Wayne County's 227,000 tons (Wayne County, 2016).

Detroit's waste is still predominantly collected by two private companies: Advanced Disposal and Green for Life Environmental (GFL), formerly Rizzo Environmental Services (Advanced Disposal, 2017; GFL, 2017). GFL collects waste and recycling for Detroit residents on the east and southwest sides of the city, roughly 90,000 households, while Advanced Disposal collects waste on the west side (Green Living Science, 2017). Waste is collected weekly in 96-gallon bins using automated side-load trucks, while recycling is picked up every other week. MSW is sent to the WTEF based on the haulers' contracts with the city. Four type-II landfills[40] are located in the county, with their remaining lifespans ranging from 15 years to over 60 years.

The curbside recycling collection program has been in effect after the program officially expanding to the rest of city in 2014 (Ferretti, 2016). When the pilot program began, residents had pay a $25 opt-in fee to receive a recycling bin. However, this fee proved to be a hindrance to the program as these costs were prohibitive for many Detroit residents who saw it as another bill to pay. The Michigan Department of Environmental Quality (MDEQ) Office of Environmental Assistance stepped in to help. They provided a total of $600,000 in Community Pollution Prevention grants to cities throughout the state, with Detroit receiving the largest portion of those funds at $95,000 (MDEQ, 2015). The majority of this grant was to be used to make the recycling bins free to residents who attended an educational workshop on recycling or took an online quiz (Green Living Science, 2017). The grant was awarded to the city on the condition that Detroit's recycling participation rate would rise to 20% by August 2017, up from about 13% in 2016. At

[39] In 2010 dollars.

[40] A type II landfill holds municipal solid waste, prohibiting any discarding of hazardous waste.

the time this report was published, the city's participation rate was 18% and it appears to be on its way to achieving the 20% goal by the end of the summer.

Recycling education programs continue throughout Detroit schools, mainly spearheaded by Recycle Here!, an educational partnership funded by the City of Detroit and GDRRA, and Green Living Science, an offshoot nonprofit focusing on recycling and waste reduction education initiatives (Recycle Here!, n.d.; Green Living Science, n.d.). Green Living Science collaborates with Detroit Public Schools, engaging 90,000 students since its start in 2007 (Green Living Science, n.d.). Zero Waste Detroit, a coalition of 20+ community organizations, is also instrumental in providing awareness and education to locals regarding recycling and waste reduction, especially in regards to diverting waste from the WTEF (Zero Waste Detroit, n.d.). In the past several years, ambassadors from Zero Waste Detroit have pushed the city forward to adopt recycling as a priority in the City Charter and expand the recycling program. As a result of Green Living Science and Zero Waste Detroit's efforts, hundreds of Detroit residents have signed up for recycling each month (Zero Waste Detroit, n.d.).

Further, Green Living Science and Zero Waste Detroit have been developing a waste and recycling app for smart phones that can be used throughout the city. Residents can use this app to find out how and where to discard certain types of materials. Both Wayne County and the State of Michigan either have or are developing their own versions of resident-focused websites and search engines to assist with recycling education efforts in Detroit.

In terms of administrative oversight in the city, Detroit's Department of Public Works (DPW) serves as the main managing entity for waste management in Detroit. However, GDRRA also serves as a quasi-public-private entity that manages waste hauling and disposal contracts and funds organizations such as Green Living Science, as described by one interview participant:

> *GDRRA is quasi-independent facility, I mean probably an independent body, and so it has different levels of accountability. It's supposed to have open meetings as it used to during the public debt. But I don't know if they had any meeting since 2010, 2011.*

Wayne County is also involved in Detroit's waste management system. All waste disposal facilities in the county, including landfills and WTEFs, are required to report annual data on waste volume and tonnage to the county. This data shows where the waste is coming from and the tonnage that is disposed (Wayne County, 2016). However, the data does not provide information on the composition of the waste, also known as a waste audit or waste characterization. This is more specific data that indicates what type of material is thrown away (like a percentage of plastic, paper, metals, etc.), and where that material goes. With this information, it would be able to better understand how much waste could be recycled in the city. Without this data, Wayne County does not have a finite baseline to use when developing future recycling goals.

Sankey Diagram

In 2015, the City of Detroit generated 324,200 tons of MSW. As **Figure 12** shows, only 1.29% was recycled and 5.34% was composted. Over 22% of Detroit's waste was landfilled. The majority, 228,500 tons, was incinerated in the DRP plant. The facility accounts for 70.48% of the total MSW generated in Detroit in 2015. Besides Detroit's MSW, DRP also accepts waste from other various locations as aforementioned. Oakland County, Wayne County, and Macomb County are the three biggest contributors of MSW to DRP besides Detroit. We can see from the Sankey Diagram that the waste from Detroit is only one fifth of refuse incinerated in DRP.

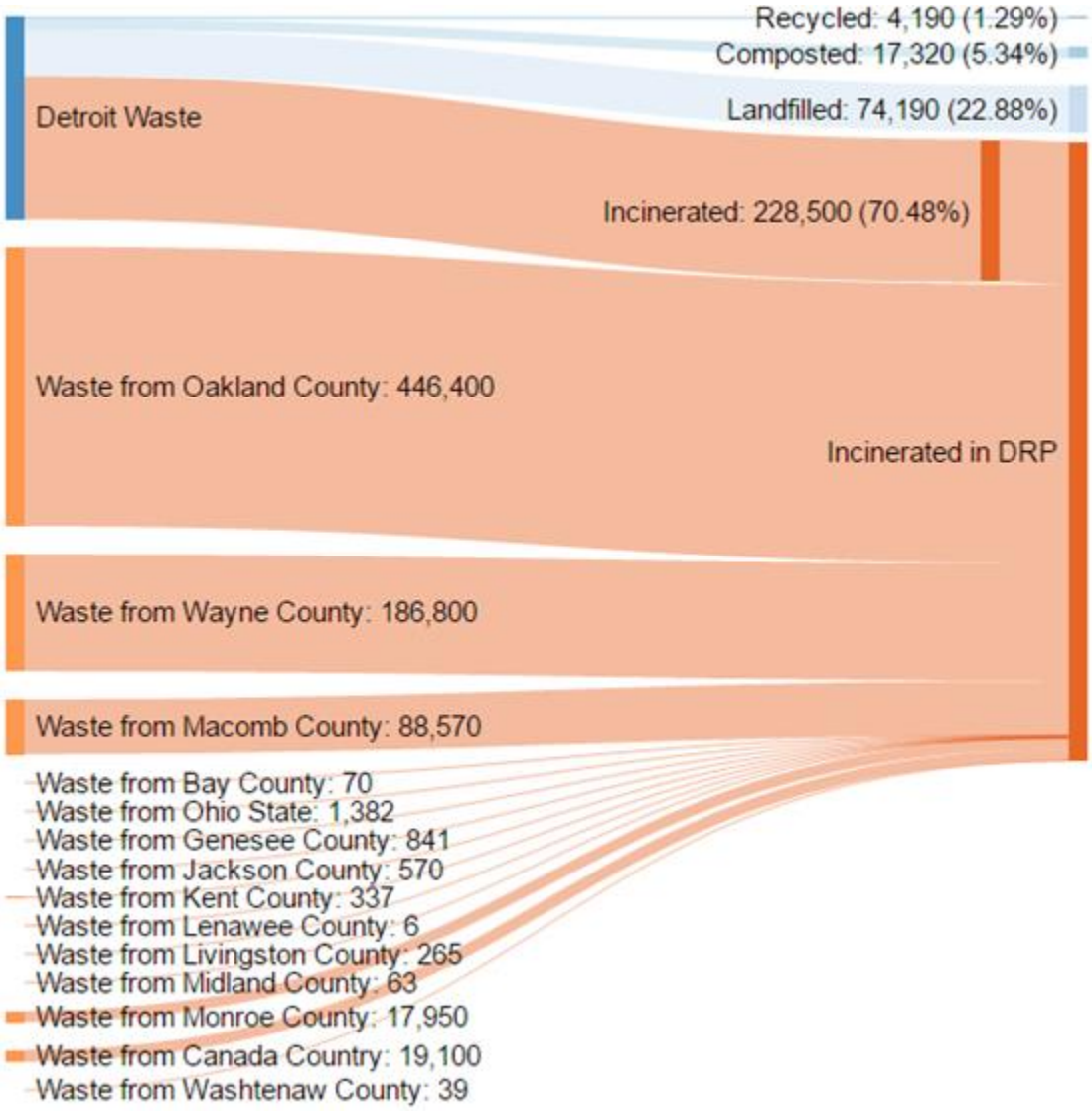

Figure 12: *Detroit Municipal Solid Waste Sankey Diagram*

This diagram shows the location of all waste disposed in DRP, which is the WTEF in Detroit, along with some other Detroit waste data that is landfilled, recycled, or composted. The numbers shown represent tonnage. Data from Wayne County, 2016.

Spatial Analysis

In general, we found a higher proportion of communities of color, poorer households, and low median housing values within three kilometers of DRP before and after the facility was constructed (see **Figures 13-16**). Using both the centroid containment and areal apportionment methods, we observed a higher percentage of Black residents within the buffer when compared to all tracts in the Detroit for the 1970 decade (See **Table 10**). The opposite was true for white residents. Additionally, the percentage of poorer households in tracts around DRP were almost double that of the tracts in Detroit. Similarly, we found lower median housing values in those tracts as well.

Within the 2000 Census tracts, however, we found different results. In this decade, the percentage of Black and Latino residents and median housing values within tracts around DRP was slightly lower than those throughout the city (See **Table 10**), which may be due to the demographics shift throughout the entire city after "white flight" occurred in the late 1960s and 1970s. There was also a slightly higher percentage of white residents within the tracts around DRP in comparison to the rest of Detroit, which could be due to the community of Hamtramck near the north. At the same time, we found a higher percentage of households living in poverty within the tracts surrounding DRP than in comparison to Detroit Census tracts. Despite these discrepancies, our findings suggest that the neighborhoods around DRP prior to construction already contained a disproportionate amount of people of color, poorer households, and lower median housing values.

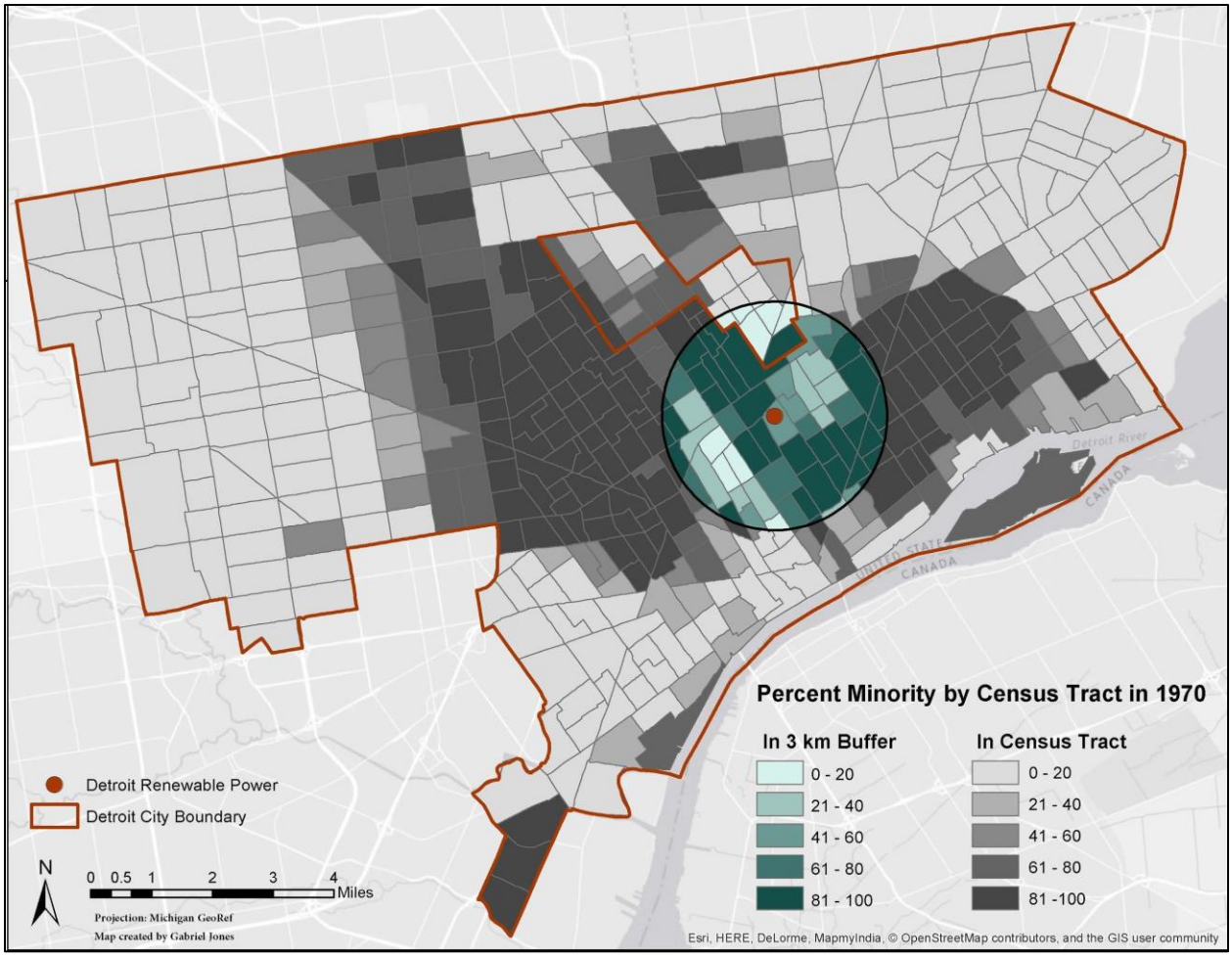

Figure 13: *Racial Characteristics Near Detroit WTEF Before Construction (1970)*

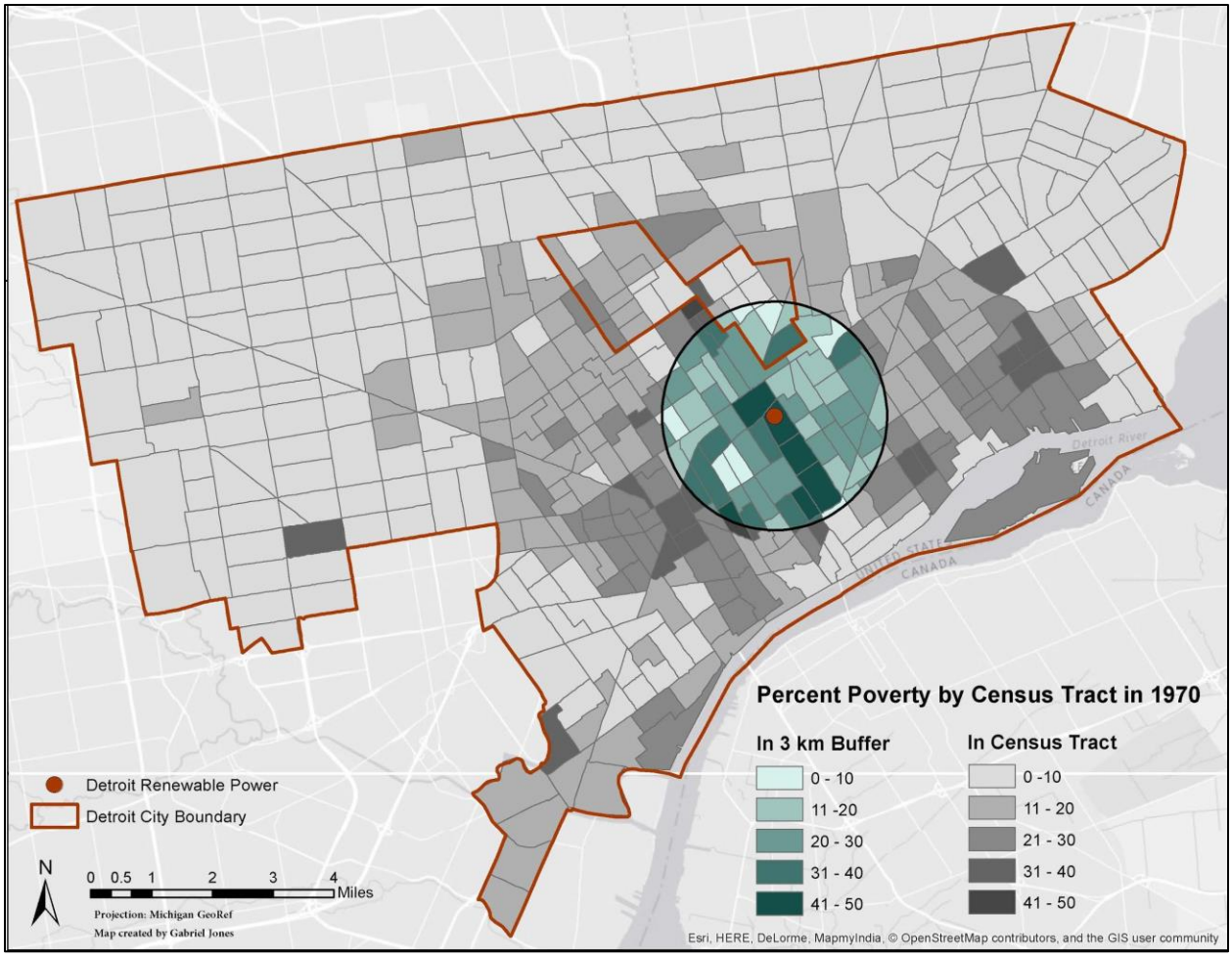

Figure 14: *Socioeconomic Characteristics (i.e. households with a ratio of income-to-poverty of less than 1.0) Near Detroit WTEF Before Construction (1970)*

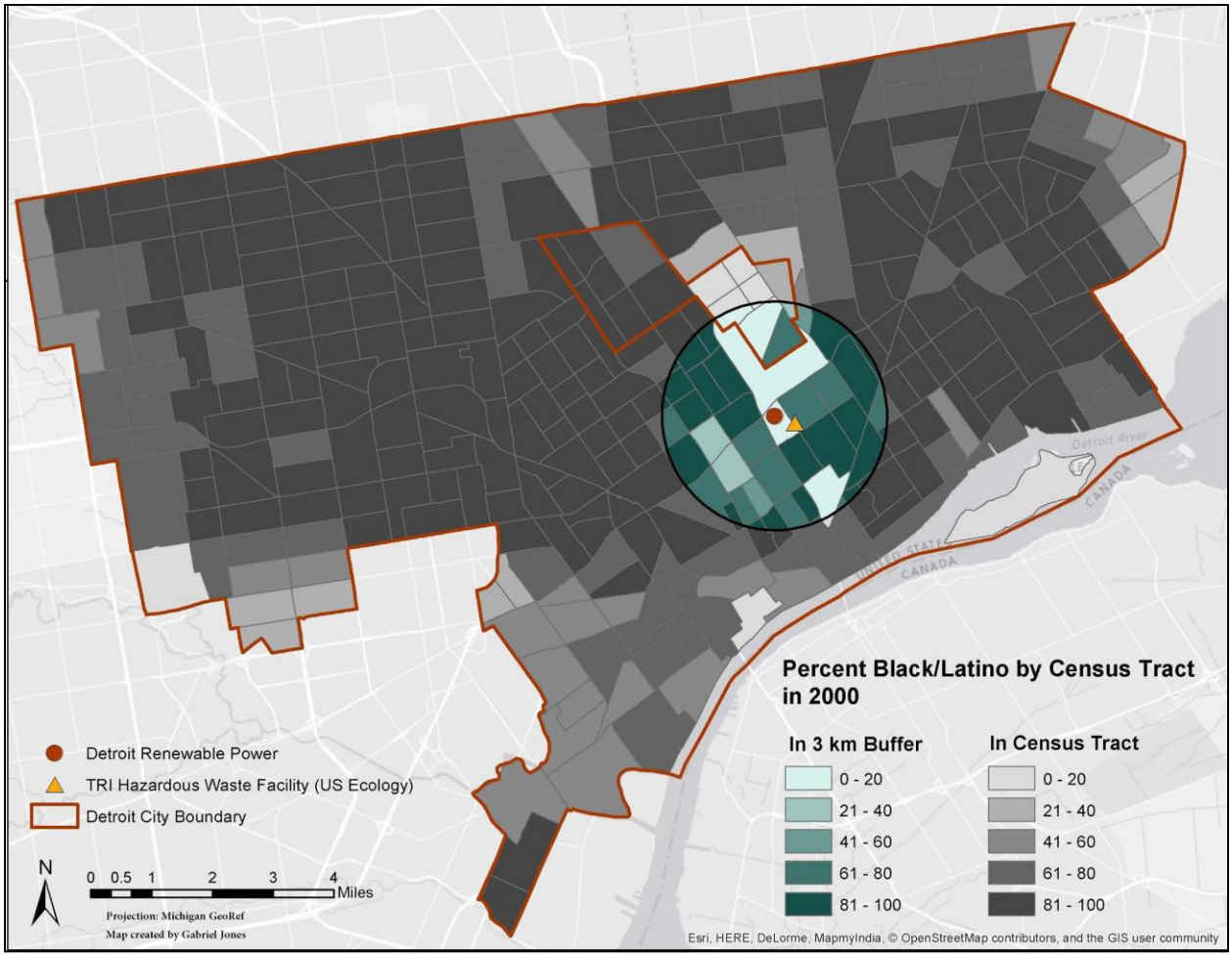

Figure 15: *Racial Characteristics Near Detroit WTEF After Construction (2000)*

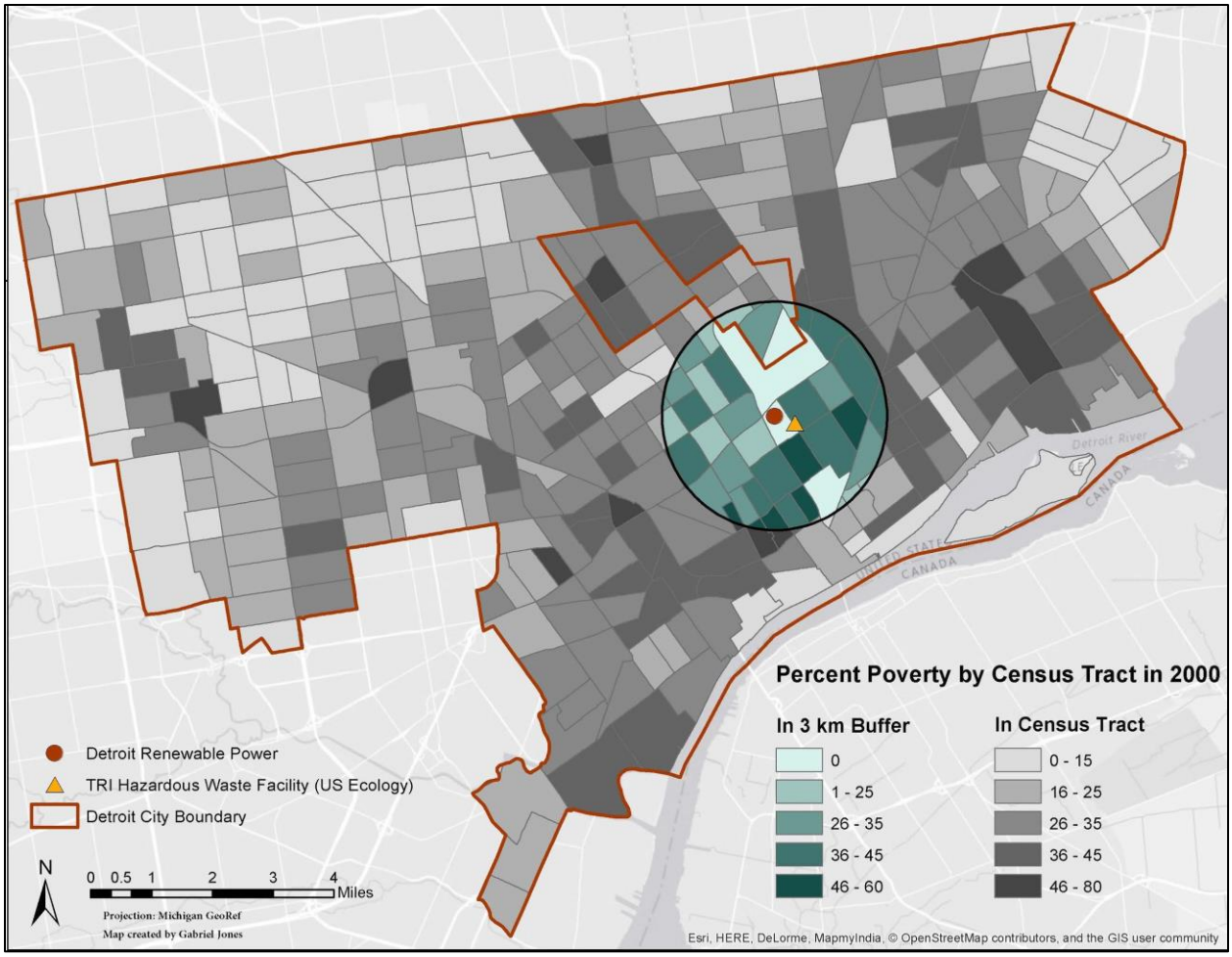

Figure 16: *Socioeconomic Characteristics (i.e. households with a ratio of income-to-poverty of less than 1.0) Near Detroit WTEF After Construction (2000)*

Table 10: *Demographic Characteristics in Communities within a 3-km Buffer of Detroit Renewable Power in 1970 and 2000*

Variables	**Centroid containment method**	**Areal apportionment method**	**City of Detroit**
1970 Census			
Race (%)			
White	45,362 (32%)	72,708 (35%)	880,109 (56%)
Black	93,234 (66%)	135,831 (64%)	683,383 (43%)
Some other race*	1,659 (1%)	2,119 (1%)	10,369 (1%)
Total	140,255 (100%)	210,658 (100%)	1,573,861 (100%)
Ratio of Income-to-Poverty (%)			
Under .50	3,075 (10%)	4,311 (10%)	18,397 (5%)
.50 to .99	4,219 (14%)	5,759 (13%)	25,593 (7%)
1.00 to 1.49	3,753 (13%)	5,394 (12%)	29,381 (8%)
1.50 to 1.99	3,672 (12%)	5,431 (12%)	37,305 (10%)
2.00 and over	14,897(50%)	24,238 (54%)	276,778 (71%)
Total	29,616 (100%)	45,133 (100%)	387,454 (100%)
Median Housing Value**	$10,479.21	$10,823.12	$14,322.47
2000 Census			
Race (%)			
White	8,192 (15%)	16,858 (18%)	115,014 (12%)
Black	41,424 (76%)	67,883 (73%)	789,687 (80%)
Hispanic or Latino	666 (1%)	1,068 (1%)	47,728 (5%)
Total	54,580 (100%)	93,363 (100%)	990,992 (100%)
Ratio of Income-to-Poverty (%)			
Under .50	10,504 (20%)	16,206 (18%)	131,730 (14%)
.50 to .99	9,329 (18%)	14,153 (16%)	123,581 (13%)
1.00 to 1.49	6,792 (13%)	11,892 (14%)	119,176 (12%)
1.50 to 1.99	6,090 (12%)	10,325 (12%)	99,092 (10%)
2.00 and over	18,864 (37%)	35,194 (40%)	497,151 (51%)
Total	51,579 (100%)	87,770 (100%)	970,730 (100%)
Median Housing Value	$63,334.34	$62,336.71	$60,253.82

*Racial category no longer used after 1970 Census.

**Values are not adjusted for 2015 inflation.

***Includes other racial groups not shown that were excluded from our analysis, such as American Indian or Alaskan Native, Asian/Pacific Islander, and multiracial individuals.

Policies & Goals

State Policies & Regulations

Natural Resources and Environmental Protection Act (Act 451 of 1994): Part 115 – Solid Waste Management

Part 115 of the Natural Resources and Environmental Protection Act (Act 451 of 1994), as amended, is the primary legislative piece that guides MSWM and planning for all counties, townships, villages, and municipalities in Michigan (State of Michigan, 1994). The statute includes "provisions for construction permits and operating licenses for the transfer, processing, and disposal of solid waste, registrations, and exemptions, with or without written approval and conditions" (MDEQ, 2016).

Aside from the permitting and licensing requirements, Part 115 contains specific regulations for different operations and materials. Section 11513 allows a facility to accept incinerator ash that was generated outside of the county if their approved county solid waste management plan approves this transaction. Section 11514 specifies that the state will develop policies and practices to promote recycling and reuse of materials, while minimizing landfill use for waste disposal to the extent practical. This section also prohibits the following materials from being sent to landfills: beverage containers, medical waste, used oil, lead acid batteries, low-level radioactive waste, regulated hazardous waste, asbestos, PCBs, scrap tires, septage wastes, and compost and yard clippings that are not diseased, infested, or composed of invasive species.

Section 11521 regulates where yard clippings may be sent, which includes composting at MSW landfills under certain circumstances. Additionally, section 11526b requires that MDEQ must notify each state, the country of Canada, and each province in Canada that sends wastes to landfills in Michigan that the prohibited materials are not accepted in any state landfills. Section 11538 of Part 115 requires that the MDEQ promulgate rules, generally referred to as Part 115 Rules, for solid waste management plans that must be submitted by each county in the state. Part 7 of the rules outlines the processes behind forming county solid waste management plans (MDEQ, n.d.).

Michigan Solid Waste Policy

The revised Michigan Solid Waste Policy addresses more recent stakeholder concerns that emerged since the initial adoption of the document in 1988. The policy is meant to be a guide for solid waste management decisions from the state level down to individual consumers, and it calls upon the MDEQ to consider the following principles of sustainability in the decision-making process: (1) economic vitality; (2) ecological integrity; and (3) improved quality of life (Granholm et al. 2007). The policy notes that the State of Michigan prefers source reduction over material recovery, with disposal remaining as the final option. Some of the goals outlined in the policy include considering all forms of waste utilization and ensuring that recycling is accessible to all Michigan residents by 2012. Options for MSWM are believed to be achieved through regulatory requirements, education, and financial incentives based on economic, environmental,

and social impacts. The policy also recommends that all stakeholders continue to be included in guiding the implementation of the policy to assist with facilitating sustainable waste management practices.

Michigan Beverage Container Deposit Law (Initiated Law of 1976)

The State of Michigan enacted a bottle bill in 1976 to require the reporting of containers sold and redeemed by bottlers and distributors. Consumers can redeem their 10 cent deposits at specified locations (State of Michigan, 1976).

Joint Garbage and Rubbish Disposal Act (Act 179 of 1947)

The Joint Garbage and Rubbish Disposal Act of 1947 allows municipalities to incorporate certain authorities for the purposes of collection or disposal of garbage of rubbish and for the operation of a dog pound (State of Michigan, 1947). The municipal authority is granted certain powers similar to that of the municipality itself, including the right to contract and subcontract with any person, firm, or corporation and the right to hold, manage, sell, or lease land. Section 123.308 grants municipalities with the power to pay these authorities as outlined in the contracts between them, and it establishes that these authorities do not have taxing power. This law establishes the legal bases for the creation of entities such as GDRRA in Detroit.

Michigan's Residential Recycling Plan

The Michigan Residential Recycling Plan is a proposed plan that was introduced in 2014 to increase the MSW recycling rate in the State of Michigan (MDEQ, 2014). The plan includes both short- and long-term components, and it identifies six components of a statewide comprehensive residential recycling plan. The main goals outlined in the plan are to increase the number of counties with convenient access to residential recycling from 29 counties in 2015 to 45 counties by 2016 and 83 counties by 2017. However, Governor Snyder has also mentioned elsewhere that he commissioned the Governor's Recycling Council to assist with increasing the state's recycling rate from 15% to 30% within two years from 2014. The plan establishes actions that will help achieve these goals by benchmarking and measuring progress, providing education and technical assistance, stimulating investment, encouraging regional collaboration, increasing convenient access to recycling, developing markets and supporting innovation, and sustaining the commitment to the Governor's Council on Recycling (MDEQ, 2014).

County Policies & Regulations

Wayne County Solid Waste Management Plan

The Wayne County Solid Waste Management Plan was updated in 2000 to reflect changes in the County's waste stream (Wayne County, 2000). The plan provides data on the waste streams of each municipality in its jurisdiction and information on waste reduction, recycling, and composting programs. The plan also recognizes that recycling should remain a major component of the waste hierarchy in the county, although it does not contain a specific hierarchy.

The plan outlines four main goals. The first goal aims to reduce MSW generation that must be landfilled by encouraging waste collection and diversion from the total waste stream, the use of WTEFs, and the promotion of industrial and commercial reduce, reuse, and recycling programs. The second goal aims to optimize the use and life of existing solid waste disposal areas by encouraging and supporting more airspace at landfills and operational changes for improved compaction rates at landfills. The third goal aims to include public participation in the solid waste management plan by forming partnerships with communities, seeking community input, and assisting local communities with compiling data for evaluating their reduce, reuse, and recycle programs. The fourth goal aims to maintain the viability of enforcement programs by continuing enforcement of the Wayne County Solid Waste Ordinance and ensuring that the Wayne County Department of Environment Land Resource Management Division's Solid Waste Program continue to provide the same level of service.

The plan identifies some alternative methods for managing MSW. These fall into the categories of waste minimization, resource conservation, volume reduction, and landfilling. Waste minimization techniques include changing product design and packaging, increasing product life cycles, reusing products, and decreasing consumption of unnecessary products. Resource conservation strategies include disposal using WTE combustion, recycling, and composting. The plan also states that WTEFs assist with volume reduction and energy production.

Wayne County Solid Waste Ordinance

The Wayne County Solid Waste Ordinance regulates specified solid waste practices among the municipalities within the County (Wayne County, 2004). Section 105-91 requires that each sanitary landfill, MSW incinerator, and solid waste processing facility must submit a quarterly waste report to the Wayne County Department of Environment Land Resource Management Division that contains information on the facility, the amount of waste received and the source from where that waste originated, the amount of material recycled or recovered, the amount of waste incinerated, the amount of waste landfilled, and the amount of ash monofilled. The Solid Waste Ordinance also provides stipulations for violations and procedures for compliance and enforcement.

City Policies & Regulations

Charter of the City of Detroit

Section 7-403 of Detroit's City Charter requires that the Department of Public Works (DPW) develop and implement a comprehensive citywide Recycling Plan (City of Detroit, 2012). The plan must be approved by the City Council before implementation, and the City Council has the authority to enact ordinances that can assist with the objectives of the plan and this section of the Charter. The section also indicates that the plan must provide for and encourage materials recovery, composting, and other methods of recycling. The Detroit DPW is required to consider all relevant factors, such as cost, and the recycling methods in the plan are subject to regular

assessment and evaluation to be included in future updates. DPW is also required to provide City Council with a comprehensive written update on aspects of the plan, the DPW's effectiveness in meeting objectives in the plan, and ordinances or resources needed to bring about the plan. Recycling efforts that existed prior to the adoption of the Charter may be incorporated into the plan as well (City of Detroit, 2012).

Resolution to Adopt a New Business Model for Solid Waste in the City of Detroit and Change the GDRRA Mission and Purpose

The Detroit City Council adopted the Resolution to Adopt a New Business Model for Solid Waste in the City of Detroit and Change the GDRRA Mission and Purpose in 2008 to commit to a new waste disposal system at the beginning of fiscal year 2008-2009 (City of Detroit, 2008). The Council approved to only support a budget proposal under the following assurances: (1) GDRRA was to adopt a systematic plan to change Detroit's MSW system to emphasize materials recovery using a MRF with curbside recycling and landfills to supplement; (2) GDRRA was to provide confirmation that they gave notice to recipients to phase-out the use of the MSW incinerator; (3) an amendment would be made to an agreement between the City and GDRRA to allow for the implementation of a recycling pilot program; and (4) GDRRA would develop a budget proposal to assist with the transition from incineration to materials recovery and landfilling and that they would be allocating funds to independent experts to help with this transition (City of Detroit, 2008).

Opportunities & Challenges Addressed by Interviewees

Opportunities

Interviewees mentioned community waste management programs that have had positive impacts in the city. These include educational workshops around the city that teach residents how to recycle. Currently, residents who attend these educational community workshops or take the online quiz waive the $25 fee for a recycling bin and it reduces contamination in the recycling stream. In fact, one participant explained that contamination is below 10%, which is a good thing – this could in part be due to the city's ongoing educational efforts. Two interviewees both mentioned that they felt these social programs, specifically those in schools, were a successful, positive element that should continue as part of the city's waste management structure. One Detroit participant spoke about private companies collaborating with elementary schools and the community once the recycling collection program expanded citywide:

> *We had a significant amount of media coverage. We had several grassroots community meetings. We engaged the schools, the elementary schools that ... were partners with us at the table when we designed the programs as the school system. We had, I believe it was roughly four elementary schools in each pilot area that were active partners. We actually provided bins and carts so that they could use and just see the system at work*

and what it was intended to do. You know, our roll-out, we had contests[41] that involved those elementary schools, and we had our rollout … which ultimately we were all very proud of how it turned out.

Another small but powerful strategy that a Detroit nonprofit member mentioned is simply changing the shapes of the lids of the recycling bins around the city:

A simple thing like creating a differently-shaped lid – like a small hole for a bottle or can to fit instead of an open trash can – will send a message and have people understand what goes in each bin.

Challenges

Despite the positive initiatives actively occurring in Detroit to move the recycling program forward, there continue to be challenges that hinder further progress. For one, there are ongoing budget and financial struggles that make it difficult to expand recycling. One Detroit interviewee from the public sector explains the fact that Wayne County collects tipping fees:

We collect in Wayne County 16 cents per cubic yard of waste that goes into our four type-II landfills... And we use that money to try to implement our plan, which is supposed to reduce the amount of waste going into the landfill. But you see the circle here… I don't want to put myself out of business, but I'd like to change the economics and the dynamics of how that [waste management financing structure] happens.

As illustrated above, this financing system inherently conflicts with the county's waste reduction mission, making it difficult to move forward into a more SMM-oriented structure.

This is compounded by the low density in Detroit's neighborhoods. As the city began its financial struggles, vacancies emerged in single-family neighborhoods, opening up pockets of empty homes and blocks that only have a few families living in them. This low density means that waste haulers are forced to drive longer, more inefficient routes to pick up MSW and recycling.

Procedural issues also arise involving day-to-day collaboration among Detroit waste management stakeholders. An interviewee stated that it can be tricky to navigate data sharing among city partnerships to manage the grant money allocation. The process becomes less straightforward and instead of speaking with one person to solve an issue, it is sometimes necessary to speak with several to get the job done: "Everything in the city just takes a little bit longer than we'd like."

Finally, the city is always looking for programs and strategies that can help propel recycling and zero waste forward; however, these can prove to be difficult. For example, nearby Ann Arbor, Michigan has programs that help the city hold zero waste events, focusing on

[41] These were organized by teachers, school administrators, and Green Living Science.

composting and recycling. Detroit holds numerous events throughout the year, but one participant commented on how this waste reduction strategy may be out of reach, after a Detroit coalition visited San Francisco:

> *[San Francisco] almost made [zero waste event programs] sound like it's something you can make money off of. …[But] when you think about events, event recycling is probably the hardest recycling to do. There's a lot of contamination that's involved, and it's almost not worth it to do it. I think if that was a policy that was implemented, it would help. It'd reach a greater area of people too, and that would be great if they could be throughout Michigan.*

Baltimore

History of Waste Management: Timeline

Baltimore City and Baltimore County, although different entities, have similar waste management histories. Since they mesh with each other due to their proximity, this section will outline their narratives within the same context. The WTEF, currently called Wheelabrator Baltimore (or Baltimore Refuse Energy Systems Company – BRESCO), began operation in 1985 (Wheelabrator Technologies, n.d.). Three years earlier in 1982, the Eastern Sanitary Landfill Solid Waste Management Facility (ESL) had opened. This concurrent timing was not a coincidence; in an interview, a Baltimore nonprofit staff member mentioned that the opening of the WTEF and the landfill around the same time was likely a cost-based decision to lower transportation fees.

Beginning in 1989 through the early 1990s, both the county and the city co-operated recycling drop-off centers in conjunction with local community organizations (Schwebel, 2012; Baltimore County, 2016). In 1992, Baltimore City elected "Volunteer Recycling Block Captains" to serve as neighborhood representatives to spearhead the recycling movement (Schwebel, 2012). From 1993 through 1995, the county began the One Plus One program, which meant once a week MSW and once a week recycling pickup. More recently, in 2010, the county moved to single stream residential recycling collection, expanding it to more multifamily units in 2013 (Baltimore County, 2016).

Community & Environmental Context

A 2013 study from the Massachusetts Institute of Technology analyzed the impact of air pollution on early deaths across the U.S. The researchers found that "The city of Baltimore in particular is characterized by the highest total mortality rate from all combustion sources: about 130 early deaths attribute[d] to $PM_{2.5}$ per year per 100,000 inhabitants" (Caiazzo et al., 2013). This is in comparison to Detroit (85 per 100,000) and Minneapolis-St. Paul (71.8 per 100,000) (Caiazzo et al., 2013). Like Detroit, the rate of asthma and other respiratory illnesses in

Baltimore are higher than the country's average (Wasilevich et al., 2008; Michigan Inpatient Data Base, 2013).

Despite this, in 2010, Maryland approved the plans to build a new WTEF in Fairfield, Maryland, roughly seven miles from Baltimore (Dance, 2016). However, a high schooler at the time, Destiny Watford, and her other fellow students rallied against the building of the new facility close to their home and school in Curtis Bay, MD (Watford, 2016). She argued that another WTEF would add to the community's existing air pollution and health problems. Through four years of community activism, petitions, and local effort, Watford and her group were able to stop the plans to build the WTEF (Watford, 2016; Dance, 2016). Organizations such as Free Your Voice and United Workers, with whom Watford collaborated, along with other community activist groups, continue to rally against polluting entities in the city, citing the existing WTEF.

Current Waste Management Strategy

Presently, over 75% of Baltimore's MSW goes to the WTEF to be incinerated (Baltimore County, 2016). Waste Management, Inc. previously owned the Baltimore WTEF, but Wheelabrator Technologies, Inc. purchased it for $1.94 billion in 2014 (Dinsmore, 2014). The Baltimore WTEF processes 2,250 tons of residential waste daily, and can generate up to 64 MW of energy, via steam and electricity, which powers downtown businesses and residential homes (Wheelabrator Technologies, n.d.). The incineration ash is condensed to about 10% of its original volume and 30% of its original weight (Baltimore County, 2016; U.S. EPA, n.d.).

The County's only open landfill, ESL, is expected to continue to accept waste for another 36 years, assuming the current annual input levels of 125,000 tons remain stagnant (Baltimore County, 2016). MSW that cannot be incinerated is taken to ESL, and commercial MSW is shipped outside of Maryland. Five other closed landfills exist in the county, which are currently being monitored but not used for disposal. Single-stream recyclables are taken to the County's Central Acceptance Facility MRF in Cockeysville, Maryland (Baltimore County, 2016). According to a Baltimore public stakeholder, the recycling material recovery rate is 12% in the county.

Baltimore City continues to collect its waste and recycling both once a week, still using its One Plus One curbside program (City of Baltimore Solid Waste Plan, 2015). One Baltimore public official explained that in 2015, the city took out at $9 million loan to provide residents with one 64-65-gallon garbage bin with a sensor linked to their home address (Reutter, 2015). This move was to reduce the amount of litter in the city and ultimately minimize the rat issue. A successful pilot program in mid-2015 showed a 26% decrease in resident rat extermination calls (Reutter, 2015) and the city's Sustainability Commission recommended the expansion of the program based on positive residential feedback (City of Baltimore Sustainability Report, 2016). Thus, the city decided to move forward with the full program later in 2015. The public official mentioned that while the city was interested in also giving out recycling bins to residents, the extra $2.3 million in necessary loans would be too cost-prohibitive. According to a Baltimore

County public official, the county also has a call center for residents to use to ask questions, complain, or give comments regarding waste management services.

One interesting waste management advantage that Baltimore County has is the fact that the county is in charge of three MSW transfer stations, giving them significant power to set prices and control what is going in and out. This system has been in place for about 30 years, when a county administrator at the time made this decision. A Baltimore County interviewee speaks about how this process has influenced the county's waste management strategies:

> *If commercial [waste haulers want] to move their trash, they have to come through the Baltimore County facilities. What this does with our landfill, with our MRF, is it gives us the tremendous power… it allows us to rebuild our infrastructure basically on the commercial dime ... It also gives us a tremendous amount of negotiation power … we do control our own destiny; we set our own rates. We control all the solid waste infrastructure in the Baltimore region.*
>
> *We developed ourselves basically into a large regional powerhouse by handling all wastes. We are very influential, and rather Godfather-like sometimes.*

Finally, Baltimore's proximity to a harbor creates its own unique set of issues for waste management. To clean up waste that is dumped in the harbor, in 2014 Baltimore installed Mr. Trash Wheel (**Figure 17**), an anthropomorphized water wheel that collects and disposes of the waste, powered by the river current (Baltimore Waterfront, 2017). With his own Twitter feed and massive internet community following, Mr. Trash Wheel's success inspired the Baltimore Waterfront to install a second cleanup device, Professor Trash Wheel, in late 2016 in Canton (Baltimore Waterfront, 2017; McDaniels, 2016). Funding for the latter came from about 500 individuals, along with larger entities in Baltimore such as the Maryland Port Administration and the National Aquarium. Both water wheels help spread awareness about the waste problem in the harbor, encourage residents not to litter, and make a worldwide impact on the internet (McDaniels, 2016).

Figure 17: *Mr. Trash Wheel in Baltimore's Harbor*

Mr. Trash Wheel, Baltimore's in-harbor housekeeping resident, collects waste along the water and disposes of it in a nearby dumpster. It has collected over one million pounds of waste since May 2014. Photo by Adam Lindquist, used with permission from Baltimore Waterfront (2017).

Sankey Diagram

Baltimore City's Ten Year Solid Waste Management Plan (City of Baltimore, 2015) shows that the City of Baltimore generated a total of 652,500 tons MSW in 2011. As **Figure 18** shows, MSW is divided into three components: residential waste, commercial waste, and mixed refuse. Residential waste is waste generated by residents, weighing 123,700 tons. Commercial waste is 109,900 tons, including all waste generated by businesses, and institutional waste (City of Baltimore, 2015). The majority of the solid waste generated from residents, businesses, and institutions, about 418,800 tons, is referred to as mixed refuse which does not require special collection or disposal handling. Most of the MSW, 415,900 tons, was sent to the BRESCO WTEF. A small amount, 24,070 tons of the total MSW, was accepted at Quarantine Road Landfill. Some of the rest was recycled and certain percentage of the waste collected by private waste haulers is assumed to be exported. In addition, Quarantine Road Landfill also accepted 202,700 tons of BRESCO ash (City of Baltimore, 2015).

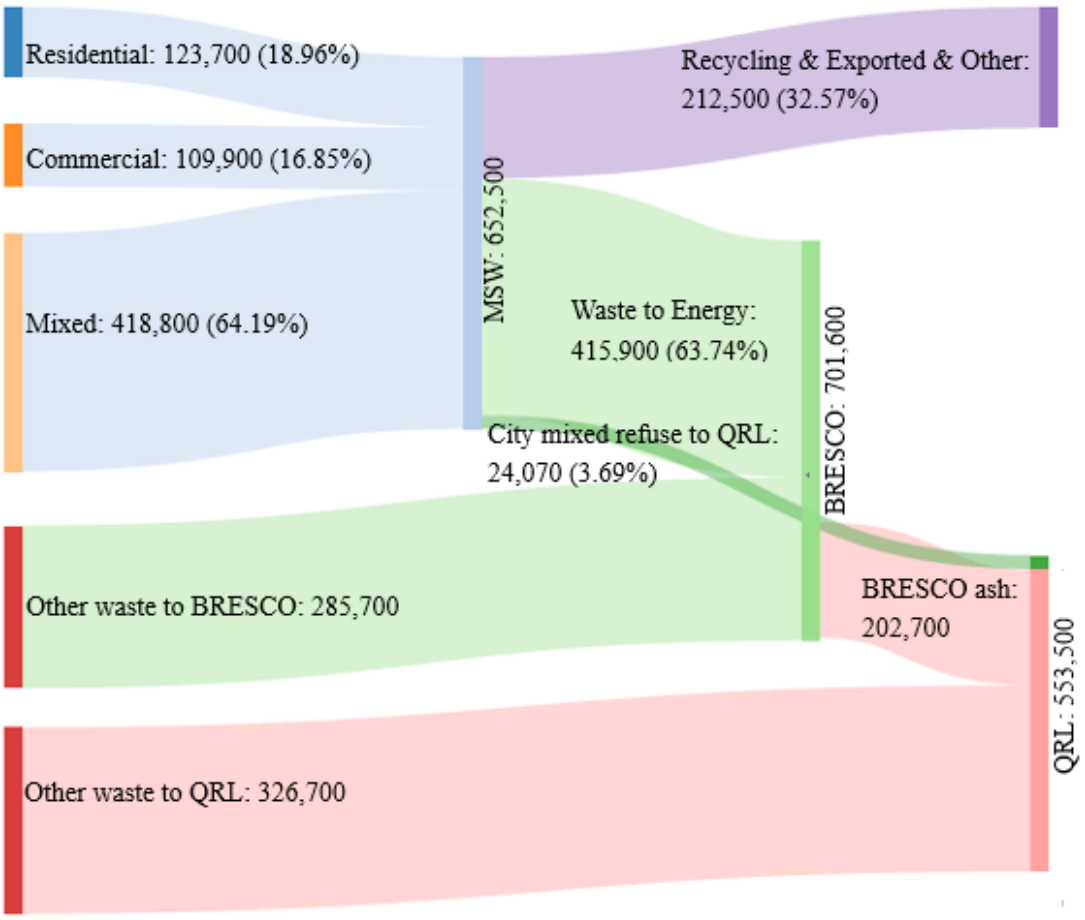

Figure 18: *Baltimore Municipal Solid Waste Sankey Diagram*

This diagram shows the waste flows in Baltimore. The numbers shown represent tonnage. Note: BRESCO represents Baltimore Refuse Energy Systems Company, Baltimore's WTEF; QRL represents Quarantine Road Landfill. Data from the City of Baltimore DPW, 2013.

Spatial Analysis

Like our findings in Detroit, we found a higher proportion of communities of color, poorer households, and low median housing values within three kilometers of Wheelabrator Baltimore before and after the facility was constructed (see **Figures 19-22**). Using both the centroid containment and areal apportionment methods, we observed a higher percentage of Black residents within the buffer when compared to all tracts in Baltimore for the 1970s decade (See **Table 11**). Although the opposite was true for white residents, the differences in percentages are less vast than we observed in Detroit. The disparities between poverty levels and housing values within the tracts around Wheelabrator and those throughout Baltimore were also similar to our findings in Detroit. Moreover, the percentage of households living in poverty within these tracts was nearly double those within the rest of the city. Similarly, the median housing values were approximately three to four thousand dollars lower in these tracts in comparison to the rest of the city.

While the percentage of Black residents was higher than that of the white residents in the tracts around Wheelabrator in 2000, these tracts still contained lower percentages of Black residents than tracts in the rest of Baltimore (See **Table 11**). As with Detroit, there was also a slightly higher percentage of white residents within the tracts around the WTEF in comparison to the rest of Baltimore. However, there was a higher percentage of poorer households within the tracts surrounding Wheelabrator than in comparison Baltimore Census tracts. Median housing values were also lower in those tracts. Nonetheless, our findings suggest that the neighborhoods around Wheelabrator prior to construction already contained a disproportionate number of people of color, poorer households, and lower median housing values. Interestingly, our results may correlate with findings from an air toxics cancer risk study in the State of Maryland, which found a higher magnitude of disparities in exposure based on income and education rather than race (Apelberg et al., 2005). Further, an interviewee from a nonprofit organization noted that there is a mixed income community near the incinerator.

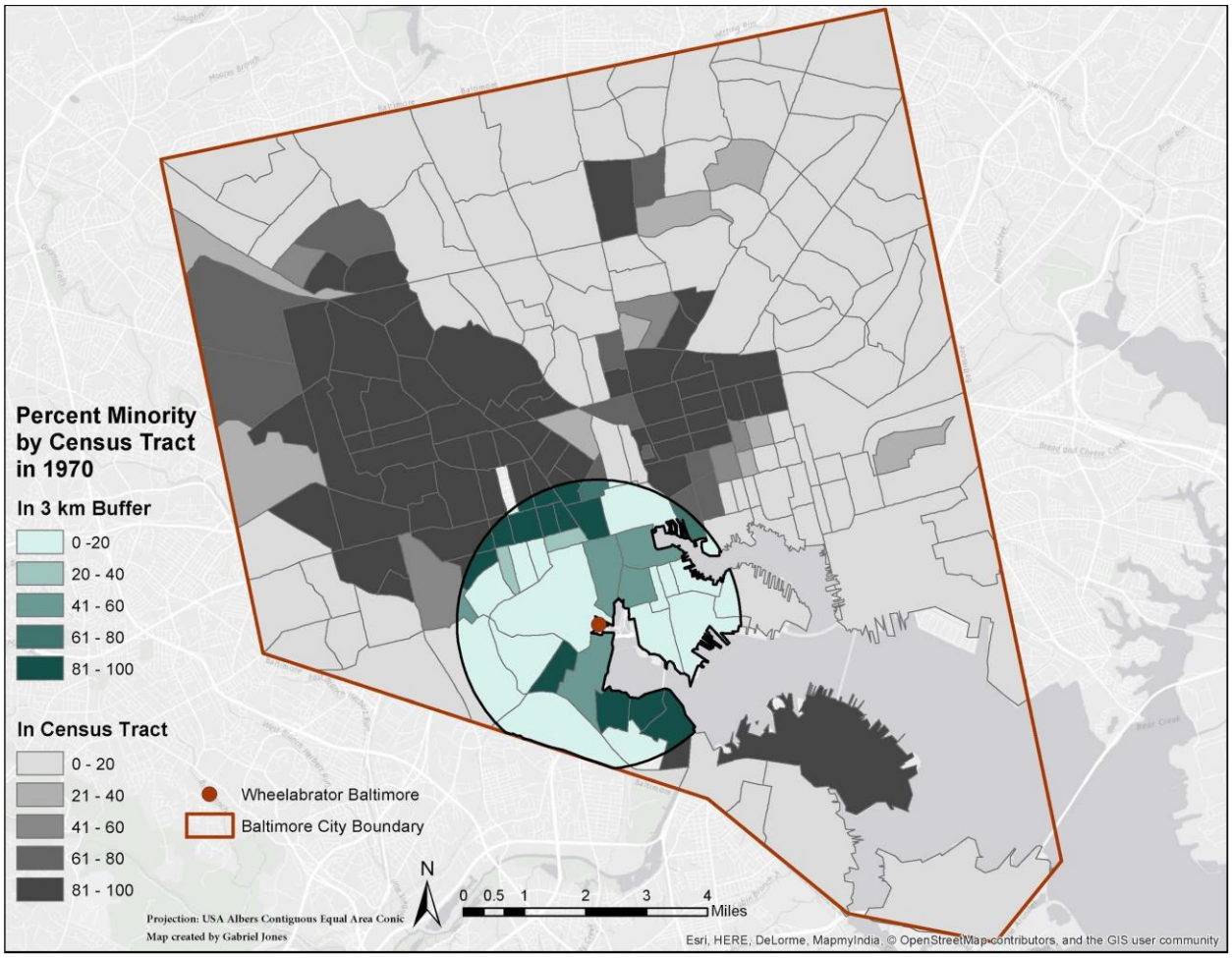

Figure 19: *Racial Characteristics Near Baltimore WTEF Before Construction (1970)*

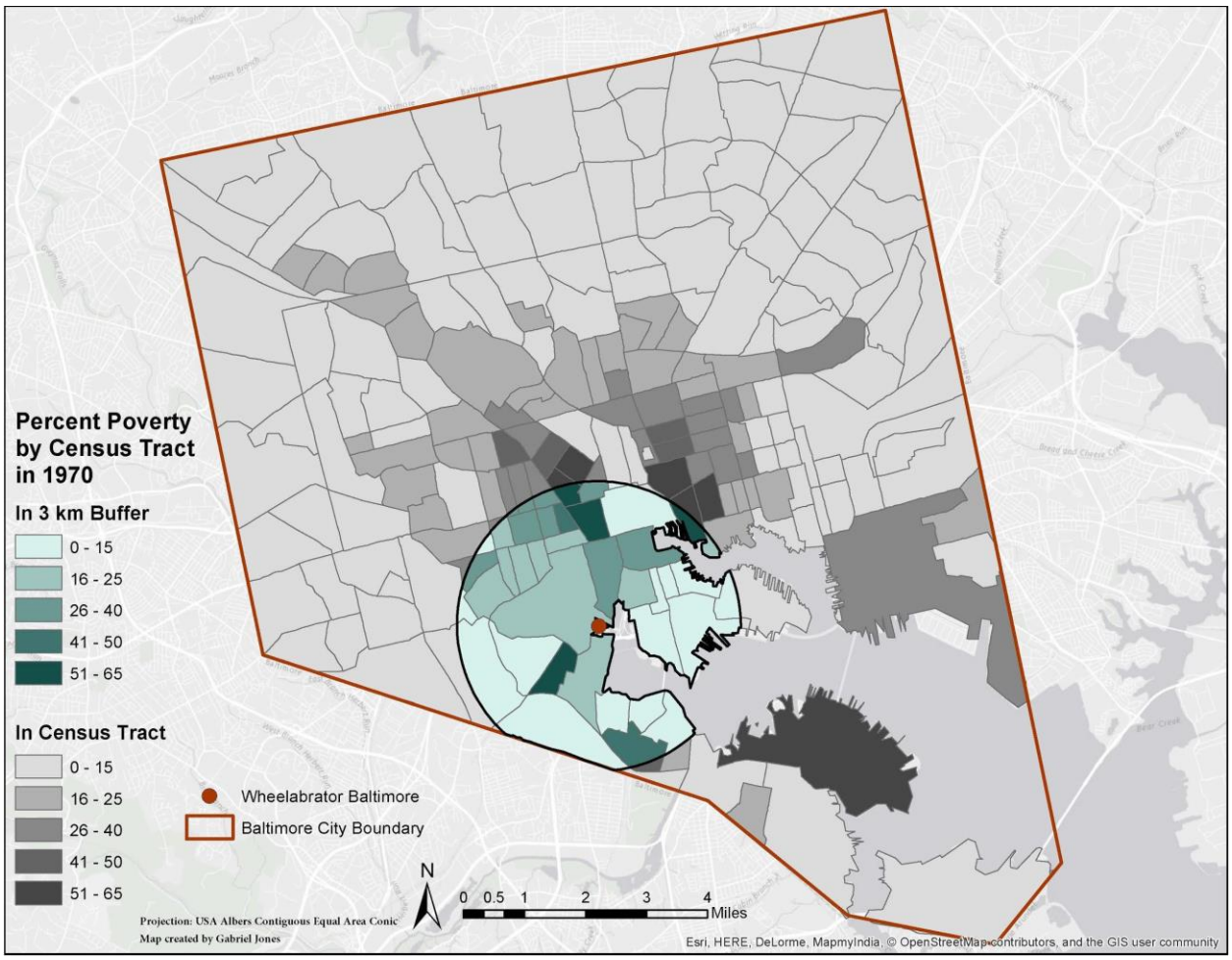

Figure 20: *Socioeconomic Characteristics (i.e. households with a ratio of income-to-poverty of less than 1.0) Near Baltimore WTEF Before Construction (1970)*

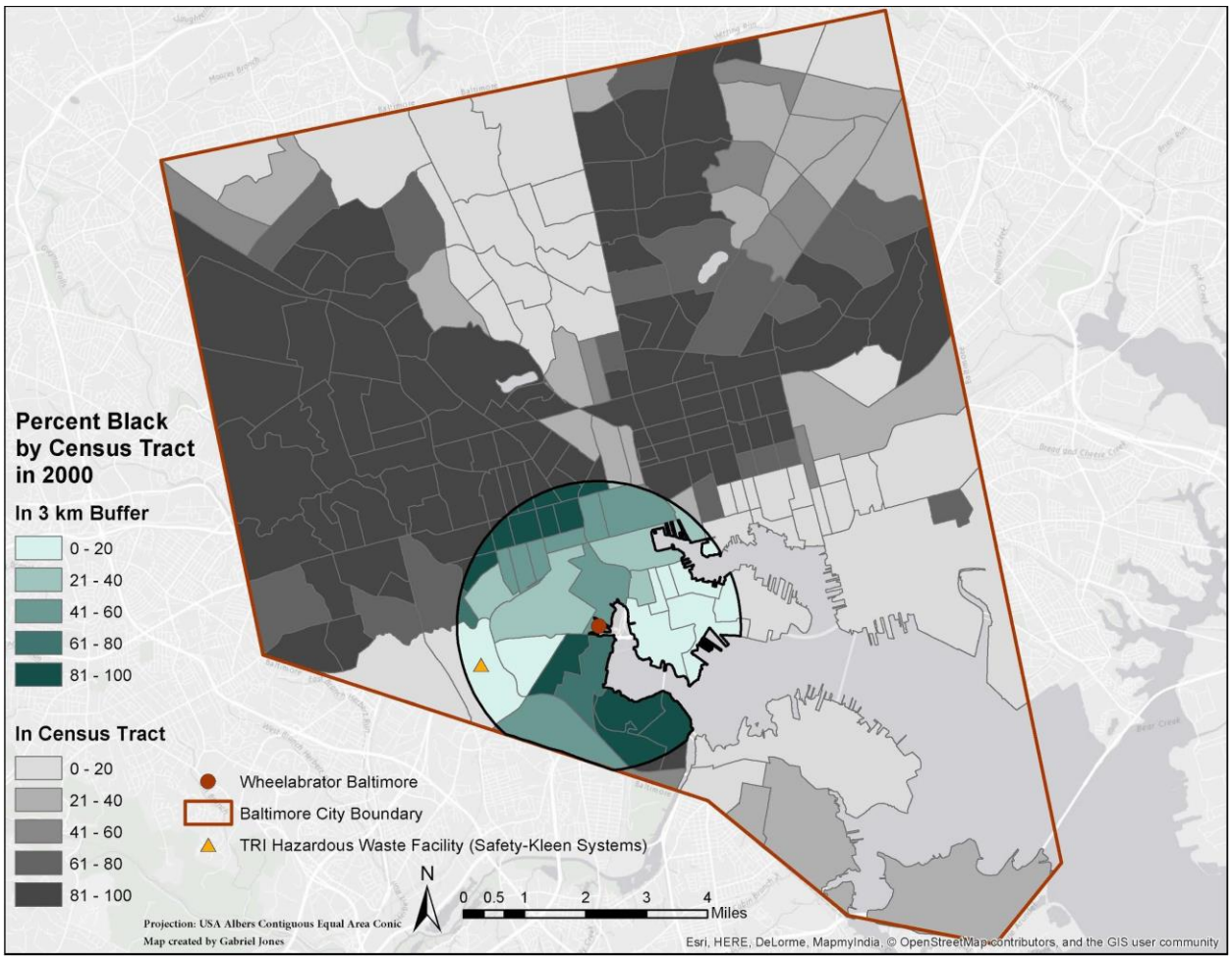

Figure 21: *Racial Characteristics Near Baltimore WTEF After Construction (2000)*

Figure 22: *Socioeconomic Characteristics (i.e. households with a ratio of income to poverty of less than 1.0) Near Baltimore WTEF After Construction (2000)*

Table 11: *Demographic Characteristics in Communities within a 3-km Buffer of Wheelabrator Baltimore in 1970 and 2000*

Variables	**Centroid containment method**	**Areal apportionment method**	**City of Baltimore**
1970 Census			
Race (%)			
White	61,206 (51%)	78,527 (45%)	479,887 (53%)
Black	57,562 (48%)	97,072 (55%)	420,112 (46%)
Some other race*	635 (1%)	863 (0%)	5,215 (1%)
Total	119,403 (100%)	176,462 (100%)	905,214 (100%)
Ratio of Income-to-Poverty (%)			
Under .50	2,748 (10%)	3,965 (10%)	12,165 (6%)
.50 to .99	3,822 (14%)	5,628 14%)	18,013 (8%)
1.00 to 1.49	3,993 (15%)	5,811 (15%)	22,262 (10%)
1.50 to 1.99	3,447 (13%)	5,006 (13%)	24,072 (11%)
2.00 and over	12,537 (47%)	18,575 (48%)	139,321 (65%)
Total	26,547 (100%)	38,985 (100%)	215,833 (100%)
Median Housing Value**	$6,879.90	$7,173.00	$10,344.37
2000 Census			
Race (%)			
White	31,006 (45%)	40,866 (38%)	205,982 (32%)
Black	35,043 (51%)	61,414 (57%)	418,951 (64%)
Hispanic or Latino	972 (1%)	1,558 (1%)	11,061 (2%)
Total	69,037 (100%)	106,889 (100%)	651,154 (100%)
Ratio of Income-to-Poverty (%)			
Under .50	10,830 (16%)	17,252 (17%)	75,715 (12%)
.50 to .99	8,615 (13%)	14,441 (14%)	67,799 (11%)
1.00 to 1.49	9,172 (14%)	13,814 (13%)	70,445 (11%)
1.50 to 1.99	6,781 (10%)	10,745 (10%)	63,746 (10%)
2.00 and over	31,930 (47%)	48,228 (46%)	348,346 (56%)
Total			
Median Housing Value	$64,883.33 (100%)	$64,954.54 (100%)	$70,312.50 (100%)

*Racial category no longer used after 1970 Census.

**Values are not adjusted for 2015 inflation.

***Includes other racial groups not shown that were excluded from our analysis, such as American Indian or Alaskan Native, Asian/Pacific Islander, and multiracial individuals.

Policies & Goals

State Policies & Regulations

The Environment Article

Md. ENVIRONMENT Code Ann. Title 9, Subtitle 2, Subtitle 5, Subtitle 17
Subtitle 2, Part II of the Environment Article outlines the requirements of permit to install, alter, or extend incinerators, landfill systems, and other refuse disposal systems. For application of landfill systems, notice of the informational meeting, and hearings should be given to the public. Under §9-204 (Md. Code Ann., Env. Law § 9-204), permits may not be issued for construction or operation of a municipal waste incinerator within one mile of an elementary or secondary school. But this requirement may not limit a resource recovery facility or an incinerator that was operating on January 1, 1997. All permitted solid waste acceptance facilities are required to provide necessary information to the Department of Environment to prepare an annual report of waste disposed of in the state. However, information that is considered as a trade secret is not required.

Subtitle 5 of the Environment Article establishes requirements of Maryland Counties and Baltimore City solid waste plans to deal with solid waste disposal systems, solid waste acceptance facilities, and systematic collection and disposal. Before adopting a new plan or any amendment, a public hearing is required to be conducted. Detailed recycling plan requirements are listed under §9-1703 (Md. Code Ann., Env. Law § 9-1703).

Under §9-1706.1 (Md. Code Ann., Env. Law § 9-1706.1), it states a 60% goal by 2020 for voluntary statewide waste diversion and a 55% goal by 2020 goal for voluntary statewide recycling. To achieve these goals, various stakeholders are listed to join the collaborative efforts. Subtitle 17, Part II focuses on recyclable materials. It requires that plastic containers for sale should be labeled indicating the plastic resin used in production. The residents of an apartment building or a condominium should be provided with recycling. Newspaper and directory publishers are required to pay the newsprint or directory incentive fee.

In addition, there is a state recycling trust fund to provide grants to counties to prepare and implement recycling plans or recycling programs. Under §9-1706 (Md. Code Ann., Env. Law § 9-1706), requirement for recycling in special events are included. Subtitle 17, Part III is focused on composting. It requires that the Maryland Department of Environment (MDE) should educate the public about composting by maintaining information online. Subtitle 17 is also known as the Maryland Recycling Act, which requires municipalities to report the recycling activities to generate their overall recycling rates. To help private vendors gather this data, MDE designed a reporting form.

Code of Maryland Regulations (COMAR)

COMAR 26.03.03 (Md. Code Regs. 26.03.03) requires that each county should have a comprehensive solid waste plan for at least the succeeding ten years. It describes the plan contents in detail and the revision procedures.

COMAR 26.04.07 (Md. Code Regs. 26.04.07) outlines the requirements for construction and operation of all solid waste acceptance facilities, including municipal, land clearing debris, rubble, and industrial waste landfills. It specifies the requirements for a permit, operating procedures, material accepted, closure activities, and post-closure monitoring and maintenance.

Maryland's Zero Waste Plan

Maryland's Zero Waste Plan outlines the framework of materials management in the state through the year 2040 (MDE, 2014). The plan provides data on waste generation and management in the past and analyzes the historical trends. Although this analysis suggests a continuing future increase in recycling and waste diversion, the plan points out several important challenges that Maryland faces in moving forward to zero waste. These challenges include reduction of the reliance on landfills, securing sustainable funding, growth in waste generation, complexity of the lifecycle approach, and siting new facilities.

The Zero Waste Plan establishes a long-term waste diversion and overall recycling goal of 85% and 80% by 2040, respectively. The plan also outlines waste diversion goals by 2020, 2025, and 2030 of 65%, 70%, and 75%, respectively, and overall recycling goals by 2020, 2025, and 2030 of 60%, 65%, and 70%, respectively (MDE, 2014). The plan recognizes many benefits from more efficient and sustainable waste management practices including more business opportunities and jobs, conservation of natural resources and money savings, GHG emissions reductions and energy savings, extended landfill capacity, revenue increases, and health improvement.

Ultimately, a series of initiatives are proposed in four timeframes, currently underway, 2015-2020, 2021-2025, and 2026-2030. These actions are identified as eight broad objectives: (1) increasing source reduction and reuse; (2) increasing recycling access and participation; (3) increasing diversion of organics; (4) addressing specific target materials; (5) incentivizing technology innovation and the development of markets; (6) recovering energy from waste; (7) collaborating and leading by example; and (8) conducting education and outreach.

City Policies & Regulations

City of Baltimore Municipal Code, Article 23: Sanitation

Baltimore City Code Subtitles 1 through 21

Article 23 of the Baltimore City Code addresses the collection and disposal of solid waste in the city (City of Baltimore, 2010). It is divided into seven subtitles, specifying the responsibility of the city and the citizen in the handling of solid waste. Subtitle 2 details the handling and collection of mixed refuse. It requires that the Department of Public Works (DPW) collect all mixed refuse, recyclable materials, and yard waste from all dwellings subject to certain quantity limitations which are specified in the section. Subtitle 4 requires that receptacles must be kept in specified location for collection. In Subtitle 6, all waste generated in city markets is required to be placed in the receptacles or containers at the designated places. Subtitle 11 instructs the surcharges charged for hauling, permitting, and waste disposal. Under Subtitle 16, the

Commission on Sustainability is required to develop and implement a comprehensive plan for recycling and composting. Subtitle 21 provides enforcement by issuance of an environmental citation and criminal penalties.

City of Baltimore Ten Year Solid Waste Management Plan for 2013-2023

Baltimore City's Ten Year Solid Waste Management Plan establishes the city's goals and actions of waste management through the year 2023 (City of Baltimore, 2015). Over the ten-year period, the city aims to meet a series solid waste management goals as follows:

- *Provide citizens with waste disposal capacity, waste collection services, and waste reduction opportunities;*
- *Increase the efficiency and cost effectiveness of the solid waste program;*
- *Educate the public on recycling and maximize the number and types of materials that can be recycled;*
- *Formulate and achieve new local waste reduction goals;*
- *Minimize improper waste disposal and littering;*
- *Protect public health and the environment; and*
- *Promote the purchasing of products made from recycled materials* (City of Baltimore, 2015).

The plan provides background information about waste generation, collection, and disposal. Based on this information and relative assessment, a plan of action is created in six sections, as seen in **Table 12**:

Table 12: *Six Areas Listed in Baltimore's Ten-Year Solid Waste Management Plan*

Section	Main Actions
Solid Waste Disposal Systems	1. Continue to educate citizens 2. Promote recycling through a combination of outreach and marketing 3. Complete the feasibility study for potential Municipal Container Program
Solid Waste Facilities	1. Enlarge the QRL and explore other projects, such as establishing a segregated "small haulers" convenience center, constructing a composting facility, and studying the feasibility of sorting and converting wastes into fuel in a waste processing facility 2. Continue to operate the Northwest Transfer Station and investigate public/private partnerships 3. Continue to use the BRESCO facility 4. Continue to allow private business to initiate waste acceptance and transfer facility projects
Managing Wastes	1. Increase residential waste collection and continue to operate five citizens' convenience centers 2. Incorporate a special bulk pickup service 3. Continue the partnership with Harford County for scrap tire recycling 4. Investigate the potential of constructing a yard waste composting facility 5. Maximize waste prevention and reduction through a series of strategies 6. Continue the current recycling programs and explore mandatory recycling implementation 7. Continue to improve the Apartment Building and Condominium Recycling Program
Implementation Schedule	(No content in plan)
Financing Waste Disposal Systems	1. Provide the financial support to update the city's existing waste disposal system through the implementation of a solid waste enterprise fund 2. Allocate capital funds based on the needs of city agencies and the availability of funds
Changes Due to Assessment	1. Explore opportunities for revenue generation to provide funding support to solid waste management

Opportunities & Challenges Addressed by Interviewees

Opportunities

One of the key aspects of moving forward with an SMM structure is through mindset and habit change. A further shift to recycling, composting, and waste reduction cannot happen without that. Baltimore County officials have an open mindset about waste management, always searching for more efficient and effective methods of disposing of waste. A Baltimore interviewee from the public sector spoke about how their department goes about this:

> *I'm always looking around. Travelling – you're doing the right thing, just calling and asking. Travel and look for yourself and know your field. And really the best thing you can do is read trade magazines. It doesn't cost you anything except the subscription. And look at how other people are doing things and then say to yourself, does this makes sense for us or not? Why not? And give your staff some fun little side trips to run down. You know, ask for debates at the next senior staff meeting: "Joe, I want you to debate the pro of a front-end can, and Suzie, I want you to debate the negative." And you give them an assignment... The most valuable thing you'll ever have in solid waste is the people in your senior staff.*

In this case, since the participant spoke more on the technical side in their interview, learning from other cities and practices could also mean how different infrastructure is built, such as MRFs and WTEFs, to accommodate materials in the most efficient means, while keeping cost in mind.

Detroit stakeholders have also travelled around to other cities, namely San Francisco, to get a sense of what is happening there and how Detroit could learn from best waste management practices. Similarly, another interviewee in the public sector spoke about Baltimore City practices involving collaboration with Washington, D.C. and composting plans:

> *Just this September [2016], out of our office, we started initiating a compost strategy for the city… We had about 80 stakeholders from the city come. We had very interested participation if you get 80 people to show up at a meeting. And we had some presentations from D.C. and some other locations.*

The interviewee mentioned that while composting may still be a long way away for the city, these collaborations open the door for more to be done, getting the ball rolling on these types of larger projects.

To learn more about what the residents have to say about waste management and to address their questions, Baltimore County also conducts mail and phone surveys regarding waste management to provide multiple opportunities for public comment. Like Minneapolis, Baltimore

has a call center and employees whose job it is to speak directly to consumers and answer questions about recycling and waste management.

Further, on the community end, Baltimore partners with numerous organizations and stakeholders around the city that help them move forward with SMM programs. For example, as mentioned earlier, Mr. Trash Wheel has become increasingly popular online, with thousands of Twitter followers. The wheel is a product of Baltimore's Waterfront Partnership, one of a handful of environmental organizations in Baltimore that focus on waste management issues. Another is Trash-Free Maryland, which works to reduce litter in the area. These organizations help bring awareness of waste management issues to the public and could be a step forward in changing habits and mindsets.

A public official also spoke about neighborhood competitions "to promote the increase in recycling" to get residents involved. An interviewee from the nonprofit sector offered an idea of having block captains to help spread this awareness and education about recycling and waste reduction.

Challenges

There have been mixed responses regarding the city's recent roll-out of 64-gallon waste bins with an attached lid and sensor. One interviewee from a public department comments about this process:

> *I think there was a miss on our part for not also giving out a recycle bin. But the city, in order to give out those trash cans, took out a $9 million loan. And it would have been an extra $2.3 million if we gave everybody a recycle bin, and [the city was not] willing to do that. You know, in certain neighborhoods, you hear you're getting a trash can and it's just ridiculous – it's like, "We have trash cans; what's the issue?" you know? "It's a waste of city money." But then in neighborhoods where there are lots of litter and lots of dumping, people are absolutely thrilled; it's changing their neighborhoods. Everybody has one and has a lid, and so there's a lot less alley trash, a lot less trash. It's... combating the trash and rat issue. So I think it's important in a lot of our neighborhoods.*

The Baltimore nonprofit participant said that not handing out recycling bins had a larger impact on the neighborhoods and created a missed opportunity for the city: "Now [the city wants] folks to use the old bins or a box or bag to provide their recyclables. That's a not a good aesthetic."

Meanwhile in Baltimore County, another interviewee mentioned that there is a challenge between manual waste collection and automated methods when it comes to increasing services:

> *One of our problems, because of our collection system the way it is, is we haven't improved anything since 1949. So our biggest issue now is when all the trash cans were 35 gallons, there was no problem. Well now you can go out and buy 96-gallon trash bins. So people load them up with weight. Well, by OSHA regulations, you can't lift more than*

> *50 pounds. So that becomes an issue. Now the solution to that would be to install hydraulic tippers on the back of your trash trucks. That would cost us $1.4 million. And that is in discussion right now to do that. So I call it the technology gap.*

Again we see this issue come back to funding challenges and logistics, which are often not straightforward to adequately address.

Minneapolis

History of Waste Management: Timeline

In 1982, the city held a pilot program for curbside recycling, focusing on 32,000 households (City of Minneapolis, 2016c). One year later, Minneapolis officially kicked off its multi-sort, curbside recycling collection via private contractors: according to one interviewee, "the City of Minneapolis was one of the first cities to organize recycling." Ever since, the city has been changing small aspects of the recycling program, such as standardizing collection days, adding collection of appliances, and widening the scope of accepted recyclable materials (City of Minneapolis, 2016c). In 2012, the city switched to single stream recycling (City of Minneapolis, 2016c). Since the recycling program has been going on for so long, the "residents became very well-educated about what was a recyclable and what was a contaminant," a Minneapolis public official said in an interview. The move to single stream was a major change for the city, because multi-sort had been difficult for both residents to pre-sort and haulers to collect in multiple bins. Other positive ripple effects came out of this shift, as described by an interviewee in the public sector:

> *We've significantly reduced a lot of our injuries, too, that were taking place in our [multi-stream] recycling from slips and falls and strains. I think the first year of implementation, we actually lessened our workmen's compensation cost by about $250,000.*

The move also caused the recycling volumes to double, and recovery rates to increase by 7%.

Five years after the start of citywide recycling, Minneapolis' WTEF, called the Hennepin Energy Recovery Center (HERC), began processing waste (Hennepin County, 2011). The publicly-owned facility has been operated by the private company Covanta since its inception, though recently there has been some friction between Covanta and the county regarding contract negotiations (Chanen and Smith, 2016). At the time, HERC was sited on contaminated land, according to a county recycling specialist.

In 1990, Minneapolis began collecting waste characterization data. Since then, it conducts a similar study every few years for the city to set and abide by recycling and waste reduction goals. This data collection continues to present day.

Organics collection is a more recent addition to the waste management structure. In 2014, the city opened five organics drop-off locations in local parks, and in 2015 it opened an opt-in residential organics collection program, which officially broadened citywide in Spring 2016 (City of Minneapolis, 2016c).

Community & Environmental Context

According to an EJ Organizer in Minneapolis, there was resistance from the community at the time of HERC's siting in the 1980s. It was originally proposed to be built in the northeast part of the city, but instead the community coalition successfully hindered that plan, citing that it was "in their backyard," as the EJ organizer explained. Instead, it was sited in its current location, which is what is now downtown Minneapolis. A Recycling Specialist noted that in the late 1980s, that area used to be contaminated, blighted, and generally not vibrant. However, today, it is in the heart of downtown Minneapolis, directly next to Target Field, home of the Minnesota Twins baseball team. A Recycling Specialist described the community around the current HERC location as "one of the trendiest areas in the Twin Cities; it's kind of an old warehouse district." Still, there are "several elementary schools and poor African American neighborhoods north of the plant [that] are impacted by emissions" (Jossi, 2016), making it an EJ issue in the community. Steam and electricity from HERC powers Target Field and other entities in the city (Hennepin County, n.d.).

Advocacy groups including the Sierra Club, Neighborhoods Organizing for Change, and Minnesota Public Interest Research Group have formed an anti-incineration campaign and are working together in hopes to ultimately shut down the HERC facility due to air pollution concerns (Jossi, 2016). There is an inherent conflict of interest between these groups and the "Minnesota state policy, which places a higher value on waste-to-energy production over landfills" (Jossi, 2016). However,

> *In a presentation Covanta's [Chief Sustainability Officer Paul] Gilman provided, the company argues that recycling increases within a waste-to-energy system because it's picked over a second time – first by the consumers and businesses, and again at the incinerator. European countries with WTE facilities have much higher recycling rates than the U.S. as a result* (Jossi, 2016).

A public-sector interviewee in Minneapolis' mentioned that the city's highest priority is material diversion from landfills and the WTEF, but to divert the most amount of waste from landfills, they explained that the WTEF is needed to dispose of the remaining MSW that cannot be reclaimed in Minneapolis.

Current Waste Management Strategy

Minneapolis' MSW collection is a public-private partnership. Public haulers collect half of the city's MSW, while a consortium of small private haulers, part of Minneapolis Refuse, Inc.,

collect the other half (City of Minneapolis, 2007). This system has been in place since the 1970s (City of Minneapolis, 2007). Residential MSW is collected on a weekly basis. The process is done via open collection, which is different from an organized system. This 2012 Minnesota Pollution Control Agency document lays out the differences:

> *In an open collection system, individual customers choose their own waste hauler. In an organized system, waste hauling services are coordinated by a public entity through a competitive bidding process. Nearly 30 percent of the communities in Minnesota have organized MSW and recycling collection systems compared to 72 percent nationally.*

There is a tiered pricing system based on the size of the waste bin; residents can opt for a 94-gallon bin for a $5 monthly fee or a 32-gallon bin for a $2 monthly fee (City of Minneapolis, 2016b). This therefore provides a small incentive for residents to dispose of less waste. The city provides residents with 96- or 64-gallon recycling carts, and single-stream recycling is collected every other week (City of Minneapolis, 2016d). Residents may also dispose of other objects such as mattresses and appliances at no extra charge.

HERC receives waste from central Hennepin County, and it can process up to about 1,400 tons of waste per day, an amount limited by a local ordinance and a state permit (Hennepin County, 2011). It produces both steam and electricity, enough to run 25,000 homes and 100 buildings downtown, as listed on the Hennepin County website (n.d.). The facility recovers and recycles 11,000 tons of metal annually, which is "almost double the 6,500 tons of ferrous metal that are collected annually in curbside and drop-off recycling programs in Hennepin County" (Hennepin County, 2011). HERC operates 24 hours a day and sends its resulting ash to a landfill (Hennepin County, 2011). The downtown location of HERC is convenient, reducing the amount of transportation that would have been used had it been more decentralized.

Currently, the organics collection program is in its initial stages, and it is an opt-in program where residents can sign up to receive a compost bin, which the city uses to collect the organics. Currently, the strategy is to focus on marketing, advertising, and education campaigns to spread the word about composting. Some of this education campaign is directed to non-English-speaking Minneapolis residents, including community members from Southeast Asia and Somalia (City of Minneapolis, 2017; City of Minneapolis, 2016c).

Minneapolis also provides other programs and services for city residents, as described by a public official and interviewee:

> *[Residents are] allowed six vouchers per year to take to our solid transfer station that we own and have Waste Management [Inc.] operating right now, and [residents] can bring up to 2,000 pounds or equivalent, up to two appliances or units of a voucher … they are also able to get two tire vouchers annually and bring up to eight tires to the South Transfer Station.*

Like Baltimore County, Minneapolis also has a call center specifically for the Solid Waste and Recycling sector. Residents are encouraged to call the number as a straightforward contact point regarding both the city and the private haulers' collection routes and practices (City of Minneapolis, 2016a). Additionally, a Minneapolis recycling coordinator mentioned that the city collaborates with the University of Minnesota, which is located in the Twin Cities, to provide a reuse warehouse for things like furniture and household items, like a Habitat for Humanity ReStore concept (University of Minnesota, 2017). Called the ReUse Program, this service not only serves as a source reduction measure, but it also provides the community with a collaborative effort to do so. Since many students at the University move frequently and rent apartments, often they cycle through furniture and household objects, which can be more easily done with this center (University of Minnesota, 2017).

Minneapolis has numerous resources for residents to reduce their waste and reuse materials. For example, the city has a tool library where residents pay a small fee to use tools year-round whenever they like (Northeast Minneapolis Tool Library, 2017). There is a repair initiative that teaches residents how to fix things instead of buying new products and disposing of their old ones (Repair Cafe, 2016). With initiatives like these, residents can take a step forward to lower their waste output in the city.

Further, the City of Minneapolis website lists numerous tips and resources for how residents can become more aware of their waste impact and how they can reduce their MSW output (City of Minneapolis, 2015). In the past, families have also participated in a zero waste challenge, as described by one interviewee: "Some families … are weighing their trash, recycling, and organics and commenting about how they can get to zero waste, or maybe more accurately, how they're having trouble getting there."

Sankey Diagram

The *City of Minneapolis Residential Waste Characterization Study and Recycling Analysis* (MSW Consultants, 2016) indicates that there were 135,000 tons of residential waste generated in the city of Minneapolis in 2015. As **Figure 23** shows, 63.2% of the total residential waste were delivered to the WTEF. This 85,610 tons of refuse includes disposed organics, plastic, paper, C&D, supermix, textiles, metal, glass, electronics, household hazardous waste, and other residential waste. Among these categories, disposed organics, plastic, and paper are the most prevalent materials, making up 57.7% of the total waste sent to the WTEF. The city recycled or composted the rest of residential waste, achieving 36.8% diversion rate, which includes recyclables and compostable organics.

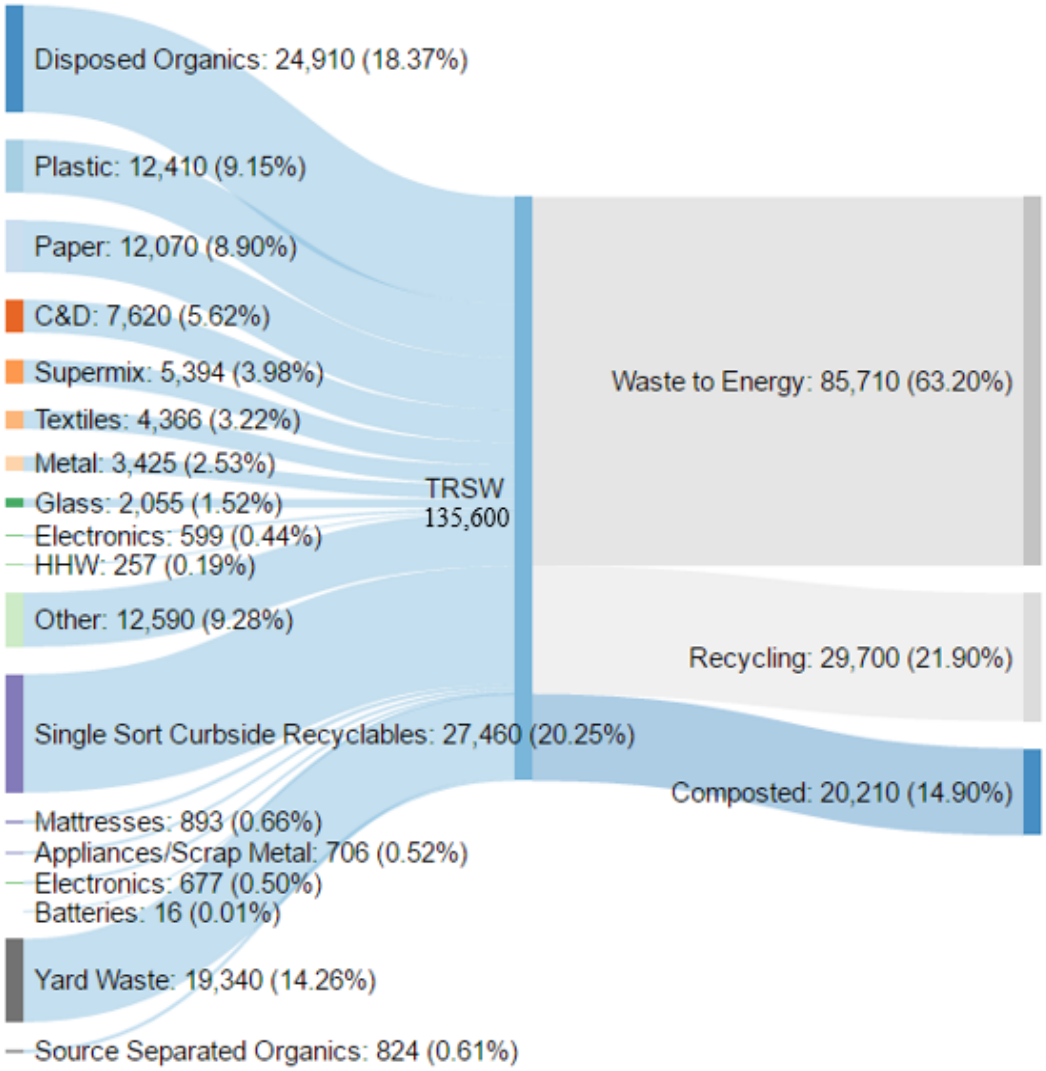

Figure 23: *Minneapolis Residential Solid Waste Sankey Diagram*

This diagram shows the type of waste flows that occur in the city. The numbers shown represent tonnage. Note: TRSW represents Total Residential Solid Waste. Data from MSW Consultants, 2016.

Spatial Analysis

As with Detroit and Baltimore, we found a higher proportion of communities of color, poorer households, and low median housing values within three kilometers of HERC before and after the facility was constructed (see **Figures 24-27**). Using both the centroid containment and areal apportionment methods, we observed a higher percentage of Black residents within the buffer when compared to all tracts in Minneapolis for the 1970s decade (See **Table 13**). The opposite proved to be true for white residents. The discrepancies between poverty levels and housing values within the tracts around HERC and those throughout Minneapolis were also similar to those we found in Detroit and Baltimore, yet the percentage differences were less extreme. Additionally, median housing values were only slightly lower in these tracts in comparison to the rest of the Minneapolis as well.

Unlike Detroit and Baltimore, there was a higher percentage of Black residents than that of white residents in the tracts around HERC when compared to those tracts in Minneapolis in the 2000s decade (See **Table 13**). In this case, the percentage of white residents within the tracts around the WTEF was also lower in comparison to the rest of Minneapolis. There was also a higher percentage of poorer households within the tracts surrounding HERC than in comparison all Minneapolis tracts. Again, unlike Detroit and Baltimore, median housing values around HERC did not differ greatly between these tracts and those in Minneapolis. Nonetheless, our findings suggest that the neighborhoods around HERC prior to construction already contained a disproportionate amount of people of color, poorer households, and lower median housing values.

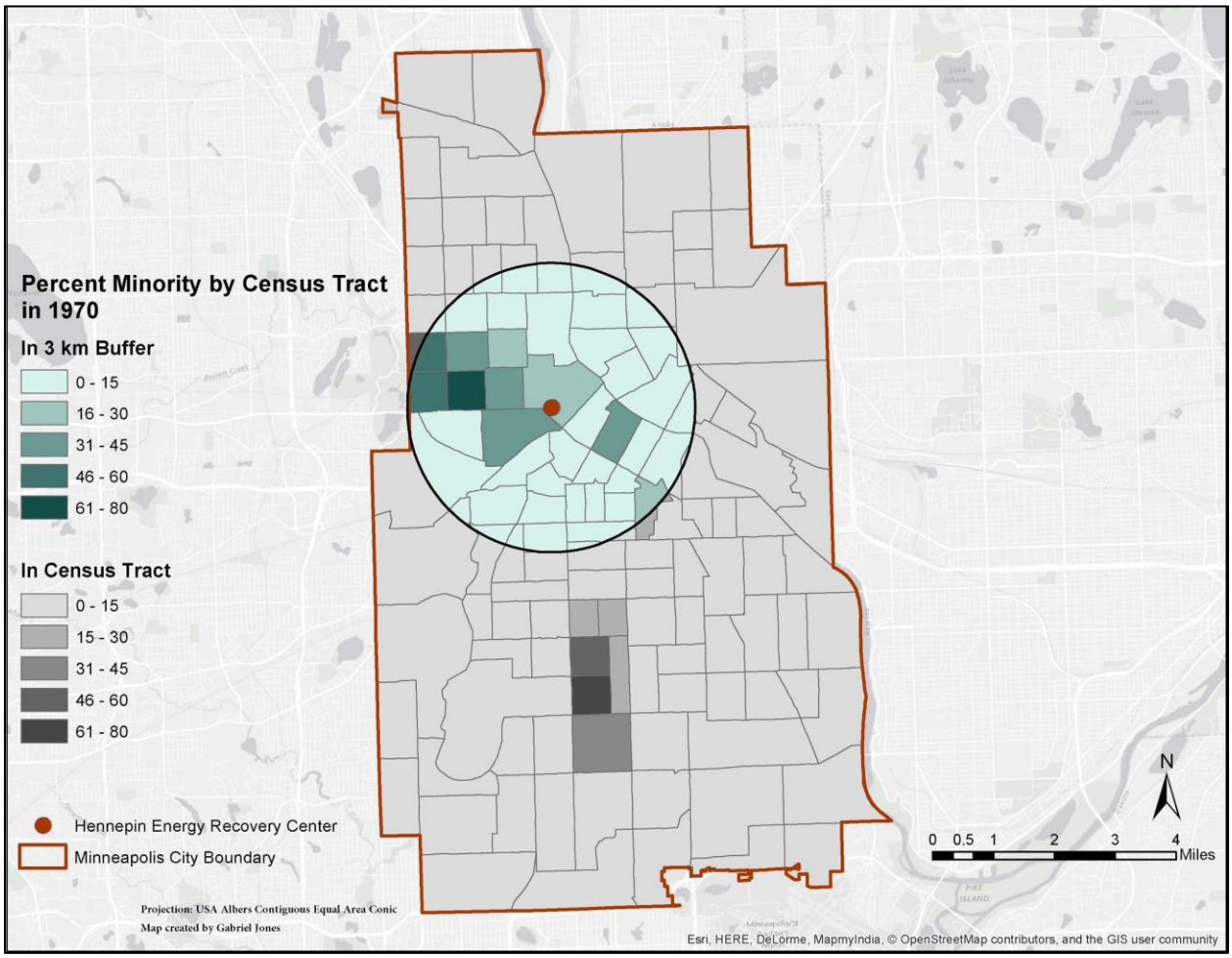

Figure 24: *Racial Characteristics Near Minneapolis WTEF Before Construction (1970)*

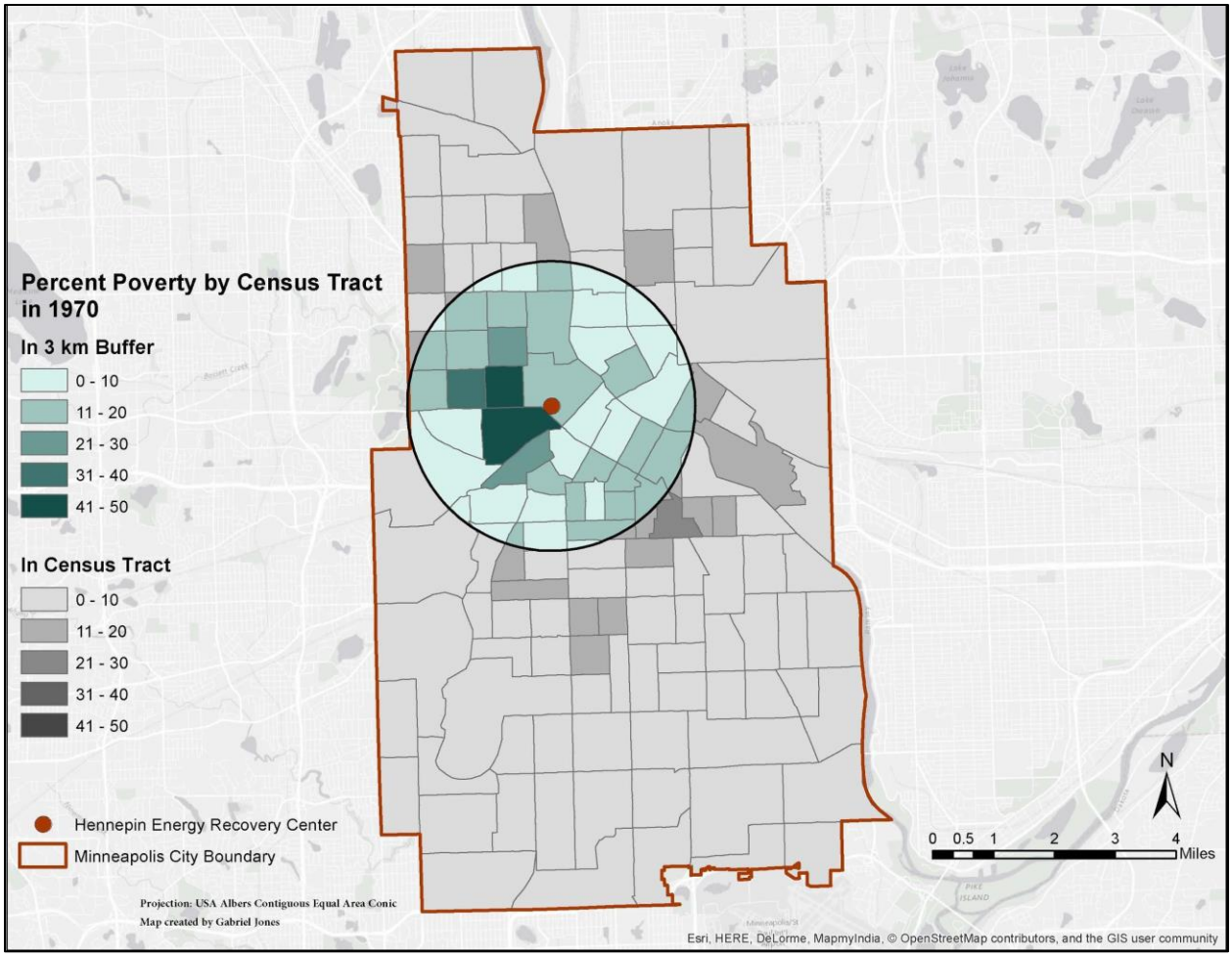

Figure 25: *Socioeconomic Characteristics (i.e. households with a ratio of income-to-poverty of less than 1.0) Near Minneapolis WTEF Before Construction (1970)*

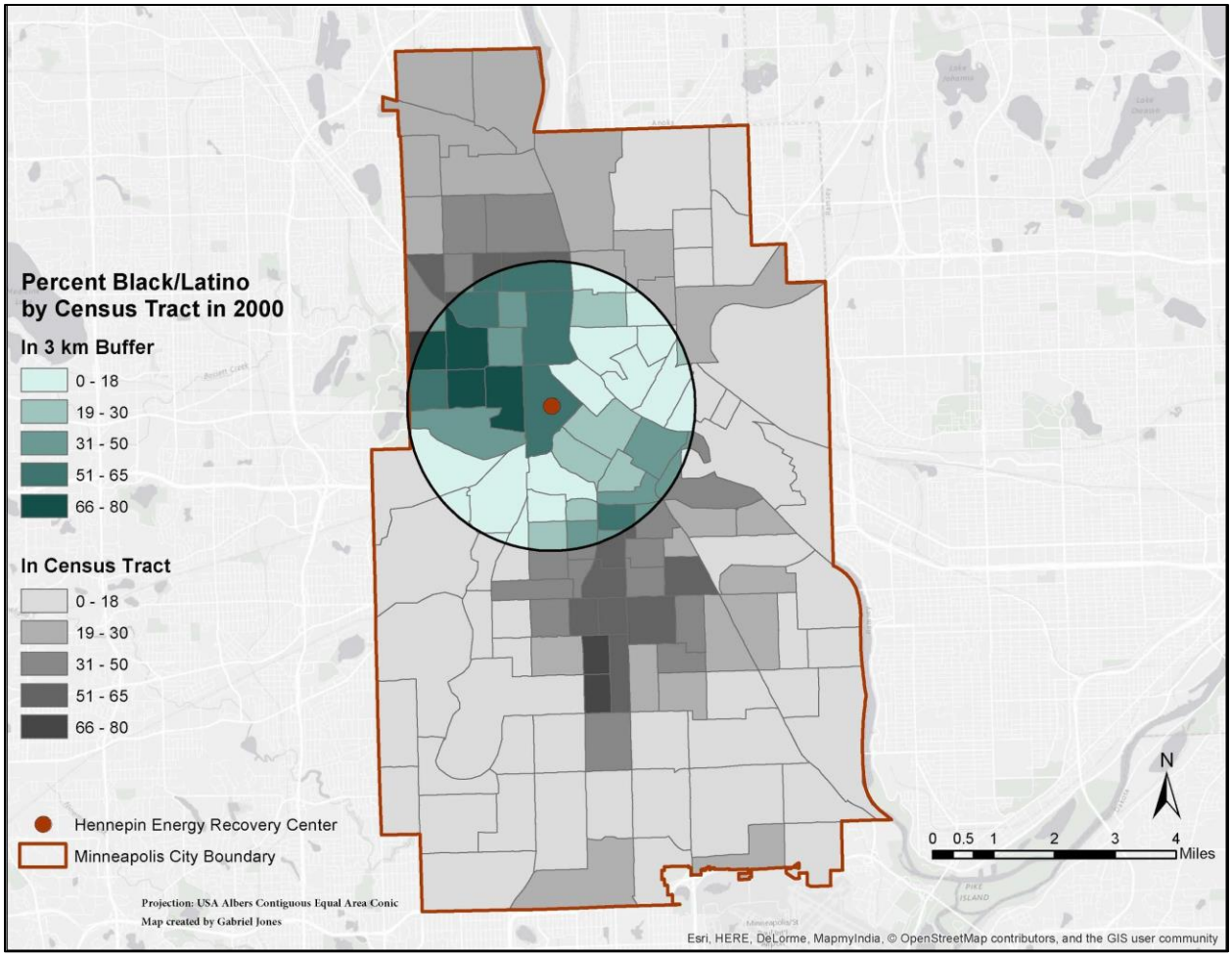

Figure 26: *Racial Characteristics Near Minneapolis WTEF After Construction (2000)*

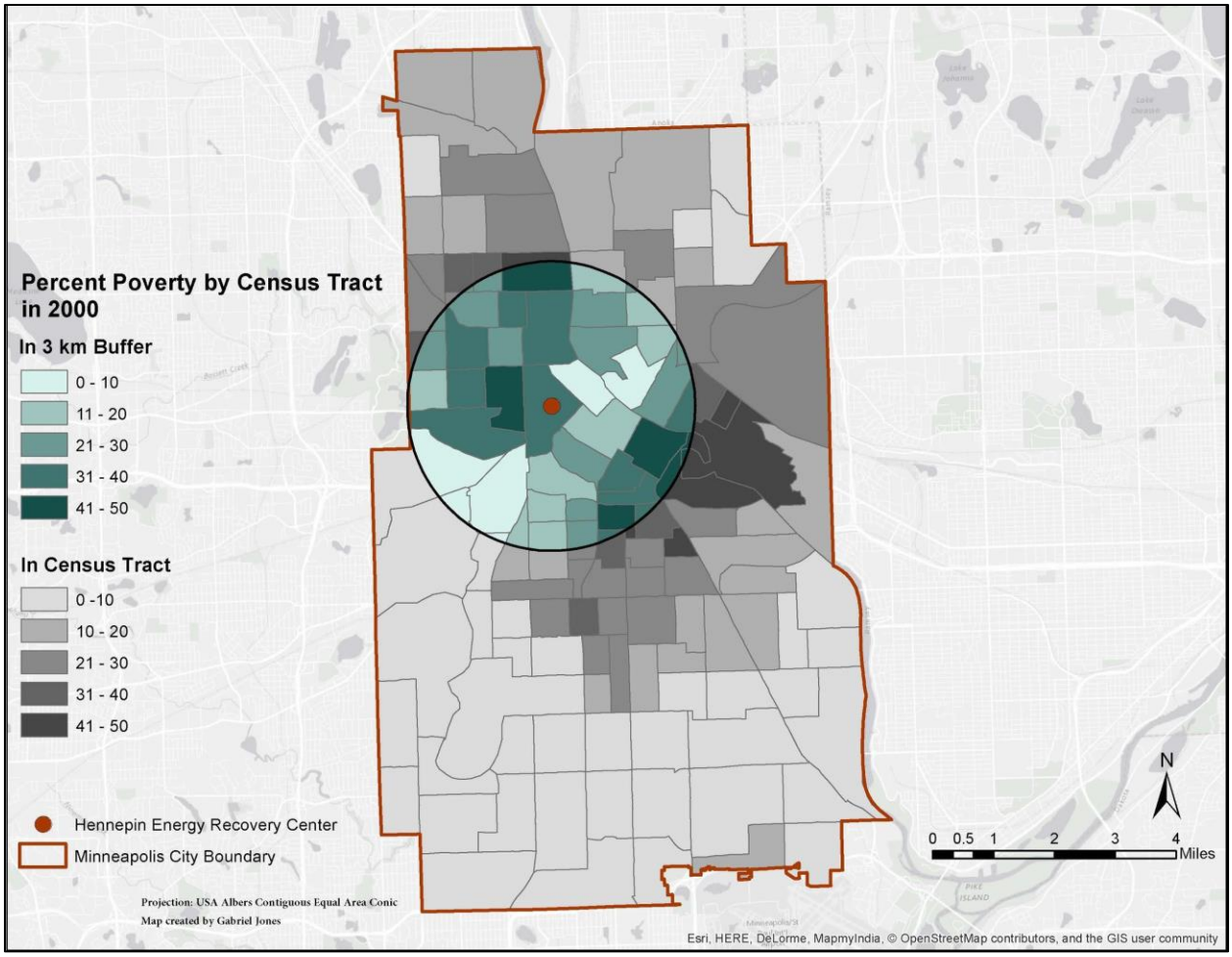

Figure 27: *Socioeconomic Characteristics (i.e. households with a ratio of income-to-poverty of less than 1.0) Near Minneapolis WTEF After Construction (2000)*

Table 13: *Demographic Characteristics in Communities within a 3-km Buffer of Hennepin Energy Recovery Center in 1970 and 2000*

Variables	**Centroid containment method**	**Areal apportionment method**	**City of Minneapolis**
1970 Census			
Race (%)			
White	77,387 (86%)	134,038 (90%)	407,091 (94%)
Black	9,282 (10%)	10,153 (7%)	18,642 (4%)
Some other race*	1,209 (1%)	1,908 (1%)	3,940 (1%)
Total	90,032 (100%)	149,139 (100%)	434,381 (100%)
Ratio of Income-to-Poverty (%)			
Under .50	957 (5%)	1,418 (5%)	2,733 (3%)
.50 to .99	1,719 (9%)	2,342 (8%)	4,733 (5%)
1.00 to 1.49	2,255 (12%)	3,359 (11%)	8,028 (8%)
1.50 to 1.99	2,151 (12%)	3,417 (11%)	10,138 (10%)
2.00 and over	11,312 (61%)	19,755 (65%)	78,092 (75%)
Total	30,291 (100%)	18,394 (100%)	103,724 (100%)
Median Housing Value**	$16,584.90	$17,370.89	$18,038.22
2000 Census			
Race (%)			
White	40,205 (49%)	82,068 (56%)	286,285 (66%)
Black	23,284 (29%)	33,629 (23%)	68,635 (16%)
Hispanic or Latino	6,435 (8%)	10,919 (7%)	29,972 (7%)
Total***	81,652 (100%)	147,323 (100%)	435,194 (100%)
Ratio of Income-to-Poverty (%)			
Under .50	8,844 (11%)	15,030 (11%)	28,878 (7%)
.50 to .99	11,382 (15%)	18,570 (14%)	35,413 (8%)
1.00 to 1.49	9,978 (13%)	16,052 (12%)	38,557 (9%)
1.50 to 1.99	8,196 (11%)	13,085 (10%)	34,971 (8%)
2.00 and over	39,022 (50%)	72,608 (54%)	281,092 (67%)
Total	77,422 (100%)	135,345 (100%)	418,911 (100%)
Median Housing Value	$109,331.25	$120,071.43	$121,275.54

*The tables we obtained for census data in Minneapolis in the 1970s did not contain the “Some Other Race” category that was used in Baltimore and Detroit. While the values for both Black and Spanish do not add up to 100 percent, we calculated the “minority” population for our maps by subtracting the White population from the total population. This value was equivalent to the sum of Black and Some Other Race populations in both Baltimore and Detroit.

**Values are not adjusted for 2015 inflation.

***Includes other racial groups not shown that were excluded from our analysis, such as American Indian or Alaskan Native, Asian/Pacific Islander, and multiracial individuals.

Policies & Goals

State Policies & Regulations

State of Minnesota Statutes §115A (Waste Management Act of 1980)

Section 115A in the State of Minnesota statutes, otherwise known as the Waste Management Act of 1980, regulates all waste management activities at the state and local level (State of Minnesota, 2016). Generally, the act developed processes for landfill siting and delineated solid waste planning responsibilities, established that solid waste abatement planning is required for metropolitan area waste assurance, created the Waste Management Board and Legislative Commission on Waste Management, and set aside grants for the Minnesota Pollution Control Agency (MPCA) to use on solid waste planning and technological improvements for resource recovery (MHRRD, 2002). Under the act, Minnesota counties are primarily responsible for MSWM, and they must adopt a solid waste management plan. Most importantly, the act established a waste management hierarchy that prioritizes source reduction and reuse, recycling, and composting methods over the use of WTE incineration and landfilling with or without methane capture.

Sections 115A.551 and 115A.557, known as SCORE, constitute a set of amendments to the Waste Management Act that were established by recommendations from the Governor's Select Committee on Recycling and the Environment. Section 115A.551 expands upon the previous definition of recycling to include "yard waste composting, and recycling that occurs through mechanical or hand separation of materials that are then delivered for reuse in their original form or for use in manufacturing processes that do not cause the destruction of recyclable materials in a manner that precludes further use" (State of Minnesota, 2016, pg. 64). Furthermore, this section established that counties outside the metropolitan area will have a goal to recycle 35% by weight of total solid waste generation by 2030, and metropolitan counties will have a goal to recycle 75% by weight of total solid waste generation by 2030. Each county is also required submit a recycling implementation strategy to the MPCA. Section 115A.557 established a state funding source for counties to be able to further recycling programs. Among other requirements, counties may be eligible to receive SCORE funds if they have an approved solid waste management plan, or master plan that includes a recycling implementation strategy, as well as a household hazardous waste management plan. Each county is also required to submit a SCORE report that details recycling and waste reduction efforts from the previous calendar year.

Section 115A.94 outlines the procedural requirements for municipalities to institute an "organized collection" system, rather than open collection, for MSW and recycling (State of Minnesota, 2016). The act defines organized collection as "a system for collecting solid waste in which a specified collector, or a member of an organization of collectors, is authorized to collect from a defined geographic service area or areas some or all of the solid waste that is released by generators for collection" (State of Minnesota, 2016, pg. 104). Under this section, local

governments may include a requirement that all or any portion of the solid waste – except recyclable materials and materials that are processed at a resource recovery facility at the capacity in operation at the time that the requirement is imposed – be delivered to a waste facility identified by the local government unit. However, in a district or county where a resource recovery facility has been designated by ordinance, organized collection must conform to the requirements of the designation ordinance. Before a city or county implements an organized collection system by ordinance or other means, they must first establish an organized collection committee to identify, examine, and evaluate various methods of organized collection. Organized collection is also exempt from state laws pertaining to competitive bidding requirements.

Metropolitan Solid Waste Management Policy Plan 2016-2036

The Metropolitan Solid Waste Management Policy Plan was developed by the MPCA to establish objectives and strategies for the Twin Cities Metropolitan Area (TCMA) to manage MSW through 2036 (MPCA, 2017). The TMCA includes the following counties: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington. The plan is updated every six years through a process involving stakeholders in state and local government, waste industry representatives, environmental organizations, private businesses, and citizens. Generally, the plan supports "the goals of the Waste Management Act hierarchy; improving public health; reducing the reliance on landfills; conserving energy and natural resources; and reducing pollution and greenhouse gas emissions" (MPCA, 2017, pg. 2). The plan identifies three goals for improving MSWM in the TCMA, along with several policies associated with each goal.

Within the plan's "Framework for Change" section, accountability and the MSWM hierarchy are identified as two consistent themes throughout the document. The plan states that while the MPCA may use different policy tools to hold public, private, and nonprofit partners accountable, powers delegated to the state and counties may be insufficient and changes in authority may be required. The plan considers Minnesota's waste management hierarchy to be an essential element for managing an integrated solid waste management system.

The plan also contains a Metropolitan System Plan that outlines several strategies, from a systems perspective, to guide waste management stakeholders in the TCMA. Specifically, the System Plan "describes broad regional system objectives, a landfill diversion goal, and the strategies necessary for solid waste programs and services to meet the region's needs for the next 20 years" (MPCA, 2017, pg. 10). Diversion rates are specified for each method listed in the state's waste management hierarchy by decade. Moreover, the System Plan emphasizes the need for both a regional approach to managing MSW across inter-county boundaries in the TCMA and the use of more practices on the upper end of the state's waste management hierarchy. The System Plan also discusses the importance of using an SMM framework to address waste management planning, and it identifies some next steps for further collaboration between the MPCA and metropolitan counties to advance SMM.

One of the appendices in the Policy Plan describes the MPCA's EJ review of the plan. This review provides information on the spatial distribution of MSW facilities in communities of color and low-income communities, descriptions of possible impacts to these communities, and

strategies for addressing these impacts and increasing community and stakeholder engagement. Some of the strategies for addressing EJ concerns listed by the MPCA include more frequent monitoring of facilities in affected communities and the implementation of organized collection for mixed MSW to reduce illegal dumping in communities. Additionally, the plan addresses community concerns over air emissions from WTEFs within their neighborhoods by emphasizing best management practices for waste reduction and increased recycling and organics recovery.

County Policies & Regulations

Hennepin County Solid Waste Management Plan

The Hennepin County Solid Waste Management Master Plan was adopted in 2012 to align with the Metropolitan Solid Waste Management Policy Plan's goals and policies (Hennepin County Department of Environmental Services, 2012). The plan is divided into five parts that describe waste generation and waste composition in the county, the process of developing the plan under statutory requirements, detailed aspects of the county's integrated solid waste management system, trends for future waste management efforts, and strategies that can be used to meet state goals. In Part V of the plan, strategies for addressing waste management issues are listed and separated by waste management methods, as identified by the state's waste management hierarchy. Progress on targets associated with each method are noted as well. Several strategies listed in Part V are a continuation of past efforts, while some represent a significant expansion of or a newly created strategy. In addition to those strategies listed by waste management methods, Part V also includes the following long-term strategies: "(1) Changing ordinances to require performance measurement by haulers and MRFs; (2) providing financial incentives for the commercial sector; (3) review[ing] regulations that would require specific actions by stakeholders; [and] (4) requiring county management of underperforming city recycling programs."

Hennepin County Residential Recycling Funding Policy

Hennepin County's Residential Recycling Funding Policy guides the distribution of SCORE funds to municipalities for curbside collection of residential recyclables (Hennepin County, 2016). The policy outlines calculation methods for allocating funding to both recycling and organics recycling. Additionally, there are requirements for continuing education and outreach efforts between the county and municipalities. Municipalities are required to report to the county on their recycling performance and/or their organic collection programs.

Hennepin County Ordinance 15: Solid Waste Management Fee

Hennepin County's Ordinance 15 established the Solid Waste Management Fee to fund environmental programs which protect the health and welfare of Hennepin County citizens in pursuant with state mandates governing waste management programs (County of Hennepin, 1995). The ordinance describes "procedures for establishing a Solid Waste Management Fee for

the entire County of Hennepin; the fee payment method; reporting requirements; and penalties for noncompliance with provisions of this Ordinance" (County of Hennepin, 1995). The fee itself may be adjusted by resolution in accordance with the administrative procedures outlined in the ordinance. Each hauler is required to submit a Solid Waste Management Fee report that:

> *may include, but not be limited to, total gross billings and receipts for all collection and disposal services performed within Hennepin County, the number of Residential and Nonresidential Generators within Hennepin County, the number of tons collected within Hennepin County and disposed of within and outside of Hennepin County, and such other information as requested by the Department* (County of Hennepin, 1995a).

Hennepin County Ordinance 18: County Collected Solid Waste Fee for Solid Waste Management Services

Hennepin County's Ordinance 18 established the County Collected Solid Waste Fee to fund waste management programs which protect the health and welfare of Hennepin County citizens through a county collected solid waste fee imposed against the market value of taxable property pursuant to state mandates governing waste management programs (County of Hennepin, 1995). Solid waste management services are defined as:

> *including but not limited to waste reduction and reuse; waste recycling; composting of yard waste and food waste; resource recovery, transportation and transfer station costs, closure and postclosure care of solid waste facility, responses to releases from a solid waste facility or closed solid waste facility, and management of problem materials and household hazardous waste* (County of Hennepin, 1995b).

The fee is imposed against the market value of taxable property in the county. Unpaid fees are considered to be delinquent property tax and are subject to the same penalties for collection.

City Policies & Regulations

City of Minneapolis Climate Action Plan

Minneapolis' Climate Action Plan outlines targets and objectives for the city to reduce GHGs (City of Minneapolis, 2013). While the plan focuses on three key sectors (buildings and energy, transportation and land use, and waste and recycling), the planning process included an Environmental Justice Working Group to provide input on social and environmental equity issues related to climate change. The plan lists six goals that pertain to waste and recycling for the city to attain:

(1) Achieve a zero percent growth rate in the total waste stream from 2010 levels, with a long-term goal of achieving zero waste;
(2) recycle 50 percent of the waste stream (commercial and residential) in Minneapolis by 2025, with a long-term goal of achieving zero waste;
(3) increase organics collection to 15 percent of the waste stream by 2025;
(4) reduce the flow of wastewater from Minneapolis and support efforts to make wastewater treatment more energy efficient; [and]
(5) increase awareness of the lifecycle impacts of products to address GHGs occurring outside the community (City of Minneapolis, 2013, pg. 31).

Resolution by the City of Minneapolis: Establishing recycling and composting goals for the City of Minneapolis

In 2015, the City Council of Minneapolis adopted a resolution to establish a set of recycling and composting goals that follows up on those set in the Climate Action Plan (Reich & Gordon, 2015). The resolution set recycling and composting goals of 50% by 2020 and 80% by 2030, respectively, with the intention to achieve a 0% growth rate in the total waste stream from 2010 levels. Additionally, city staff are directed to hold meeting with stakeholders who represent a broad range of waste management perspectives. The resolution states that a zero waste plan will be put forth for consideration by the City Council in the spring of 2016.

Environmentally Acceptable Packaging Ordinance

The City Council of Minneapolis amended the Food Code (Chapter 204 of the Municipal Code) in 2014 to allow for more compostable food packaging products (Rudlong & Kish, n.d.). The Environmentally Acceptable Packaging Ordinance, also known as Green To Go, requires food establishments within the City of Minneapolis to offer reusable and returnable packaging, recyclable packaging, or compostable packaging for the packaging of food that will be immediately consumed (City of Minneapolis, 2014). Each of these different types of packaging are defined within the ordinance. The packaging will only be considered environmentally acceptable if a food establishment provides consumers with an opportunity to recycle and/or appropriately manage compostable plastics and uses a qualified recycling and/or organics management system. Hospitals and nursing homes are exempt from the requirements of this ordinance, as well as any packaging that is not environmentally acceptable and has been determined by the City's Environmental Health Division to not have a commercially available alternative.

Commercial Recycling Ordinance

Section 174.435 of the City of Minneapolis Municipal Code requires that all commercial and business property owners who operate in the city provide recycling collection and recycling plans (City of Minneapolis, 2011). Commercial building owners must contract with recycling collectors, or self-haul recyclable materials to a recycling facility, and provide recycling storage. Recycling containers in commercial buildings with multiple tenants must locate recycling

containers in accessible or shared locations. All owners or operators are responsible for providing tenants and/or employees with annual written recycling information and instructions about the building's recycling collection and storage services. Owners or operators are also required to submit to the fire marshal a written recycling plan that describes where recycling collection occurs on-site and who collects the materials.

Opportunities & Challenges Addressed by Interviewees

Opportunities

Minneapolis houses a population of non-English speakers, and the city feels that it is important for these communities to be included in the recycling and organics collection process:

> *We're getting more involvement from our public that did not participate or didn't have a good understanding of what we're trying to achieve. So from that end of it, I think we've talked to more and more people – non-English speaking and multicultural – than we ever have, and I think that's a very huge benefit, because we've got a very diverse public here, a very diverse population, and we want everybody to be involved and feel that they're part of what we're trying to achieve.*

The City of Minneapolis' website offers both a recycling guide and an organics guide in three languages other than English: Spanish, Hmong, and Somali (2017). Minneapolis interviewees perceived this to be a positive step forward towards broadening access to these SMM resources and including all types of community members. Still, one interviewee in the public sector mentioned there is more to do to ensure that these populations continue to receive adequate messaging.

In terms of waste collection, the city is glad to have a two-person collection crew instead of an automated system for three reasons: They are able to pick up bulky and oddly-shaped items that may be more difficult otherwise, they can provide quality control to ensure that fewer contaminants make it into the recycling stream, and they can tag residential bins of residents who do not follow the correct recycling rules. In addition, Minneapolis interviewees mentioned that larger and extra item pickup is included in the residents' cost of waste, so the process is more streamlined than otherwise. Finally, in conjunction with the contaminant issue, an interviewee noted that the opt-in program allows for residents who better understand the composting process to sign up, meaning that there is less contamination in the organics stream.

Challenges

As mentioned in the Current Waste Management Strategy section, Minneapolis presently has an open waste collection system. Two participants commented that organized collection, in contrast, is a better and more effective system overall:

> *We can contract out and reduce the number of traffic by – or the number of trucks by having zones in the city. So each hauler maybe picks up in the zone, their designated zone, rather than in one cul-de-sac you have eight trucks picking up from the households there. So that's going to be a process going from open collection to organized collection. But that's a process that is defined by state law, and you have to jump through a lot of hoops.*

This process becomes slightly more complicated because Minneapolis has numerous smaller sized haulers rather than, for example, two large private haulers in Detroit. Therefore, they must be parsed out carefully with an extensive planning process, as explained in Minneapolis' Organized Collection Statute (City of Minneapolis, 2007). Neighboring St. Paul has recently passed a resolution to organize MSW collection to be officially completed by mid-2018 (City of St. Paul, 2016).

The Minnesota Pollution Control Agency put out a report in 2012 explaining the benefits of organized versus open collection. Not only does it provide economic benefits – through a reduction of road infrastructure impacts and residential rates – but also reduced environmental impacts – higher rates of recycled materials, more city control of logistics, and more straightforward residential messaging (Minnesota Pollution Control Agency, 2012).

Another issue that poses a challenge for Minneapolis is collection in multi-unit residences, specifically complexes that contain over four housing units. The city is required to pick up recycling in buildings up to four residential units, but there is no requirement for buildings that contain more than four. Further, the infrastructure in many cases makes it difficult to collect waste, recycling, and composting altogether because these may not fit in alleys or may not have been accounted for in the construction of the units. City officials are working through means of addressing this issue.

Minneapolis also struggles with measuring commercial waste and recycling data. While it has an ongoing program of measuring and characterizing residential MSW, the city has lower capabilities of doing the same for the commercial sector. This is because commercial entities in the city choose their own haulers, and the city does not have a hand in that. As a result, however, the city doesn't "have the whole picture" when it comes to waste characterization data, as one interview participant noted. Part of the reason for the difficulty of commercial data collection may be, as one participant noted: "Private haulers… are always reluctant to share too much information for the fact that they think that it's all proprietary and could be used against them for a competitive disadvantage." This is difficult to change because not only are there so many players, many of which are private companies, but these companies have their own business plans and missions.

Interview Findings: Addressing Waste Management Framework

> *You have to have the sun, the moon, and the stars to come into alignment to get anything done [in waste management], which is a combination of social, politics, and economics.*
> – **A Baltimore interviewee**

When asked how their respective cities developed and implemented their current waste management strategies, participants identified several factors that can influence decision-making on waste management programs and policies. Given that we used a grounded theory approach to analyze qualitative data, we grouped our codes into a set of interview themes that provide insight on the waste management frameworks in each of the three cities we explored. We organized the themes (political, social, economic, technical/procedural, and environmental) based on the factors that may determine the success of certain waste management programs and policies. We also included a brief section on other waste management considerations that were outside of the scope of our analysis but relevant for stakeholders to think about. Many of these themes overlap with each other, yet we chose to separate them to understand the interactions between different agents and structures.

Political

We coded factors as political if they referenced policies at various levels of government (i.e. local, county, state, federal), planning documents, local or state waste diversion or recycling goals, leaders in the public realm, lobbying efforts, or issues with accountability or enforcement of goals or policies.

Collaboration

Within each of the cities we explored, collaboration on waste management issues spanned across the public and private sectors to include regional or local nonprofit organizations as well as residents. Our participants reported that while collaboration can occur at different scales (i.e. within the city, county, region, or state), they also noted that the degree of effectiveness with regards to communication and coordination between waste management entities can be mixed.

In Detroit, collaboration around waste management issues or concerns extends to the public, private, and nonprofit sectors. Two participants stated that one hauler in particular has been coordinating well with local nonprofits that received an MDEQ grant to host educational workshops for residents, while another participant noted that the hauler visits local schools to provide recycling education programs. One participant who works within the community stated that the New Business Model for Solid Waste in Detroit, which then became Zero Waste Detroit,

came about from a meeting in which several nonprofits came together after a councilwoman had brought up discussions on how to push the city to move past incineration:

> *That EJ task force was starting to think post-public debt. At the same time, there was a bubbling up of what to do. A group of us representing Sierra Club, EMEAC, Michigan Environmental Council, and Detroiters Working for Environmental Justice, Rosedale Recycles – about seven or eight groups at the beginning – started meeting again in our living room. And talking about how do we talk about and how do we look at the potential [for zero waste] post-2009.*

At the same time, this participant also mentioned that collaboration in Detroit can be somewhat complicated as relations between the city and a nonprofit became muddled once the city signed contracts with two private haulers.

Collaboration occurs across multiple levels of government as well. One participant noted that Wayne County has coordinated on solid waste issues with the City of Detroit more often within the last few years, before and after the city went bankrupt, and that the state has formed the Solid Waste and Sustainability Advisory Panel to revise Michigan's Part 115[42]. Similarly, another participant mentioned that recent conversations between waste management stakeholders at the state level led to the creation of the Governor's Recycling Council, which is a nine-member council appointed by the Governor to advise MDEQ on how to implement strategies outlined in the Michigan Recycling Plan.

In Minneapolis, collaboration seems to occur within the city as well as at the county and state level. When asked about specific elements that "make or break" a particular waste management policy or program, a member of a statewide nonprofit organization cited the importance of national advocacy groups in getting legislators on board to promote an agenda. While city staff noted that the city is engaging with the public when considering how to move forward with their emerging zero waste plan, a local community organizer mentioned that residents did not show up to one meeting in particular since they are mainly promoted through the city's website:

> *Long answer short, the reaction to that plan, and one other thing that I'll say, is that they've had a couple of community engagement meetings and things. I went to one of them. There was no one there from the community. And I [asked], "So what did you do to tell people about this meeting?" They said, "Oh, well, we put it on our website." So you know, I'm like, you thought people would show up because it's on your website? It's a real lack of understanding of how people would live their lives day to day. They are not going to check the Hennepin County or the City of Minneapolis waste management website to figure out what's going to happen to their trash. That's just not gonna happen.*

[42] Refer to policies listed in the case study of Detroit section in this report.

In both Minneapolis and Detroit, collaboration around recycling education seems to be less formalized between the city and nonprofits. While many of the recycling efforts in Detroit were initially community-driven, mainly through community drop-off centers, there seems to be an uneven distribution of work between the city and these groups with regards to administering education programs. Even though their organization receive funding for their work, one participant who coordinates with the city describes the day-to-day activities that they perform:

> *When we do [recycling education] workshops, we don't just go to the workshops to get people signed up and just hand it over to the city. We enter all the stuff into the database. We prepare the orders for the haulers. And then we prepare invoices, we get paid for each workshop from the city. … And then we got lots of calls from residents: "I went to [a] workshop two months ago. I don't have my cart yet." We go back to cart orders. We find that person, we contact the haulers and copy to the city and say, "Jane Jones went to the workshops on April 11, she was part of the order of April 28, [and] she hasn't received the cart yet." Some people say we are really doing the city's work …. I don't mean that's something to complain [about]; it's just the reality. What we are doing is a lot of that detailed work.*

Another organizer expressed similar sentiments when discussing how recycling and organics collection occurs in Minneapolis:

> *So the problem with the City of Minneapolis is that it runs waste management for single-family homes and very, very small apartment complexes, but for multi-family units and for commercial-like businesses – that is not ran through the city. These are done by independent contractors or through Hennepin County, honestly. They gotta do more than just "Here is the composting bin." … They need to make sure there is training, they need to make sure there is education around that. But they also need to, of course, make sure people aren't facing these barriers and figure out why people are facing these barriers if they are not recycling and composting. And you know what? They label a lot of that work to organizations like ours … They say, "We want to engage in the community, so we want you guys to engage in the in community and figure out why people are having such a hard time recycling." Okay, we can do that, but also resources are very, very important. Can't do that for free. None of us do any of this work for free because we basically do it for free anyway. You don't get paid very much to be community organizers.*

However, city departments that specifically address sustainability issues seem to act as more direct entry points for communities and nonprofit organizations to discuss waste management issues.

In Baltimore, both a city staff member and a community organizer discussed the degree to which the Commission of Sustainability has been engaging with residents, politicians, and

private and nonprofit organizations over rodent concerns, composting, recycling, and the use of incineration. One participant mentioned how the Commission of Sustainability's waste subcommittee held listening sessions that led to the city administering 64-gallon covered waste bins with attached GPS units to address rodent problems with waste collection. The participant also mentioned that the Office of Sustainability has partnered with nonprofits and foundations to begin the Clean Corps program and a litter campaign, and that their office conversed with stakeholders in Washington D.C. to consider how to integrate composting for community gardens. The other participant mentioned that the Commission of Sustainability has been more receptive to discussions of moving beyond the use of incineration:

> *Our current other collaborators have been the Baltimore Sustainability Commission and we've been doing a lot of engagement with them. Just two weeks ago there was a panel, specifically based around waste management in Baltimore City and what we want to do with moving the city forward… Last year when we began our conversations with the city, they were very reluctant, the Department of Public Works in particular, to engage this idea of "zero waste" and moving on from the incinerator because it's what we had, it's been here, it creates some sort of financial gain for the city – although it's minimal, relatively – and that's just what we gotta do. Over the last year, they've certainly evolved. Now in that panel, even the head of Solid Waste was discussing the impact of moving on from the incinerator and what have you … So we've wanted to start with the sustainability crew and go at council folks and get them on board, and then from there build out to other agencies.*

When discussing the approval process for the curbside recycling program in Detroit, one participant alluded to the need for a centralized location in Detroit in which solid waste issues can be addressed. This participant felt that many initiatives require various levels of approval, which may slow down progress, and that officials in different department may be "busy addressing other things that might be more important" at the moment.

Planning & Policy

Participants discussed how each city was meeting state goals on recycling, composting, or waste diversion from landfills and/or WTEFs. As they identified a host of different issues for stakeholders to consider when meeting these goals, several participants emphasized that the regulatory and political framework is important for determining how a MSWM system can become more sustainable. Others pointed to the need for strategic planning. While mandated recycling ordinances seem to have both positive and negative outcomes, a few participants mentioned that development requirements for recycling bins in multi-family units is desirable.

It can be complicated for a city to adopt a waste management hierarchy, yet several participants in Detroit noted that it is important for both the city and the state to develop such a

framework. One nonprofit member mentioned how public officials seem to be thinking about recycling in the context of developing a hierarchy in the future:

> *I think the city officials have seen that there is an importance to having some sort of hierarchy strategy for waste. I think right now their main focus is trying to get everybody on the same level of recycling. Everyone should know and have access to it first, and then maybe in the coming years then we can really focus on setting that up a little bit better.*

Another participant who works for the county described the need for the adoption of a waste management hierarchy at different levels of government. Even though all municipalities in Wayne County, and Michigan generally, have the authority to decide where to send their MSW, the county solid waste plan plays a part in determining the prioritization of MSWM strategies:

> *They're somewhat dependent on our plan, and our solid waste management planning kind of lays out basically what the goals are. And we don't necessarily have a hierarchy identified in our plan, at least this current [Wayne County] plan, yet either… but [that] will very likely be an element of future plans.*

This participant also believed that adopting a hierarchy at the state level would change that relationship as cities would no longer be making decisions based on storage capacity alone:

> *I think we're going to be moving away from state law that's driving these plans, these county plans, based on capacity – do you have the capacity to get rid of the waste you generate. And I think we're in the process, hopefully now, flipping that upside down … you develop a way to build a hierarchy. And when it's written into my plan, that means I have to do it that way, right, instead of, "No, it's cheaper to go to the landfill, so it's always going to go to the landfill."*

In addition to the establishment of a waste management hierarchy, there is a need for strategic planning efforts to ensure that programs and policies will be successful. City staff in Minneapolis informed us that they were happy about incoming councilmen who have a "greener attitude and passion." However, the city staff felt that these councilmen wanted to push for strategies to meet Minneapolis' recycling goals without considering how that might influence program evaluation. A member of a county department echoed a similar statement when describing this process at the county level:

> *With our Green To Go ordinance, it did not allow for the use of expanded polystyrene foam, starting of Earth Day last year [2015]....The Green To Go ordinance also, starting next year [2017], will require any plastic-lined paper items to be a certified compostable plastic-lined paper item. And there's only a couple manufacturers out there that currently*

are doing that. We waited for that aspect of that ordinance to be a requirement until the city's organic program was in place so that people actually had somewhere to be putting those items.

One Detroit participant stated that this kind of strategic planning is also needed to ensure that any small-scale zero waste events that may come about will consider long-term behavioral changes across the large city.

Given the politics that surround MSW procedures, the way in which policies are framed to meet the needs of each stakeholder is significant. One participant, who works for a nonprofit that promotes zero waste, mentioned that defining zero waste within a zero waste plan is important since the definition will guide both future investments and policy making. Furthermore, when asked about the barriers that would prevent the adoption of certain waste management policies or programs, this participant discussed how communities might represent zero waste:

I think a barrier is, for a community, is figuring out how they can frame zero waste to meet the benefits of the community. There's a lot of benefits. I think every community is looking for ways to increase jobs and increase economic development opportunities. I think the environmental issue can be a barrier sometimes for people if it's gonna create an immediate increasing cost, but I think it can be framed in a way that's preventing long-term costs. It's a smart investment for a community to make… Manufacturers are against any sort of requirements or regulations that could potentially impact sales or consumption. So that's certainly something that needs to be addressed, and that's why we think it's important to work with the manufacturers to try to figure out a way to make it happen or to even implement reduction and recycling strategies. That would eliminate the need for some legislation or regulation. I think that's everyone's goal.

Similarly, both participants in Baltimore and Detroit referenced the need to frame zero waste in terms of potential revenues and new jobs that are associated with zero waste practices. Another Detroit interviewee also noted that some city staff seemed interested in developing zero waste policies if they can be implemented easily and will generate revenue for the city.

While mandated recycling ordinances can assist with achieving zero waste or waste diversion goals, they also present some challenges. One Minneapolis interviewee stated that mandates can be ill-received by the public, and a member of a statewide nonprofit organization described how they could result in increased contamination in the organics waste stream. However, one participant who works with the community in Detroit believed that mandated recycling was a must for the City of Detroit:

> *I would say that we need to mandate commercial recycling. Meaning for all entities, recycling is part of how you manage your materials. If you operate a business or whatever in the city, now … you have to demonstrate that you have a hauler. That is what the requirement is.*

In contrast, many Minneapolis participants seemed to agree that development standards requiring the placement of recycling bins in multi-family units should be a policy that is instituted. Participants who either worked for the city, county, or at a nonprofit all mentioned how requirements for new residential development to include space for recycling and composting would be beneficial. Two of those participants also noted that waste chutes in these residences should also include recycling.

Leadership

Champions in local or state government and industry leaders can be an important asset for moving innovative waste management policies forward. Since MSWM issues are highly political, local or state officials must be willing to push the agenda forward with regards to more sustainable practices.

Some participants mentioned that it takes "political will" to push for more sustainable waste management strategies at the local or state level. One participant in Minneapolis described how this factors into overcoming barriers related to shifting towards an organized collection:

> *I think it's particularly tough right now. I think it more depends on perhaps even just local action. If you have a city that's really dedicated to it, if the council members are dedicated to it, if the mayor is dedicated to it, they can take the time to move something through, but unless there is political will, it's probably not going to go anywhere.*

A city staff member in Baltimore mentioned that political will is important not only for city staff and officials, but also within the context of collaboration with other organizations:

> *Political will is huge for getting larger things done across cities. It depends who's in power. But then there's things like … mid-level managers who have been around for years, we're all embedded in all different agencies, and we all know each other, and we know how to get things done … so we do move the agenda forward even though mayors come and go, and agencies come and go. So that's really an important factor… especially once you get to know other people who are interested in making a difference and doing things about it and working closely with community and nonprofits. You can get stuff done. Even underneath political will or around political will. When you have the political will and that, then you have everything.*

Another participant in who works in Baltimore County seemed to support this notion as well by stating that a long-term vision for waste management must "last several administrations, several chiefs, and several directors." In contrast, a community organizer in Baltimore noted that the momentum behind a proposed Clean Air Ordinance broke down in part due to one councilman who decided to no longer serve as the local champion for that policy.

In Detroit and Wayne County, public support for SMM strategies from government leaders or champions seems to dictate the direction of policies or programs much more so than in Baltimore. While a participant in Baltimore noted that established "mid-level managers" can shift political discourse around waste management, another participant in Detroit stated that it takes the support of several public officials to push through a particular policy or program in Wayne County:

> *There has to be leadership and support from all levels… I can develop a policy for Wayne County that says … that we're going to increase our county-wide recycling rate by 5% in the next fiscal year. If I don't have the support of those above me, especially those above me starting at the administration, starting at the county CEO, if it's not important to him, it's not going to happen. So leadership is critical. When you're talking about a government entity – the mayor, the CEO, the city council president, the council members, it is extremely important for them even to verbally say that "I'm supportive of what you're doing, and I want to see you do this."*

Two participants in Detroit also described how Councilman Scott Benson's Green Task Force has been instrumental for raising awareness waste management issues in the city, yet one participant noted that "recycling isn't one of [the mayor's] initiatives, so there isn't too much support … from his end… which makes other people less encouraged to support it." Several participants in Detroit also noted how General Motors has adopted a zero waste approach, yet some noted that this is solely zero waste to landfill – meaning that materials are still sent to the WTEF.

Since our interviews were conducted during the months leading up to and after the 2016 presidential election, participants in Baltimore and Minneapolis were mostly hopeful about incoming, more progressive members of City Council. This sentiment held true for the members of city staff as well as the community organizers that we interviewed.

Role of State-Level Lobbying

At the state level, policy proposals can be quickly deterred by strong lobbying efforts. Participants in Baltimore and Minneapolis referenced how plastic or paper bag manufacturers, as well as bottle-making companies, can present challenges to passing more comprehensive legislation:

You're also gonna have lobbying money from all sorts of the plastic bag manufacturers or paper bag manufacturers for that matter if you're talking about a bag ban or a fee, and you've got election seasons and there's tons of things.

With the bottle bill, I'd say the bottle industry – you know, the Pepsis and the liquor industry and all the people who don't want to deal with it. It's cheaper for them to just put out a bottle and not have to deal with the re-use. I think that's – I remember in New York State that was the issue.

One participant in Minneapolis noted how waste management corporations that owned landfills were opposed to the adoption of the state waste reduction goals:

Organics is extremely heavy material so they get "big money" as a landfill. That's landfill there. It's a lot of tonnage. They're looking at revenue losses and that never goes over well for corporations. And so they opposed [the organics program]. The companies that own a landfill – it's really owning a few of them, three of them maybe – were opposed to it and lobbied against it of course. That's what they do.

Accountability or Enforcement Issues

Since waste is an issue that transects several different systems in a society, it is important that different stakeholders ensure that regulations, MSWM plans, or waste diversion goals are properly enforced. Some of our participants mentioned specific challenges with regards to how certain policies or regulations are being implemented or how more sustainable waste management policies may be less effective due to weak follow-through.

Much of the lack of accountability within the public sector may tie into the need for strategic planning, as identified in the previous section. Minneapolis seemed to run into some trouble with enforcement and follow-through of collection services, as participants describe below:

They already have a mandatory business recycling ordinance. I guess my criticism of that would be, it's great on paper, but there hasn't been a lot of enforcement or staff to follow up on it. So it's like, "Yeah, we have mandatory commercial recycling, but has there been an assessment of who's participating? Is everyone on board already? Where are they at with it? Is it adequate?" So they say they're doing it; are they really doing a good job if you show up and take a look around? How are they actually doing? I think there's a few things where there could be better follow-through, better enforcement of it. And I guess it wouldn't even have to be enforcement; it could just be better outreach for the city to connect with their businesses. But that said, they are huge. We understand that in a big city it's hard to get the resources for that.

> *I think the difficulty from a lot of municipalities [like] ourselves is that … we changed over to our [single-sort] recycling program in 2012 and really never got the opportunity to go back and look at some of the challenges that our public had with those that were either low participating or not participating in the program, and then we were kind of prodded to … get into the organics collection – which, looking back, we're glad we did, but we could have used a little more time to really get out and engage our public on recycling before the organics. So I think that's the importance of some of the initiatives when the programs get implemented is to take a pause a little bit and go back and evaluate the programs, and a lot of times that's not done at our level.*

One participant who works in a local nonprofit noted that accountability is also an issue for the State of Minnesota as it pursues its waste diversion goal:

> *I am not sure what the accountability is. Is there really any specific results of not achieving it? At this point, I think it's more just a goal. And I think Minneapolis is probably the closest, you know, with organic and recycling.*

However, one community organizer in Minneapolis claimed that there seem to be difficulties with regards to separating recyclables at the county's WTEF:

> *They have this recycling goal, yes. However, they did not do a good job explaining how exactly they are going to ensure the diversion of recyclables and compostables to the incinerator because … a very big problem with the incinerator at the HERC is that they don't sort anything … A few of us from our coalition took a tour of the HERC a month ago. They don't sort anything. The funny thing was that actually they were sorting. They were doing this big sort for media. So they could literally call it a "media waste sort." They had cameras and news crews in there during the time we took this tour. But we asked the guy, "Great, so where do you send all these recyclable after you sort it? Does it get sent to Eureka [Recycling], for instance?" Nope, it doesn't. He said, "Oh no, this is the first time we've done the sorts, this kind of sorts, so no, they'll just go back in the burner … but maybe in the future." And we were just like, "What?!" This has been 30 years you've been operating like this and you haven't sorted ever before? You are doing this waste sort right now and you are not gonna make sure that things get recycled? I was just floored by that … And, you know, this is just one employee.*

Another community organizer in Baltimore also noted issues of accountability with regards to the WTEF and other facilities:

The incinerator has dealt with some mercury violations a few years back. It also had kind of a shutdown at various points … They only test it once a year, and they know when that test is coming. They get to choose which boiler the tester will monitor. There's a lot of lack of accountability I would say for all other 364 days out of the year when it comes to their emissions.

Social

We coded information related to people or about social activities as the social theme, such as community engagement, education, mindset, and behavior change. EJ issues are included in this section although some of them may be overlapped with economic, environmental, and/or even political factors. Most interview participants noted that community engagement and education are two principal factors in the implementation of sustainable waste management strategies. At most of the time, these two elements are closely linked. Effective education can increase participation and positive community engagement in turn influence the impact of education. Similarly, mindset and behavior change relate to each other. It is the conversion of the mindset that leads to behavior change and behavior change also can reinforce the transformation of mindset. In addition, interviewees referred to mindset at both individual level and decision maker level. In the sub-theme of EJ, we included concerns and views about WTEF, barriers to accessing recycling, and availability of waste management recovery elements.

Community Engagement and Education

Community engagement is closely related to program participation. Most of the participants in our interviews considered community engagement as an important factor in waste management. For the City of Minneapolis and Baltimore, interviewees mentioned various effective impacts of public awareness and community engagement. Some interviewees in Baltimore and Detroit also noted some lack of the community piece within the cities. In addition, many suggestions and strategies about engagement were discussed during the interview process.

Participants in Minneapolis and Baltimore stated that active public engagement increases the participation because the public plays a critical role:

People have been recycling since [before] 1990, so they have an understanding of recycling being a very high participation rate. I think that plays a lot. So I think that is a big factor. There is a lot for the general public to do.

A key ingredient is having early community engagement and buy-in and participation throughout the entire process.

One of them later noted that an effective way to develop a program in Minneapolis is to publicize the project first, gather feedback and comments from residents, then push the program

forward citywide. Another interview participant expressed a similar sentiment about the community engagement in Minneapolis. The interviewee believed that it is the good relationship with the neighborhood and community that helps them with communication:

> *We have got a very good neighborhood and community relations area that we have worked with, our communications area on getting the word out. So it cannot be just us, and I think we are realizing that more and more every day and getting the involvement of other areas within the city to help us get the word out to help communicate. I think it is just very important for any municipality*.

Participants in Baltimore mentioned several effective examples as well, such as the compost strategy initiation process. Many stakeholders attended the meeting and the working groups met together to develop strategies for composting and a vision for the city moving forward. Litter campaigns, community gardens, and neighborhood competitions were utilized as effective practices to get the community engaged.

However, there are some concerns there in the City of Baltimore and Detroit. A Baltimore public stakeholder thought they often are missing the people at the initial stages and it takes time for residents to gain awareness. In addition, another participant in Baltimore expressed concerns about the decision the city made to give out large waste bins but against free recycling bins. This decision is likely to hinder residents from dealing with recycling since they may instead choose to put everything in the large waste bin. For Detroit, one interviewee was worried about community engagement in the city because residents may not necessarily be able to tackle recycling when they may be preoccupied with other, more pressing things, especially in low-income households.

To improve the community, several interviewees shared effective strategies used in their city or provided some suggestions based on those. One of them mentioned the composting program in Minneapolis. The strategy used in this process is an opt-in program rather than mandating because it is human nature that people do not like to be forced into things. At the same time, the residents pay regardless of whether they use the service or not. It turned out, based on these methods, not only have residents begun to participate, but the resulting organic material was of high quality. The participant also suggested that it is easier to sell recycling and composting from the standpoint of what individuals believe rather than on the basis of climate change, as the latter may not resonate with everyone as strongly. Another advice from this interviewee is to understand the economic system and target messages to particular individuals.

In Baltimore, an interviewee described a strategy of hiring residents in the communities to do the recycling work, which can build up a community that residents would be prouder of: “If you are hiring folks in those communities that are having to recycle more to do this work, then you are building up and transforming the community that way.” Speaking about public engagement, participants often connected it with education. A public stakeholder in Minneapolis stated that it is important to make residents aware of these services so there will be more positive

results: “[Key strategies are] reaching out to people, working on your education and outreach, and making sure people know it is important, and just really increasing participation.”

Three participants in Minneapolis and Detroit all explicitly stated education is one of the key elements that can either make or break a waste management policy or program. An interviewee in Baltimore commented that the public seldom knows how waste management works. Similarly, one participant who works in public sector noted that there is still a significant amount that needs to be taught. The interviewee also mentioned it is difficult to draw residents back in who have previously been fined or had trouble with recycling. A Detroit stakeholder thought the city will benefit from education, which can help change the behavior and mindset – while the lack of education results in low participation. When talking about the importance of the education, an interviewee in Detroit referred to some communities in Oakland. They have recycling rates as high as 50% and the underlying reason is education. Besides all these impacts that education has, many participants mentioned that education is vital regarding material quality and lowering contamination levels.

There are many effective examples discussed in the interview. Most of the interviewees in Minneapolis expressed that they did a respectable job in education. One participant in Minneapolis noted that the residents in the city are well-educated on recyclables and contaminants. The interviewee later mentioned that much of the information is provided for education, and their crews do that through tagging at the collection points. Similarly, another participant in Minneapolis thought this tagging is a fast way for residents to learn when the material is still in the bin. When moving to carts, Minneapolis used the touch screen system specifically to try to continue education. Regarding education in Detroit, most of the participants in Detroit pointed to the same program that provides free carts with education, expanding recycling. One of them described this program as follows: “I would say that what the offshoot group Green Living Science has been trying to do in terms of education of students and residents, I think it has been really important in the city.” Although this program seems to be successful, another participant brought up that education is still limited. Some education has done but not following the principle of repeat and consistent messaging. There are limited resources for organizations to do massaging work. Haulers do not always provide convenient access for residents to know recycling or other services.

One public stakeholder in Detroit mentioned that a statewide education campaign would be ideal. Another participant in Minneapolis spoke about the flow of individuals coming and going: “With populations, you are always going to have people coming in and people leaving, and they need to receive that information as well.” One interviewee in Minneapolis also pointed out that there was a workshop about compostable plastic. Interesting topics like these can help city officials implement programs.

Environmental Justice Issues

EJ is an important part when dealing with both environmental and health problems, as one interviewee in Detroit stated:

> *Environment is about the quality of life … issues such as poor air quality, asthma, and people suffering and having the ill effects and stuff. Those are experiences that the residents of the city have. Those are environmental justice issues. But they're environmental and they're about the quality of life. And if the city is going forward, those kinds of issues are critical to us really being a 21st-century city. You can't only think about … [job creation] without looking at green infrastructure and quality of life issues that impact people's health.*

Around waste management, interviewees talked about the incinerator, air emissions, race, and class. One participant in Baltimore explicitly pointed out that the EJ issues the incinerator facilities have:

> *There is an environmental justice and environmental racism issue when it comes to the incinerator facilities. They do try to come into communities to say, "Hey, we are going to provide these decently paying jobs and everything." In actuality, [incinerators] cost a lot of money, especially nowadays to build.*

The interviewee also mentioned that the City of Baltimore has 56% of the total population with a high school diploma or less, while the percentage is 72.5% in the community where the WTEF is located. The Baltimore interview participant stressed that incinerators are built in areas with higher concentrations of African-American and Latino citizens. Besides siting decisions, few workers at Wheelabrator live in the region that the WTEF is in, and as a result, the facility is not keeping money in the community.

Participants in Detroit also mentioned EJ issues about the incinerator in Detroit. For example, Detroit's MSW is a just small portion of waste burnt in the incinerator. The interviewee also explained the put-and-pay situation where residents will pay regardless of how much waste you put in the incinerator because the city kept the public debt through 2009. When it comes to incinerator, air emissions are always an issue. One Baltimore stakeholder mentioned that traces of some toxins could spread five or even 30 miles away from their source; the interviewee cited a study that found traces of these emissions in Inuit communities with no incinerators in their area. Another interviewee in Minneapolis said that air emissions could be one of many issues for overburdened communities, and there could be transportation, housing, heavy industry, and other things.

Another big EJ issue is about race and class. One participant in Baltimore thought that race and class have been a major challenge for Baltimore to move forward to zero waste in the future. The interview participant also mentioned that there is a perception that residents in Baltimore are not able to move the city because of its race and class.

Not many interview participants spoke about how to deal with these issues, although it is mentioned that the Pollution Control Agency in Minneapolis incorporated EJ into their evaluation and in Baltimore, there is a collaboration with United Workers, a community

organization. Just one participant in Baltimore suggested using a multi-tiered piece to approach it, showing that more jobs are created through recycling or other SMM programs.

Our interview participants had varying points of view and opinions regarding WTEFs. Two participants in Baltimore and Detroit were skeptical on the term of WTE as renewable power. The interview participant in Baltimore took issue with the use of the term WTEF instead of incinerator:

> *Waste-to-energy is just the commercial term that incinerator companies use … It is not really waste-to-energy; it is a waste of energy when you consider all the energy it takes to actually produce the raw materials, transport them to processing plants, ... and then you use the product and then you send them to the incinerator and no longer use the product because it is now in its grave, or ash, or in pollutants in the air. Waste-to-energy is a way that the industry has managed to try to rename themselves and make it seem less… polluting when it comes to what they are doing.*

Another participant in Baltimore looked at the WTEF from a different perspective for waste management in the long term and what it means to the community:

> *You need to look at waste-to-energy as a whole … When you burn trash, it becomes 10% by volume and 30% by weight. Now what that means is this … when you burn 100 tons of trash, you only get 10 tons back to the landfill. So what that means is your landfill has lasted ten times as long by using waste-to-energy. It also means this: That over the life of an ash landfill, you have saved your community ten closed landfills.*
>
> *So basically, there are several things that are never brought up or talked about. So if a community is looking at what they want to do long-term, and I'm talking beyond their lifetimes, when you decide to build a waste-to-energy plant, you decide not to have nine landfills close to your community. You decide to have only one. What's the value of that to the future generations?*

One Minneapolis stakeholder thought that it is easy to be against something like incinerators, but future changes require forward motion in the promotion of recycling, composting, and waste reduction.

Another main justice issue is about barriers to recycling access. A number of interviewees in Minneapolis and Baltimore thought multi-units are a big challenge to SMM. These multi-units likely need more resources and are often omitted in these programs. Regarding multifamily units, most Minneapolis interview participants noted that there should be a plan or an enforced ordinance about building design towards access: "I think it's important to make [SMM practices] available and give people a chance to participate."

Almost all participants in Detroit, along with one interviewee in Baltimore, mentioned the $25 opt-in-fee is a challenge for residents especially for those who are facing poverty, however, this issue is currently being solved through the extension of the MDEQ grant through community education initiatives. One participant in Minneapolis also mentioned that language and cultural challenges hinder some residents' understanding of the SMM programs. In Baltimore and Detroit, two interviewees believed that there are some neighborhoods or certain regions that just have been neglected.

Toward Mindset, Behavior Change, & Reframing Waste Management

Waste management is a political, social, and environmental problem and it is complicated. Sometimes it requires residents to change their mindset at different levels. In addition, mindset change can help waste management move forward from low-hanging fruit. One participant in the interview mentioned framing and language change, education, and strategy can be used:

> *I think defining the definition of zero waste is a really great place to start because that is going to drive how people look at all the investments and the policies going down from there. It sounds simple but it surprisingly potentially the most difficult thing to do is to get everyone rallied on that. I think beyond defining that definition.*

Education about source reduction involves asking residents to change their mindsets, then their behavior and lifestyle. One interviewee in Minneapolis mentioned that they conducted education programs to promote better shopping habits of residents and now the single-sort recycling and organics program help community members make behavior change decisions. Another participant in Minneapolis added that the 32-gallon cart (instead of the larger one at the larger price) also affects residents' purchase behavior because they do not want to buy too much to contain all waste in the relatively small cart.

Interviewees also mentioned reframing waste management to help the decision makers' process. One Minneapolis stakeholder noted it is key to understand how the economic system works and how reducing, reusing, and recycling our waste can fit into that. Two participants in Detroit suggested a shift in language from waste to SMM would allow for mindset and behavior change.

Economic

The economic aspect is a key factor to consider when making waste management decisions on multiple levels, from individual to business to government levels. Oftentimes, it is the economic factor that incentivizes or disincentives stakeholders to make more sustainable decisions. Therefore, it is important to understand the system and then use the principles to direct the sustainable routes.

On the residential side, two participants noted that it costs more to reuse or recycle than to throw waste away in Detroit, which fails to motivate residents to make waste diversion decisions: "On the residential side – when the price gets cut, the cost for recycling isn't nearly as attractive … So the bottom line is, it's way too inexpensive to throw away trash in our region."

Increasing the tipping fee can increase diversion from landfills, but the state law limits how much the state can collect. One Baltimore stakeholder pointed out that residents can have an incentive to participate in waste diversion practices if the money from the incinerator tipping fee was sent directly to the communities themselves. One interviewee in Minneapolis thought there can be a law that every hauler should provide differential service pricing based on the amount of garbage. Another participant in Minneapolis brought up the idea about the pay-as-you-throw system where it is more expensive for things that are not recycled or diverted. One interviewee in Baltimore mentioned a similar pay-as-you-throw program or SMART policy they want to move forward with. The participant also shared a potential pilot program where they reward the communities that go past diversion rate of a certain percentage as an incentive. Besides these, educating residents why it is sometimes important to spend more money for a more sustainable practice is also a way to approach the incentive issue. Community engagement can be enhanced by framing waste diversion in a way that it prevents long-term costs and may create jobs and increase economic development opportunities, as noted by one Minneapolis stakeholder:

> *I think a barrier is, for the community, how they can frame zero waste to meet the benefit of the community. There are a lot of benefits. I think every community is looking for ways to increase jobs and increase economic development opportunities. I think you know, the environmental issue can be a barrier sometimes for people, but I think it can be framed in a way that's preventing long-term costs. It's a smart investment for a community to make.*

For businesses which make decisions mostly based on revenue, there are few incentives for them to make any changes. One interviewee in Detroit stated that tipping fees are a barrier for SMM:

> *Right now the tipping fees are so low, with incineration and also with landfill, that is actually more cost-efficient for them to just throw everything away in the trash. Whereas recycling is something that actually costs the waste haulers to dispose of. We are trying to work out and get that to start balancing. Because in [some] other cities … it is free to recycle but it costs money for trash.*

Hauling companies may shy away from supporting recycling because they have to make money. WTEFs stick with put-or-pay contracts because they result in more waste being burned. Interviewees brought up many strategies to guide businesses to be more sustainable. Another participant in Detroit mentioned trash-to-cash proposals, but these businesses also run into the same problem of economics because it is hard for them to compete with the private haulers. One Minneapolis stakeholder thought the state should help develop markets for materials to create

some demand for recycling or other facilities. A participant in Detroit also mentioned that if there is a market, then innovative strategies will happen. In addition, one interviewee shared a strategy of revenue-sharing agreements that recycling facilities can use to deal with the fluctuation of market prices.

At the government level, economic factors still need to be taken into consideration. Funding is a big one for most cities. One Detroit participant stated that it is the element which can make or break a policy or program. The interview participant suggested a funding structure that would help promote local programs:

> *[Other states] have things that we don't necessarily have here in Michigan in terms of policies in place – like landfill bans on certain materials for example, or funding structures that really help to prop up to local programs. We have very limited funding here in Michigan. The make-or-break at a state level would be policy and funding.*

One participant even mentioned that in Minneapolis, when the waste characterization study can be done is dependent on the funding. Another interview participant in Detroit noted: "If a policy costs someone too much money, it is going to get broken. And so then, it is really critical to make sure the policy is really well-founded and the reasons for it being there are [credible]."

Similarly, one interviewee noted that available funding is helpful for recycling requirements or other policies. In Minneapolis, two participants mentioned they charge residents through a base fee as a funding source. One of them also mentioned the SCORE funds which creates some incentives for counties or cities to achieve MSWM goals (SCORE Association, 2017). The county is trying to meet the state requirements and then their cities can get SCORE funds from the county discretion.

Technical/Procedural

This section encompassed a broad range of practices, namely procedural elements like waste collection procedures, technical elements like efficiency and data measurement, and the connection between policy with infrastructure. In some cases, this category is vague, referring to general processes, ways of doing things, or technical challenges, and melding into other categories. That said, much of the commentary from this section came from interviewees who were more familiar with the structural and day-to-day functions of waste management processes in each city, and less from those representing community or neighborhood-level organizations. However, there is still representation from both sides of the technical and social spectrums.

MSW often becomes tricky to manage because political, socioeconomic, and structural elements are inherently interlaced within one another. Each city's current waste management structure can be slightly, or sometimes vastly different, and a Baltimore public official noted that the public may not know of or fully understand the minutiae of the process:

> *There's a lot of misconceptions out there. So [the public gets] involved out of ignorance, which conflicts with efficiency… politics is to deliver to people what they want or they think they want, but that's where the economics come in, and economics have more to do with efficiency.*

Economics was reiterated in this category as a barrier hindering residents from moving forward with SMM processes. Three Detroit stakeholders noted that sending waste first to a WTEF and charging more for recycling is a product of how the system is structured, and therefore becomes a disincentive for residents to recycle. The process to move forward, then, is not only to change individual elements such as economic structures and political structures, but focus on how these elements work together in the broader waste management system to ensure a more streamlined process overall.

One way to create a streamlined process specifically in curbside MSW collection is through organized collection (defined earlier in this report under the Minneapolis section), mentioned by three of the interviewees across two cities. Minneapolis currently has an open collection system, and some interviewees mentioned that this is not as efficient overall as organized collection. A Minneapolis public official spoke about this process:

> *We can contract out and reduce the number of trucks by having zones in the city. So each hauler maybe picks up in the zone, their designated zone, rather than in one cul-de-sac you have eight trucks picking up from the households there. So that's going to be a process going from open collection to organized collection.*

Detroit in fact has this system, with both of its private haulers collecting MSW in designated sections of the city. However, the means for Minneapolis to reach organized collection involve some planning and logistical hoops to jump through.

Another issue is the fact that it takes time to put a process in motion in a city with hundreds of thousands of residents. Progress may seem slow because there are so many components that must come together for a project or program to get off the ground, not to mention gain acceptance. Speaking specifically about behavior change and organics programs, a Minneapolis community-level interviewee elaborates:

> *That's all about behavior and attitude change. That takes a very, very long time to do… People recycle now. It did take 40 years to do it. … Really, organics is going to take the same route as traditional recycling did back to 80s – that's where we are today with organics.*

This participant also mentioned that it is a social process – if residents see their neighbors recycling or composting, they may consider it further if they hadn't done so already. In fact, interviewees in two cities mentioned that community initiatives could have a larger impact on

overall waste management steps forward in the city. A Detroit public official spoke about the city's recycling program and its shaky beginnings:

> *It's been a very slow start, because there was the $25 fee for the bin, and for people facing extreme poverty like many people are in the City of Detroit, $25 is a bill…. But I just see it as – there's such a huge opportunity for growth when it comes to reduce and recycling in Detroit. And to me that's super exciting, and I know it's a really slow start, but it's – when you're going from zero [recycling collection programs] to something, you know, your universe is wide and huge, and it's only gonna help the recycling rate for the entire region.*

A Minneapolis interviewee voiced that the opt-in curbside organics collection in Minneapolis was a good strategy to start, because it allowed residents who knew most about it to participate first. Not only did this bring up the participation rate initially, but it also reduced contamination since residents knew which items were compostable and which ones were not. The participant also said that it likely would have been more expensive to have an opt-out method rather than an opt-in method. This would have potentially increased contamination and allowed for wasted time and efforts on the city's part to pass out carts to some residents who may not have used them.

Further, two interviewees from Detroit and Minneapolis mentioned that contamination goes hand in hand with education. The more education the residents can get, the lower the potential for contamination in the recycling and/or organics streams. A Detroit interviewee elaborated on their city's recycling pilot program:

> *In 2009, [Detroit] started pilot programs in nine different areas of the city. Those areas have the highest contamination levels, because they didn't receive education. That's how they were able to prove that it's necessary for people to learn how – you can't just give them a cart and [expect residents to] know how to use it.*

Interviewees across all three cities mentioned that efficiency in some cases may lead to inefficiency in others. For example, because the trucks must take as few trips as possible from residences to the MRF, they compact the material as they go about their routes, which can pose a challenge to the material processing. All three cities have single stream recycling, and both Baltimore and Minneapolis used to have a multi-sort system in the past. A public stakeholder in Baltimore spoke about the pros and cons of single stream recycling:

> *One of the reasons of going to single stream is because it is easy. That's better in some ways than dual stream even though dual stream might produce better product. But … people are more likely to participate … We immediately increased our intake by about 40%, so that is why we switched from dual stream to single stream. [However,] now we recover a little bit less in single stream than we did in dual stream.*

A higher participation rate and a more straightforward means of collection were reasons enough for all cities to commit to single stream, though it is not a perfect process.

Contamination also shows in composting. A Minneapolis interviewee describes the necessity for low contamination in the organics stream:

> *[The organics processing facilities] need really clean material … when they bring the material to the facility just like the landfill. Then they process it and then they have to be able to sell that product… That is a critical part of the revenue in being a successful business. And so contaminants are problems throughout that. It's a problem getting them out. It's a problem when you sell your materials, the final product. They really want clean stuff.*

Data Concerns

Six interviewees across the three cities mentioned the issue of skewed, inconsistent, or unavailable waste management data in one way or another. In Detroit and Baltimore, the major issue is the representation of data. Two participants in Detroit both brought up the fact that in the Wayne County data, Detroit lumps MSW that goes into the WTEF with recycling and composting, considering them all to be waste diverted from landfills. While this is technically true, it does not provide an accurate picture of the city's SMM practices and it is confusing in its use of "diversion," because in some cases, diversion means any waste that is diverted entirely from the waste stream, such as through source reduction, recycling, and composting. In Baltimore County, one interviewee mentioned that the County reports a recycling rate of 19%; however, the material recovery rate is only 12%. This again misrepresents the data in a way that is not necessarily wrong, but perhaps misleading and inconsistent.

Interviewees spoke about the importance not only of collecting data, but of doing it in a way that could feed into policy:

> *If you want to show you're doing something, you need to have a baseline, and you need to have a way to be tracking whatever activity it is that you're changing to show that what you're doing is having an impact.*

Another interview participant added, "You can't manage what you don't measure." The process of data collection and framing could have broader future impacts for all three cities' waste management structures, goals, and plans.

Infrastructure

Both Detroit and Baltimore have a problem with residential vacancies, which can be problematic when it comes to waste management strategies. A Baltimore interview participant explains:

> *We [in Baltimore] have a lot of vacants, like... Detroit does. Our vacants are a little different though, our vacant houses, because Detroit's are mostly single-family homes that are vacant. In Baltimore they're mostly detached row houses, and they're made of brick, not wood. So I know at one point even your city manager, mayor, went in and bulldozed all these houses, and like buried them there on site. We had 40 rowhouses attached to a block, so if you had four people living there, spaced out in 40 rowhouses, it poses a lot more expensive to take stuff down. But we do have a requirement now for reuse of a certain percentage of materials when you're taking down buildings.*

The interviewee is referring to construction and demolition, or C&D, waste recycling, which is mentioned below in the Other Waste Management Considerations section.

This vacancy issue raises another point – there is the wrong balance of infrastructure when it comes to waste management. A Detroit public sector interviewee said: "In some places we have more than enough infrastructure to handle more materials we were able to recover, and in other places we don't." This may turn into a positive opportunity for Detroit, that since there is vacant land that is not currently being used, it could serve an SMM purpose. A Minneapolis interview participant suggested an option for Detroit's future vacant land use: "[Detroit does] have a lot of vacant buildings that I think could be retrofitted into some waste management operation or practice, you know, anything, just trying to think outside the box."

This notion of adding infrastructure where available and where needed could tie into the policy aspect of waste management. Two Minneapolis interviewees mentioned that while policy can be a powerful tool for moving forward with SMM practices, it does not mean much without the necessary infrastructure: "No matter what's passed, there needs to be infrastructure to manage it." For example, if there is a goal to increase recycling in a city, there must be enough capacity in nearby MRFs to handle this increase if and/or when it occurs. One interviewee from each city expressed the fact that there is a need for more MRFs and/or composting sites in each of the three cities. Infrastructure and policy can be a chicken-and-egg situation, though, because the question might arise whether to build a facility first or to set a policy first for it to make the greatest difference moving forward.

Upstream & Downstream: Materials

At least four interview participants from all cities mentioned the need for manufacturers to have more responsibility with the products that they produce upstream. This could involve the creation of more compostable products, but if that's the case, it must be ensured that these products are in fact composted, not thrown in the garbage: "It's actually worse for the environment to require the use of a compostable plastic-lined item or a compostable plastic item if it's going to end up in the garbage." This, then, must be linked with policy to ensure that the upstream products are disposed of in the manner that they were meant to be.

Further, MRFs themselves have been adapting where possible to process newer materials that are coming into the waste stream. In fact, the material itself has been changing with the

times. A Minneapolis Recycling Specialist talks about the history of materials processed by MRFs and the struggle to keep up:

> *They're calling it the "evolving ton." You know, when we started 15 years ago, I think we had like, close to 70% newspaper. Now it's more like 40%. Things are moving a lot. So it's like, there's a lot more bottles and cans running through the facility. And now manufacturers are coming out with new packaging all the time. Things like K-cups or Keurig, … in cosmetics there's a lot of smaller bottles. And those are items that are typically, a MRF isn't designed to recover.*
>
> *It's technically feasible to capture some of this material… But then the question comes down to who pays for the upgrades in the recycling facility and technology and how many – can we go from seven or eight sorts to sorting to 15 or 20 different types of streams to capture that?*

The "evolving ton" that the participant mentioned refers to the fact that "companies are becoming increasingly aware of the disconnect between what has traditionally been a form of waste management and what is needed in the way of a regenerative materials supply system," as described by Environmental Leader (Silverstein, 2016).

As for source reduction downstream, there was not much overlap in this category; the only interviewees that mentioned reuse programs were those in Minneapolis (described in the case study section). This realm can be tricky to understand, because there may be a reduction and reuse of materials occurring on a household level in each city, but it is impossible to measure:

> *There's always been that culture of reuse in [Detroit] because when it is economically critical for reuse, it happens. What I don't think happens is I don't think we've ever been able to capture what that is. I think there's a lot of recycling that goes on in residences that we don't ever see. That's hard to measure. You hear anecdotal stories – if you talk to your own grandparents, for example, you understand how incredibly resourceful they could be when their resources are limited. And I think there's a lot of that happening in the city, and I don't think we necessarily know what it all is.*

Environmental

A handful of interviewees referenced the environment as the bigger-picture impact of waste management practices. Seven interviewees across all three cities mentioned some aspect of waste management and its environmental footprint. Air pollution specifically, may be invisible, as one participant noted: "If you don't see those emissions, then you're not going to associate a clear day from the smokestack to be something negative. I think it's a matter of out of sight, out of mind." This air pollution related to waste management practices largely comes from WTEFs, and interviewees spoke about the link between WTEFs and air emissions, including GHGs.

Participants from both Minneapolis and Detroit mentioned that some people are against incineration solely due to its air emissions and pollution. One Baltimore interviewee acknowledged the WTEF in their city as having a negative environmental impact on Baltimore and its residents: "It's quite a polluter to Baltimore, the waste-to-energy [plant]; it's right downtown in the city. We have this smokestack – it's a polluting entity for our city." Another interviewee mentioned that these air emissions from WTEFs could travel five miles or farther, so the neighboring communities are not the only ones that could be negatively affected.

Speaking about landfills specifically, a Detroit public official discussed the broader impact on the land that comes out of that process:

> *What I don't think is captured in those … individual decisions [in the city] is the larger scale picture of what disposal in landfills really means to the environment, to the future of these sites, to the future of our natural resources. There is not yet a good capture for … the ultimate impact these facilities have in the region.*

Even before the waste gets to its destination, the collection process should be streamlined to enable a lower carbon footprint, as one participant points out: "You want your haulers to be as efficient in collection as possible. That should be part of the contract as well. There should be some ways … the hauler can demonstrate that they are reducing the current footprint." If the waste haulers find a way to be the most efficient in their waste and recycling pickup, it could not only prevent the trucks from emitting more carbon into the atmosphere, but it could even have the potential to save money in the long run. This money could, in turn, be allocated to more SMM-based programs.

In terms of composting in Minneapolis, one participant mentioned that this process is unique because it deals with purely organic plant material. Since there are no other materials, this process uses natural cycles as the organics break down. The emissions that might come out of this process, the interviewee argues, are already part of the natural cycle:

> *Essentially, the composting process is considered to be fairly neutral… from the GHG perspective, because this is a plant material that absorbs the carbon dioxide from the atmosphere and releases it in the composting process. It's not considered a GHG emitter because it was there already.*

Finally, a Detroit interviewee pointed out a link between thinking along environmental lines and changing residents' mindset, the framing of the waste management process, and ultimately, habit change:

I think [the city] will benefit as we continue to get more residents involved [in the recycling program] because more people are going to be more mindful of the environment. They're going to be more mindful of the waste that they produce. Right now there's just the pollution issue. People are so used to throwing things on the floor, so what we do – and what we hope to achieve by going into schools – is that we're changing the behavior. One thing we really encourage to our kindergarteners is, "Are you gonna throw this on the floor?" "No." ... It's all about behavior change with anything ... it's changing your mindset that there's a blue bin and a marked bin, that you put [waste] in the appropriate bin. Eventually, it'll be common knowledge – you just know; you don't have to think.

Other Waste Management Considerations

Some interviewees commented on other types of waste that are outside the scope of this project; however, since some were repeated, we included them here as an additional element. The most often referenced type of waste besides MSW was C&D waste. Interviewees in Minneapolis and Baltimore mentioned the need for a better system to recycle and reuse construction waste, which could be the most applicable in Baltimore and Detroit, which have the most home vacancies. A Detroit public official also spoke about household hazardous waste and medical waste, and existing programs to help keep these out of the waterways around the cities. Finally, a Detroit interviewee mentioned the need to properly dispose of scrap tires, which they mentioned are often found in the thousands on empty lots in Detroit.

Discussion & Recommendations

This section will provide a summary of the most germane points from the Interview Findings section and where they fall in the context of the report as a whole. Then, in the Recommendations section, we outline our recommendation list for the City of Detroit based on the major points listed in the Discussion section.

Discussion of Interview Findings

In the political realm, interviewees mentioned that collaboration with other departments and organizations is beneficial and often necessary in waste management. However, collaboration is not always straightforward and may be complicated. For example, responsibility for certain duties may fall disproportionately on one party. Planning and policy decisions or processes can also support waste management strategies, but success can only be achieved through proper infrastructure and follow-through from different governmental units. Moreover, local leaders' forward-thinking actions and decisions can be the difference between a decades-long successful SMM method and long-standing EJ concerns. Despite local interest in statewide material bans, such as plastic bag bans or bottle bills, lobbying interests in the state legislature can deter any achievements to move towards an SMM or zero waste framework.

Socially, education, marketing, and community engagement strategies are the cornerstone for a successful waste management system because little progress can be made unless residents themselves understand the services available to them. It is crucial to recognize EJ issues that arise in a city; barriers to access may prevent certain populations from fully taking advantage of a city's offered services. Awareness of institutional or geographic injustice is key to moving forward in a just, sustainable manner. Above all, the way to switch from a waste management framework to an SMM system is a mindset and habitual change, which requires a fundamental reframing of the concept of waste and disposal.

Economically, funding is often a major obstacle when creating, expanding, or restructuring a city's material recovery systems. A city's limited waste management budget may hinder further growth and investment in programs that could have benefitted residents. Existing policies, laws, and market prices may serve as a disincentive for residents to recycle or otherwise divert waste from WTEFs and landfills. Further, interviewees mentioned that the promise of job creation in recycling, composting, and zero waste initiatives should be further publicized and recognized, especially for those communities closest to WTEFs.

Procedurally, even if plans and funding structures are in place, if collection logistics are not made efficient and straightforward, it could mean a misuse of state budget. It is imperative to consistently collect waste data in an ongoing and comprehensive manner to understand what is being disposed in a city, where it comes from, and where it goes, which could feed into policy and goal creation. Perhaps even more importantly, the data must be framed in a way that does not invite misinterpretation, and it should be made readily available to the public. Further, there must be careful balance of the right amount of infrastructure for the city's material to be properly

processed – which can be much easier said than done. Policies must feed into this infrastructure balance, and vice versa. Additionally, interviewees highlighted the importance of recognizing the entire life cycle of a material and keeping sustainability in mind, from its design to its disposal, in the process, preventing contamination in MRFs and composting sites.

Finally, it is necessary to understand the environmental ramifications of each aspect of the waste management process and the system as a whole. Both WTEFs and landfills pollute the air, and these emissions can have negative health effects on the city's neighborhoods. Residents should be assured that these facilities are operating within clean air standards and are appropriately penalized for violating environmental regulations.

Recommendations

Based on the interview themes, policy review, Sankey flow diagrams, and demographic spatial analysis, we have structured eight recommendations, as shown in **Table 14**, for Detroit to consider as their SMM system continues to evolve. Ultimately, these recommendations are working towards the overall goal of waste reduction, diverting waste from both landfills and WTEFs, and changing the language around waste management to portray it as SMM. Note that since SMM is an inherently integrative process, many of the recommendations may fit in more than one theme or overlap slightly with others.

Table 14: *Eight Recommendations for Detroit to Consider for SMM Moving Forward*

#	Recommendation	Theme
1	Collect waste stream data in a continuous, consistent, and publicly available manner.	**Procedural/ technical**
2	Advance efforts to engage the community in SMM practices.	**Social**
3	Change the framing of waste management and instead refer to the process as materials management.	**Social**
4	Encourage the State of Michigan to enact or initiate more legislation that furthers SMM.	**Political**
5	Strengthen monitoring and enforcement to hold MSW facilities more accountable and reduce air emissions violations.	**Environmental & Political**
6	Make Detroit's Office of Sustainability a hub for SMM initiatives and collaboration.	**Procedural/ technical & Political**
7	Conduct a pilot feasibility study to determine if the city can adopt differentiated pricing for city-owned and commercial buildings.	**Economic**
8	Incorporate SMM strategies in long-term planning efforts (i.e. develop an SMM roadmap).	**Political**

Recommendation #1

Collect waste stream data in a continuous, consistent, and publicly available manner.

The City of Minneapolis has been collecting data waste disposal volume data since 1990, and as a result, they have a better idea of how much waste they are generating, where it is disposed, and the type of waste that is thrown away. This is a positive practice for two reasons: Minneapolis residents can access this data, understand how their household contributes, and perhaps have a better idea of what they can do to reduce their waste if they are interested. This first element allows for better transparency with the public. Second, with this extensive data collection, Minneapolis can base their waste reduction goals on real numbers, also citing the capacity of local or regional MRFs, the WTEF, and nearby landfills. As an interviewee in Baltimore mentioned, "You can't manage what you don't measure," which is especially true in the case of waste management. Therefore, Detroit should consistently collect waste characterization data to have better transparency and to better understand the distribution of waste throughout facilities.

Wayne County is already collecting volume data, but the information does not appear to be readily available to the public, or at least not in an easily accessible format. Further, the State of Michigan, along with three private partnerships, conducted a Waste Characterization Report for 2016 (West Michigan Sustainable Business Forum, 2016) that illustrated in detail the type of waste that was being disposed in the state and where it is going. These are both positive practices that should continue for Detroit, but can be streamlined to provide further transparency. Detroit should then continue to partner with Wayne County and the State of Michigan not only to keep collecting volume data, but to also collect waste characterization data and ultimately create a website hub where residents can access it if they choose. With this information, the city will be better able to create policies and goals based on real numbers.

Recommendation #2

Advance efforts to engage the community in sustainable materials management practices.

Detroit is currently collaborating with nonprofit and community organizations including Green Living Science and Zero Waste Detroit to propel community involvement. Based on interviewees' comments, these are heading in a positive direction and should be continued. Our review of policy and planning documents indicates that Minneapolis and Baltimore pay close attention to community participation and education. The State of Maryland lists education and outreach as one of the objectives in its Zero Waste Plan (MDE, 2014). In addition, enhanced education is one of the solid waste management goals in Baltimore's Ten-Year Solid Waste Management Plan (City of Baltimore, 2015). Minneapolis utilized outreach in multiple different language to reach non-English speakers; in Baltimore, litter campaigns, community gardens, and neighborhood competitions were employed to engage the community. Baltimore's "Volunteer Recycling Block Captains" program was successful to spread recycling awareness and educate residents. Our recommendation is to recognize the importance of neighborhood outreach to further SMM and for Detroit to continue these efforts. This will ensure not only that the recycling participation rate increases in the city, but also that the residents feel they are included in SMM programs.

Recommendation #3

Change the framing of waste management and instead refer to the process as materials management.

The City of Detroit should reframe the process of waste management as materials management, changing the mindset from dealing with waste to using and reusing materials in a more productive way. Several interview participants mentioned the need for this SMM-focused reframing. The use of the terminology "material" insinuates that the disposed material has value, rather than throwing waste "out" or "away." Although this language change seems like a slight mindset shift, in the long term, it can lead to behavior change with regards to increasing

recycling participation and knowledge around how to recycle. Recently, the U.S. EPA has emphasized the need to move towards SMM. The agency incorporates a material life cycle perspective and formally promotes an SMM framework. Detroit and the State of Michigan could respond to this movement and use the terminology of "material," rather than waste, throughout the future solid waste plans and legislation. This could potentially lead to positive marketing of materials management, highlighting the economic opportunities generated from materials that could be reclaimed or reused. It is also likely to incentivize businesses to transition to an SMM system.

Recommendation #4

Encourage the State of Michigan legislature to enact or initiate more legislation that furthers SMM.

The City of Detroit should pass a resolution that calls on the State of Michigan to develop a waste management hierarchy. Having a waste management hierarchy at the state level is important for cities to move forward with waste diversion or reduction goals, as evidenced in Minneapolis. What seems to make Minneapolis a leader in our case study sites is the strength of their state legislature in promoting SMM. While the State of Maryland has identified a materials management hierarchy in their state zero waste plan, there seems to have been little follow up on their waste diversion targets under the current governor's administration. However, interview participants mentioned that Baltimore is trying to meet the state's recycling goals. Alternatively, the State of Minnesota's waste management hierarchy was established by the legislature through the Waste Management Act of 1980. As a result, Minneapolis refers to the hierarchy when implementing more sustainable practices, such as the environmentally preferable purchasing ordinance and curbside organics collection program. It should still be noted that even though this hierarchy is a helpful tool, the inclusion of WTE incineration within the hierarchy continues to present concerns for EJ and zero waste advocates in the Twin Cities Metropolitan area. Such concerns are noted in the Metropolitan Solid Waste Management Policy Plan, as well as in our interview findings and spatial analysis of the demographic characteristics around the HERC plant.

Instituting legislation to develop a waste management hierarchy can be challenging, yet this challenge can be minimized through stronger data collection efforts on materials management. Again, we refer to Minneapolis for their strong adherence to the state's hierarchy, which was possible due to their waste characterization reports and state requirements for data collection and reporting. However, before Detroit can collect similar data on their waste stream, it would befit one of Michigan's largest and most populated cities to pass a resolution that puts the onus on the state legislature to develop a waste management hierarchy to guide jurisdictions throughout the state. In recent years, Governor Snyder put together the Solid Waste and Sustainability Advisory Panel to develop recommendations for amending Part 115. Their report contains information that can potentially assist stakeholders in Detroit with developing a resolution to call attention to the state on waste management issues (MDEQ, 2017).

In addition to pushing for Michigan legislature to consider adopting a waste management hierarchy, the City of Detroit could pass another resolution to call on the state to develop regulatory incentives for businesses to follow EPR policies. Within the U.S. EPA's waste management hierarchy, and even among Minnesota and Maryland's waste management hierarchies, source reduction is listed as the highest preferred strategy to reduce environmental impacts from waste management systems. Detroit can stand out among other municipalities in Michigan by passing a resolution that supports state efforts to provide incentives for manufacturers to be more responsible for designing products to be more sustainable towards the final life cycle stage.

Recommendation #5

Strengthen monitoring and enforcement to hold MSW facilities more accountable and reduce air emissions violations.

Given the persistent emissions violations over the past few years, the City of Detroit should develop policies that will assist with more thorough tracking of emissions from MSW facilities like DRP. One Baltimore interview participant described how their organization attempted to work with city staff to pass a clean air ordinance in Baltimore so that the city can receive continuous emissions updates from the Wheelabrator facility in real time. This policy tool could not only allow for further regulation of air pollutants from WTEFs and other facilities, but it could also address the issue of accountability that several interviewees mentioned regarding waste management and pollution.

A clean air ordinance would result in a win-win situation for Detroit residents as well as the DRP plant for several reasons. Many Detroit residents who live near the DRP plant have had an unfavorable view towards the WTEF, even though its emissions are below the maximum emissions allowed by the U.S. EPA. Moreover, findings from our spatial analysis suggest that the demographics of neighborhoods around the facility prior to its construction were mainly comprised of people of color and poorer households, which fuels EJ claims of racial and socioeconomic disparities within DRP's siting. Nonetheless, several residents, including some of those we interviewed, feel that the facility is not taking proper responsibility to address odor complaints and emissions violations from their operations. A clean air ordinance would require that DRP be more transparent in their practices, while also providing residents, EJ advocates, and other stakeholders in the city with sufficient data to be able to hold the facility accountable if emissions violations continue in the future.

Ultimately, while Detroit has its WTEF in place to handle waste reduction, the city is using very few strategies outlined in the U.S. EPA waste hierarchy that have the least environmental impact. Much of the waste that goes to DRP comes from outside of Detroit, as evidenced in our Sankey diagram for Detroit's waste stream. While an analysis of clean air ordinances was outside of the scope of this study, an interviewee did mention that the City of Allentown, Pennsylvania was able to adopt such an ordinance. Their policy sets more stringent monitoring emissions standards and civil and criminal penalties for facilities that violate clean air

laws to address concerns around WTE incineration (City of Allentown, 2013). Detroit city officials could champion this ordinance through meetings with residents, city agencies, GDRRA, and DRP and discuss viable solutions to addressing long-standing EJ concerns around the city's WTEF.

Recommendation #6

Make Detroit's Office of Sustainability a hub for sustainable materials management processes and collaboration

Some interviewees highlighted the time and procedural difficulties of working across multiple sectors, spotlighting the public sector. For example, one interview participant explained that moving SMM projects and plans forward took several months longer than expected. They also explained that it is difficult to know whom to contact in some cases when it comes to certain waste management issues; it may be necessary to reach out to more than one person before it is clear who the contact point is. All three cities deal with this time lag and inefficiency because all three collaborate along sector lines when it comes to waste management processes, so this issue is not unique to Detroit. However, to help create a more streamlined process and allow for more efficiency and better use of employees' time, Detroit's new Office of Sustainability can serve as the key player in SMM. As the city continues to plan the structure of this new department, it should keep this procedural element in mind; if city employees and collaborators from other sectors have better means of collaborating with one another, there may be a higher level of efficiency, which will ultimately be a time and money saver.

Further, several interviewees discussed the rift between residential and commercial waste and recycling collection. Oftentimes, these are kept separate, but there should be more effort in representing both when it comes to data collection and future SMM projects. Along those lines, Detroit's new Office of Sustainability, if it does not already, should have a stated mission that aligns not only with the city's trajectory for SMM, but also that of the nonprofits, community organizations, some private companies, and Wayne County, since all will be working together to the same goal. This mission statement will ensure that all stakeholders have a transparent understanding of how their work fits into the bigger picture, moving forward with SMM.

Finally, private companies such as the MGM Grand casino and the GM plant in Detroit have been working towards composting and diverting waste from landfills. These companies, as well as others in the city, are beginning to incorporate these waste reduction and SMM tactics into their mission. The city's Office of Sustainability can collaborate with, and continue to network with, these companies to further progress in SMM in the community.

Recommendation #7

Conduct a pilot feasibility study to determine if the city can adopt differentiated pricing for city-owned and commercial buildings.

A two-phase study in the Coleman Young building can be conducted as first step of moving forward to a funding structure that favors SMM. Perhaps this study could involve partnerships with local students or universities to help shoulder the cost. The Zero Waste Subcommittee has planned to do a waste characterization study of the building. Then a following pilot feasibility study to determine if municipal and commercial buildings can adopt differentiated price structures which charge based on waste and recycling container size – differentiated pricing of waste bins is a strategy Minneapolis also uses in residential waste collection. Detroit can partner with private haulers, academic institutions, and nonprofit institutions to study if there are any revenues generated from this structure. If the research shows that the system works, then this case can be a leading example to expand the differentiated pricing structure to the whole city. By charging more for larger containers and less, revenue gained by using smaller bins can fund continued recycling efforts in the city. It is likely that Detroit could pay less for collection by diverting more waste to recycling. The system also creates potential incentives for other city-owned and commercial buildings to adopt a similar approach. In addition, data from the pilot study can be employed by the city when applying to grants for further research and future expansion efforts. In this way, the City of Detroit could be a leader among cities in Michigan and call on the state to develop a tiered funding system.

Recommendation #8

Incorporate SMM strategies in long-term planning efforts (i.e. develop an SMM roadmap).

Although Detroit has been coordinating with Wayne County and MDEQ to increase recycling, there is potential for further collaboration on strategic, long-term planning efforts to integrate SMM practices into the city's waste management system. SMM efforts in Minneapolis stand out among each of the cities in our report due to their emphasis on implementing programs and policies in a phased approach. For example, the requirement for "plastic-lined paper items to be a certified compostable plastic-lined paper item" (Minneapolis interview participant) in the Environmentally Preferable Purchasing Ordinance was delayed until the city's organics collection program was widely available so that individuals and households would already have a designated place to discard these items. Moreover, the level of cohesion between the state-administered Metropolitan Solid Waste Management Policy Plan 2016-2036 and the Hennepin County Solid Waste Management Plan demonstrates how developing a roadmap for incorporating SMM practices can be beneficial to future SMM planning.

These Minneapolis examples emphasize the need for Detroit to mold policymaking around SMM issues with existing policies and current and future infrastructural capabilities. Such long-term planning efforts to develop an SMM roadmap may begin with a collaborative

inventory assessment between Detroit and Wayne County on waste compositions within facilities located in and around Detroit. In the meantime, the city may also consider hosting zero waste events in populated venues so long as these events align with education campaign timelines set by the Zero Waste Subcommittee and local nonprofits such as Green Living Science and Zero Waste Detroit. To determine the effectiveness of this approach, the city and nonprofits can weigh the materials diverted from landfills and WTEFs and gauge interest in recycling participation by having sign-ups for recycling education workshops. Information collected in this manner would assist with providing data that could then inform the SMM roadmap and guide future planning for MSWM.

Planning to implement SMM practices over a long timeline also requires support from local and state champions. While Councilman Scott Benson has taken on the role of promoting increased recycling within the city, others are needed in various departments to ensure that efforts to promote SMM practices will remain in place through multiple administrations. In Baltimore, the loss of support from a City Councilman slowed down progress on the passage of a clean air ordinance. Since our Detroit interview participants reported that many policy efforts are top-down driven in the city, we believe that it is important for different stakeholders involved in waste management to continue to approach possible candidates in the city who may be willing to champion certain SMM causes. These efforts could be incorporated into long-term planning processes by convening different stakeholders on a sustainability panel in a setting that is accessible to the public, perhaps affiliated with the new Office of Sustainability.

Study Limitations

Due to the timing, resources, and the number of researchers, the scope of this project was carefully defined. The focus was solely on MSW, so we did not delve deeper into C&D waste, for example, which is especially prevalent in Detroit and Baltimore and mentioned specifically by some of the interviewees. Next, while each additional interviewee gave us another valuable perspective on waste management and SMM in each city, we were limited by time and were unable to speak with more. Further, attempts to reach the following key Detroit stakeholders: the DRP WTEF, city representatives, Detroit's DPW, and GDRRA, were unsuccessful. As a result, their perspectives or commentary are not included in this report.

Data collection was complicated, as it often required speaking to multiple different stakeholders in the three cities to be able to locate the data we hoped to present in the report. The data we were able to find ended up being in inconsistent formats across the three cities, with some data going into further detail than others, for example. Since we were relying on outside parties' data collection processes and methods, we had to work with what data was available. For our spatial analysis, the unavailability of shapefiles for some cities in the 1980 and 1990 Census made it difficult to establish claims for post-siting demographic changes around the WTEFs since we could not follow the demographic changes in communities within the three-kilometer buffers throughout each decade.

Next, the number of interviewees in Baltimore was lower because we were limited geographically; we could not visit them in person to form deeper connections as we were able to do in both Detroit and Minneapolis – we made regular visits to Detroit over the course of the project, and we attended a Zero Waste conference in Minneapolis in October and networked with numerous stakeholders. Ideally, we would also have visited Baltimore and spoken directly with stakeholders while we were there, but the timing was too tight to do so.

Finally, since this report focused on three specific case studies, our findings may not be generalizable to other cities. While they are most relevant to post-industrial Rust Belt cities, which may be able to glean some SMM suggestions, the final comments listed in this paper were molded to the context of Detroit.

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Appendices

Appendix A: City Selection Process (narrowed down to 24 from 81)

% Black and % Nonwhite columns (A-B) are ranked as the top highest percentages (1-12 each); Percentages closer to zero (- or +) in the Density column (C) are more closely related to Detroit. 4819.46

Criteria to Consider											Demographics			
% Black	% Nonwhite	% Density from Detroit	Privatized	State	City	Population	Square miles	Density (pop/mi2)	Privatized WM?	Recycling program	% Black	% White	% Other	% Nonwhite
		-49.46%	Private/Public	IA	Ames	58,965	24.27	2,435.60	Private/Public	Yes	3.4	82.5	14.1	17.5
3	4	59.18%		MD	Baltimore	622,793	92.1	7,671.50	Public	Curbside & drop off c	63.7	28	8.3	72
		42.97%	Private/Public	Mass	Boston	617,594	89.63	6,890.48	Private/Public	Residential & comme	24.4	53.9	21.7	46.1
		-53.18%		CT	Bristol	60,477	26.8	2,256.60		Curbside Recycling	3.8	83	13.2	17
2	2	17.48%	Privatized	PA	Chester	33,972	6	5,662.00	Private	Residential, commerc	74.7	15.1	10.2	84.9
5	10	-22.54%		OH	Cincinnatti	296,943	79.54	3,733.25	Public	Yes, for 20+ years	44.8	49.3	5.9	50.7
1	1	0.00%	Privatized	MI	Detroit	**688,701**	**142.9**	**4,819.46**	Private	Curbside residential	82.7	7.8	9.5	92.2
8	12	-11.03%		FL	Ft. Lauderdale	165,521	38.6	4,288.11	Public	single-stream curbsid	31	52.5	16.5	47.5
		-11.86%		MI	Grand Rapids	192,294	45.27	4,247.71	Public	Curbside single strea	20.9	59	20.1	41
4	3	-10.39%	Private/Public	PA	Harrisburg	49,188	11.39	4,318.53	Private/Public (?)	Since 1988, by law	52.4	24.8	22.8	75.2
		-41.34%		VA	Harrisonburg	48,914	17.4	2,827.00	Public	Single Stream	6.4	72.4	21.2	27.6
11		-52.84%	Privatized	IN	Indianapolis	848,788	372	2,273.00	Private	Curbside residential r	27.5	58.6	13.9	41.4
		-31.88%		UT	Layton	67,311	22.2	3,283.00		No	1.7	82	16.3	18
6	9	28.20%	Private/Public	WI	Milwaukee	598,078	96.8	6,178.49	Private/Public	Yes, curbside	39.3	47	13.7	53
		42.14%		MN	Minneapolis	400,070	58.4	6,850.51	Public	Yes! And compost (as	17.9	66.4	15.7	33.6
		-38.01%		NY	Niagara Falls	50,193	16.8	2,987.68	Public	Recycling Collection	21.6	69.1	9.3	30.9
	5	7.68%		NY	Peekskill	23,583	5.5	5,189.70	Public	Part of City's Sanitati	23.6	35.8	40.6	64.2
9	11	-18.44%	Private/Public	FL	Pompano Beach	99,845	25.4	3,930.91	Private/Public	Single-family, multi-fa	28.9	50.6	20.5	49.4
		-35.53%		ME	Portland	66,194	69.44	3,107.20	Public	Recycling and Compo	7.1	83.6	9.3	16.4
7	7	33.19%		NY	Poughkeepsie	32,736	5.7	6,418.80	Public	Recycling and Compo	33.5	43.5	23	56.5
		-27.15%		WA	Spokane	210,721	60.02	3,510.85	Public (WM)	Yes, curbside	2.3	84	13.7	16
		-17.69%	Privatized	FL	St. Petersburg	253,693	137.6	3,967.00	Private	Residential, multi-fam	23.9	64.3	11.8	35.7
12	8	-38.38%	Privatized	FL	Tampa	347,645	170.6	2,969.60	Private	Curbside residential	26.2	46.3	27.5	53.7
10	6	72.75%	Private/Public	PA	York	43,718	5.251	8,325.65	Private/Public	Curbside & dropoff ce	28	41	31	59

Appendix B: Detroit Private Company Interview Guide

EMEAC_P08: Interview Protocol
Interview Guide

INTERVIEWER:
Thank you for taking the time to participate in this interview. Before I describe the purpose of this interview, let me tell you a little more about our team. We are Master's students in the School of Natural Resources and Environment at the University of Michigan. The purpose of this interview is to learn more about how the City of Detroit was able to develop and implement their current waste management practices. Through this interview, we hope to gain a more comprehensive understanding of how the city is approaching waste management to create a set of recommendations for the City of Detroit in the future.

The interview should take about an hour to an hour and a half of your time. We have received IRB exemption from the University of Michigan, which is why we will verbally ask for your participation in this interview. All information that you share with us in this interview will be kept confidential, however we cannot guarantee your anonymity when this research is published. Do you still wish to participate in this interview? Are you willing to be recorded for this interview?

Section 1: Background Information

1. Could you tell me about your position at [BUSINESS]?
    a. How long have you worked in this position?
    b. How long has your business worked with the City of Detroit?

INTERVIEWER:
Great, thank you. These next set of questions will focus on the overall waste management structure of your city.

Section 2: Waste management hierarchy structure

2. Can you tell me some more about how waste management works in the City of Detroit?
    a. What are the current waste management strategies being used in the city?
        i. Does the city have a preferred hierarchy of waste management strategies (i.e. landfill, waste-to-energy, recycling, composting)?
            1. Does your business coordinate with any public departments or non-profits on waste management?
        ii. *Would you say there are any innovative strategies in waste management in Detroit?*
            1. What innovative waste management strategies does your business engage in?
            2. Who initiated these policies and programs?
            3. Are there any additional costs associated with these programs or policies?

4. Do you know of any source reduction strategies being used in the city?

Section 3: Factors influencing adoption and implementation of recycling or "zero waste" programs and policies

CITIES WITHOUT WASTE DIVERSION GOAL (Detroit and Baltimore)

INTERVIEWER:
Were you working at your current position when the city initiated its recycling program?

3. ***IF YES:*** Now I'd like you to think back to when the city initiated its recycling program. How would you describe the events leading up to the implementation of this program?
    a. From your perspective, what factors influenced the implementation of this recycling program?
    b. Did your business play a role in setting up this program?
        i. ***IF YES:*** Were there any groups that supported your stance on this program?
            1. Did any groups oppose your stance?
    c. Did your business have a goal associated with the expansion of the recycling program? (waste diversion goal, zero waste, etc.).
        i. ***IF YES:*** How has your business adapted to meeting any goals related to this program?
            1. What policies or additional programs support this recycling program?
            2. **Have you encountered any challenges with meeting these goals?**
                a. What are some challenges that your business often encounters nowadays?
        ii. Do you see any opportunities for your business to help others in the area who are working on waste reduction or prevention?

Section 4 (present): Key elements of a successful or unsuccessful zero waste program or policy

INTERVIEWER:
This is great. It seems like there are various factors that affect the adoption or implementation of these policies or programs.

4. Can you describe some specific elements that either "make or break" a particular waste management policy or program?
    a. In your opinion, which policy or program has been the most effective in promoting innovative waste management strategies the City of Detroit?
        i. Who or what made this policy or program successful?

b. Is there a certain innovative waste management strategy that can be improved?
    i. How can this policy or program be improved?

Section 5: Recommendations for future zero waste and recycling programs or policies

5. Are there any particular waste management policies or programs that you feel should be implemented at the local, state, or federal level?
    a. **IF YES**:
        i. What would this policy or program look like?
            1. *Probe:* What might be some of the benefits of this policy or program for the City of Detroit?
        ii. Can you think of any barriers that would prevent the adoption and/or implementation of this policy or program?
        iii. Does the city plan on implementing a similar type of program or policy?

Final thoughts

INTERVIEWER:
Alright, well we're nearing the end of our interview, but before we finish, I wanted to ask **if I left anything out** or didn't talk about something that you feel is important for assessing the factors that influence decision-making on waste management programs and policies?

Data Questions:

1. Is there a one-stop-shop source where we can find out more information about the city's waste management strategies?
2. We are also collecting data on sources of waste generation (location) and waste composition (type) in the city's waste stream, do you know where we might be able to acquire some data for this?
3. **Contacts**: Who else do you recommend we interview in waste management in Detroit?

Appendix C: Baltimore Public City/County Staff Interview Guide

EMEAC_P08: Interview Protocol
Interview Guide

INTERVIEWER:
Thank you for taking the time to participate in this interview. Before I describe the purpose of this interview, let me tell you a little more about our team. We are Master's students in the School of Natural Resources and Environment at the University of Michigan. The purpose of this interview is to learn more about how your municipality was able to develop and implement your current waste management strategies. Through this interview, we hope to gain a more comprehensive understanding of how your municipality is approaching waste management to create a set of recommendations for the City of Detroit in the future.

The interview should take about an hour to an hour and a half of your time. We have received IRB exemption from the University of Michigan, which is why we are verbally asking for your participation in this interview. All information that you share with us in this interview will be kept confidential, however we cannot guarantee your anonymity when this research is published. Do you still wish to participate in this interview? Are you willing to be recorded for this interview?

Section 1: Background Information

1. Could you tell me about your position in [CITY/COUNTY DEPARTMENT]?
    a. How long have you worked in this position?
    b. Have you worked in a similar position before?

INTERVIEWER:
Great, thank you. These next set of questions will focus on the overall waste management structure of your city.

Section 2: Waste management hierarchy structure

2. Can you tell me some more about how waste management works in Baltimore?
    a. What are the current waste management strategies being used in the city?
        i. Does the city have a preferred hierarchy of waste management strategies (i.e. landfill, waste-to-energy, recycling, composting)?
            1. Does your department coordinate with any other public departments or non-profits on waste management?
            2. Can you talk a little bit about the community around the waste-to-energy facility?
                a. Does the community have any issues with the waste-to-energy facility?
        ii. Would you say there are any innovative strategies in waste management in Baltimore?

1. What innovative waste management strategies does your department engage in?
2. Who initiated these policies and programs?
3. Are there any additional costs associated with these programs or policies?
4. Do you know of any source reduction strategies being used in the city?

Section 3: Factors influencing adoption and implementation of recycling or "zero waste" programs and policies

CITIES WITHOUT WASTE DIVERSION GOAL (Detroit and Baltimore)

INTERVIEWER:
I saw online that your city has a has a recycling program. Were you working at your current position when the city initiated this program?

3. ***IF YES:*** Now I'd like you to think back to when the city initiated its recycling program. How would you describe the events leading up to the implementation of this program?
    a. From your perspective, what factors influenced the implementation of this recycling program?
    b. What role did your organization play in setting up this program?
    c. Did the city encounter any challenges (economic, legal, political, cultural, or environmental) when implementing this recycling program?
        i. Who was pushing for the program?
        ii. Who was opposing the program?
            1. Why did these groups oppose the program?
                a. Did the city try to get these groups to change their opinion?
                    i. **IF YES**: What did the city tell them?
4. *Does the city have a set of goals or objectives related to the program?*
    a. How has the city adapted to meeting any goals related to this program?
    b. What policies or additional programs support this recycling program?
    c. What are some **challenges** that your organization often encounters nowadays?
    d. Do you see any opportunities for the city to help others in the area who are working on waste reduction or prevention?
    e. In retrospect, how has the city benefitted from the decision to implement this program?

Section 4 (present): Key elements of a successful or unsuccessful zero waste program or policy

INTERVIEWER:
This is great. It seems like there are various factors that affect the adoption or implementation of these policies or programs.

5. Can you describe some specific elements that either **"make or break"** a particular waste management policy or program?
    a. In your opinion, which policy or program has been the most effective in promoting innovative waste management strategies in Baltimore?
        i. Who or what made this policy or program successful?
    b. Is there a certain innovative waste management strategy that can be improved?
        i. How can this policy or program be improved?

Section 5: Recommendations for future zero waste and recycling programs or policies

6. Are there any particular waste management policies or programs that you feel should be implemented at the **local, state, or federal level**?
    a. **IF YES**:
        i. What would this policy or program look like?
            1. *Probe:* What might be some of the benefits of this policy or program for Baltimore?
        ii. Can you think of any **barriers** that would prevent the adoption and/or implementation of this policy or program?
        iii. Does the city plan on implementing a similar type of program or policy?

Final thoughts

INTERVIEWER:
Alright, well we're nearing the end of our interview, but before we finish, I wanted to ask **if I left anything out** or didn't talk about something that you feel is important for assessing the factors that influence decision-making on waste management programs and policies?

<u>Data Questions:</u>

1. Is there a **one-stop-shop** source where we can find out more information about the city's waste management strategies?
2. *We are also collecting **data** on sources of waste generation (location) and waste composition (type) in the city's waste stream, do you know where we might be able to acquire some data for this?*
3. **Contacts**: Who else do you recommend that we interview in Baltimore?

Appendix D: Baltimore Nonprofit Interview Guide

EMEAC_P08: Interview Protocol
Interview Guide

INTERVIEWER:
Thank you for taking the time to participate in this interview. Before I describe the purpose of this interview, let me tell you a little more about our team. We are Master's students in the School of Natural Resources and Environment at the University of Michigan. The purpose of this interview is to learn more about how your municipality was able to develop and implement your current waste management strategies. Through this interview, we hope to gain a more comprehensive understanding of how your municipality is approaching waste management to create a set of recommendations for the City of Detroit in the future.

The interview should take about an hour to an hour and a half of your time. We have received IRB exemption from the University of Michigan, which is why we are verbally asking for your participation in this interview. All information that you share with us in this interview will be kept confidential, however we cannot guarantee your anonymity when this research is published. Do you still wish to participate in this interview? Are you willing to be recorded for this interview?

Section 1: Background Information

1. Can you tell me about your position at [ORGANIZATION]?
    a. How long have you worked in this position?
    b. Have you worked in a similar position before?

INTERVIEWER:
Great, thank you. These next set of questions will focus on the overall waste management structure of your city.

Section 2: Waste management hierarchy structure

2. Can you tell me some more about how waste management works in Baltimore?
    a. What are the current waste management strategies being used in the city?
        i. Does *your organization* have a preferred hierarchy of waste management strategies (i.e. landfill, waste-to-energy, recycling, composting)?
            1. *What do you see as the alternative to using a WTE facility?*
            2. *Can you talk a little bit about the community around the waste-to-energy facility?*
                a. *Does the community have any issues with the waste-to-energy facility?*
                b. *Did the community around the incinerator change before and after the facility was built?*
        ii. Would you say there are any innovative strategies in waste management in Baltimore?

1. What innovative waste management strategies does your department engage in?
2. Who initiated these policies and programs?
3. Are there any additional costs associated with these programs or policies?
4. Do you know of any source reduction strategies being used in the city?

Section 3: Factors influencing adoption and implementation of recycling or "zero waste" programs and policies

CITIES WITHOUT WASTE DIVERSION GOAL (Detroit and Baltimore)

INTERVIEWER:
I saw online that your city has a has a recycling program. Were you working at your current position when the city initiated this program?

3. ***IF YES:*** Now I'd like you to think back to when the city initiated its recycling program. How would you describe the events leading up to the implementation of this program?
    a. From your perspective, what factors influenced the implementation of this recycling program?
    b. What role did your organization play in setting up this program?
    c. Did the city encounter any challenges (economic, legal, political, cultural, or environmental) when implementing this recycling program?
        i. Who was pushing for the program?
        ii. Who was opposing the program?
            1. Why did these groups oppose the program?
                a. Did the city try to get these groups to change their opinion?
                    i. **IF YES**: What did the city tell them?
        iii. How did the community around the incinerator react to this goal?
    d. What are some **challenges** that your organization often encounters nowadays with meeting the goals of this program?
    e. In retrospect, how has the city benefitted from the decision to implement this program?
        i. Do you think that community relations regarding the incinerator have changed at all since the implementation of the recycling program?
            1. Could you talk about the broader history of the community opinions on the incinerator? Have they changed throughout the years in Baltimore?
    f. Could you talk about past successes your organization has had regarding waste management in Baltimore?

Section 4 (present): Key elements of a successful or unsuccessful zero waste program or policy

INTERVIEWER:
This is great. It seems like there are various factors that affect the adoption or implementation of these policies or programs.

4. Can you describe some specific elements that either **"make or break"** a particular waste management policy or program?
    a. In your opinion, which policy or program has been the most effective in promoting innovative waste management strategies in Baltimore?
        i. Who or what made this policy or program successful?
    b. Is there a certain innovative waste management strategy that can be improved?
        i. How can this policy or program be improved?

Section 5: Recommendations for future zero waste and recycling programs or policies

5. Are there any particular waste management policies or programs that you feel should be implemented at the **local, state, or federal level**?
    a. **IF YES**:
        i. What would this policy or program look like?
            1. *Probe:* What might be some of the benefits of this policy or program for Baltimore?
        ii. Can you think of any **barriers** that would prevent the adoption and/or implementation of this policy or program?
        iii. Does the city plan on implementing a similar type of program or policy?
    b. Are there specific policies you can think of that would tie further into the community aspect of and waste management?

Final thoughts

INTERVIEWER:
Alright, well we're nearing the end of our interview, but before we finish, I wanted to ask **if I left anything out** or didn't talk about something that you feel is important for assessing the factors that influence decision-making on waste management programs and policies?

Data Questions:

1. Contacts: Who else should we interview in Baltimore?

Appendix E: Minneapolis Public, Community, or Nonprofit Interview Guide

EMEAC_P08: Interview Protocol
Interview Guide

INTERVIEWER:
Thank you for taking the time to participate in this interview. Before I describe the purpose of this interview, let me tell you a little more about our team. We are Master's students in the School of Natural Resources and Environment at the University of Michigan. The purpose of this interview is to learn more about how your municipality was able to develop and implement your current waste management strategies. Through this interview, we hope to gain a more comprehensive understanding of how your municipality is approaching waste management to create a set of recommendations for the City of Detroit in the future.

The interview should take about an hour to an hour and a half of your time. We have received IRB exemption from the University of Michigan, which is why we are verbally asking for your participation in this interview. All information that you share with us in this interview will be kept confidential, however we cannot guarantee your anonymity when this research is published. Do you still wish to participate in this interview? Are you willing to be recorded for this interview?

Section 1: Background Information

1. Could you tell me about your position at [CITY DEPARTMENT/ORGANIZATION]?
    a. How long have you worked in this position?
    b. Have you worked in a similar position before?

INTERVIEWER:
Great, thank you. These next set of questions will focus on the overall waste management structure of your city.

Section 2: Waste management hierarchy structure

2. Can you tell me some more about how waste management works in the City of Minneapolis?
    a. What are the current waste management strategies being used in the city?
        i. Does your organization have a preferred hierarchy of waste management strategies (i.e. landfill, waste-to-energy, recycling, composting)?
            1. *What do you see as the alternative to using a WTEF?*
            2. Can you talk a little bit about the community around the WTEF?
                a. Does the community have any issues with the WTEF?
            3. Does your department coordinate with any other public departments or non-profits on waste management?
                a. Collaborative efforts

ii. Would you say there are any innovative strategies in waste management in Minneapolis?
    1. What innovative waste management strategies does your department engage in?
    2. Who initiated these policies and programs?
    3. Are there any additional costs associated with these programs or policies?
    4. Do you know of any source reduction strategies being used in the city?

Section 3: Factors influencing adoption and implementation of recycling or "zero waste" programs and policies

(3.1) CITIES WITH WASTE DIVERSION GOAL (Minneapolis)

INTERVIEWER:
I saw online that your city has a recycling and compost goal. Were you working at your current position when the city adopted this goal?

3. ***IF YES:*** Now I'd like you to think back to the time when this goal was adopted by the city. How would you describe the events leading up to the adoption of this goal?
    a. From your perspective, what are factors may have influenced the adoption of this goal?
        i. How did the existing recycling program factor into the adoption of this goal?
            1. (this may tell us more about the recycling history)
    b. What role did your organization play in the adoption of this goal?
    c. Did the city encounter any **challenges** (economic, legal, political, cultural, or environmental) when adopting this goal?
        i. Who was pushing for the adoption of the goal?
        ii. Who **opposed** the goal?
            1. Why did these groups oppose them?
                a. Did the city try to get these groups to change their opinion?
                    i. **IF YES**: What did the city tell them?
                    ii. (were there any collaborative efforts?)
        iii. How did the community around the incinerator react to this goal?
4. How has the city/organization adapted to meeting any goals related to this program?
    a. What policies or additional programs support this recycling program?
    *b. What are some **challenges** that your organization often encounters nowadays?*
        i. Ex. price of material = effect on local industries...
    c. Do you see any opportunities for the city/organization to help others in the area who are working on waste reduction or prevention?
        i. In retrospect, how has the city benefitted from the decision to implement this program?

1. What kind of ripple effects did it have?

Section 4 (present): Key elements of a successful or unsuccessful zero waste program or policy

INTERVIEWER:
This is great. It seems like there are various factors that affect the adoption or implementation of these policies or programs.

5. Can you describe some specific elements that either 'make or break' a particular waste management policy or program?
    a. In your opinion, which policy or program has been the most effective in promoting innovative waste management strategies the City of Minneapolis?
        i. Who or what made this policy or program successful?
6. Is there a certain innovative waste management strategy that can be improved?
    a. How can this policy or program be improved?

Section 5: Recommendations for future zero waste and recycling programs or policies

7. Are there any particular waste management policies or programs that you feel should be implemented at the local, state, or federal level?
    a. **IF YES**:
        i. What would this policy or program look like?
            1. *Probe:* What might be some of the benefits of this policy or program for the City of Minneapolis?
    b. Can you think of any barriers that would prevent the adoption and/or implementation of this policy or program?
        i. What's stopping this from happening here?
    c. Does the city plan on implementing a similar type of program or policy?

Final thoughts

INTERVIEWER:
Alright, well we're nearing the end of our interview, but before we finish, I wanted to ask **if I left anything out** or didn't talk about something that you feel is important for assessing the factors that influence decision-making on waste management programs and policies?

Data Questions:

1. Is there a **one-stop-shop** source where we can find out more information about the city's waste management strategies?
2. We are also collecting **data** on sources of waste generation (location) and waste composition (type) in the city's waste stream, do you know where we might be able to acquire some data for this?
3. Contacts: Who else do you recommend we speak to in Minneapolis?

Appendix F: Master Codebook

	Parent Code	Child Code	Grandchild Code	Code Description
1	Political			
1.1		Collaboration – departments, organizations		The process of working together and/or communicating with other entities & stakeholders in the waste management process
1.1.1			Effective	Led to a positive outcome for waste management in that city
1.1.2			Ineffective	Hindered further progress toward SMM, or untapped opportunities
1.2		Planning and policy		Regarding planning documents, policies, legislation, structure
1.2.1			Established goal issues/hierarchy	Goals that are written or otherwise explicitly specified by a governing body, company, or organization (including company/organization missions)
1.2.2			Need for goals/planning	Gaps, untapped potential, or missed opportunities in goal-setting (including company/organization missions)
1.3		Leadership		Includes administrators, politicians, institutional, and/or community leaders/"champions"
1.3.1			Advocating for SMM	Local leaders who have propelled SMM forward
1.3.2			"Inclusive" waste management structure: include WTEFs	Local personalities who say that WTEFs are inherently a part of the SMM waste management structure in the city
1.4		Role of state-level lobbying		
1.4.1			Barriers for SMM	Ex. plastic companies lobbying to prevent plastic bag bans
1.4.2			Opportunities for SMM	Lobbyists who lobby for SMM
1.5		Accountability/enforcement issues		
1.5.1			Effective follow-through on goals	Following through on a city's goals, enforcing waste management-related laws that are already set

1.5.2			Lack of/difficulty with goal follow-through	The city/organization/department has somehow been unable to follow or ineffective in following these goals, especially in ways that prevent other SMM measures from being carried out
2	Social			
2.1		Education, marketing, & community engagement strategies		
2.1.1			Effective or well-received	Positive collaboration efforts and education with the community
2.1.2			Ineffective or ill-received	Lacking collaboration or education efforts or untapped potential with the public
2.2		EJ issues		
2.2.1			Barriers to accessing recycling	Socioeconomic barriers to recycling, such as prohibitive costs for bins or language issues, that prevent people from being able to recycle
2.2.2			Availability of waste management recovery elements	This includes recycling mainly, but could also include things like composting or other city services
2.2.3			Historic incinerator (WTEF) siting decisions	Decisions that politicians and companies have made in the past regarding where WTEFs are located
2.2.4			Views on/commentary about WTEF incinerators	These can be positive or negative. This may bleed into the "technical" category if it is about the capacity/functions/outputs of WTEFs
2.3		Towards mindset, habit change, and reframing waste management		These are broader topics that contribute to long-term thinking about waste management

3	Economic			
3.1		Funding/budget sources		
3.1.1			Limited	Lacking collaboration efforts or untapped potential with the public
3.1.2			Available	Department/organization was able to get sufficient funding
3.2		Incentives		
3.2.1			Positive	Policies, laws, market price fluctuations, or infrastructural arrangements that decreases incentives for people to move away from SSM
3.2.2			Negative	Policies, laws, market price fluctuations, or infrastructural arrangements that decreases incentives for people to move forward to SSM
3.3		Job creation		Jobs created/lost
4	Technical/ procedural			
4.1		Data issues		
4.1.1			Collection	Successes/challenges with or ideas about data collection – procedures
4.1.2			Framing	Questions about the framing of data points (ex. recycling rate vs. recovery rate)
4.1.3			Availability (or lack of)	Is the data available to the public?
4.2		Waste collection strategies		Day-to-day activities for waste management and recycling collection (could include composting in MN)
4.3		Infrastructure		
4.3.1			Too much / too little	Challenge with or success from the right amount of infrastructure
4.3.2			City density	Comments about how city density affects waste management
4.4		Diversion from landfill & WTEFs		Current practices or future potential practices involving lowering the amount of waste that is put into the waste stream at the downstream (consumer level) – waste reduction/source reduction
4.5		Contamination		Efficiency of recycling, WTEFs – issues with materials that should not be in those streams

4.6		Historical process		How cities/organizations got where they are today, from the procedural perspective – could overlap with politics and social elements
4.7		Materials (life cycle)		Upstream – regarding design of materials and company decisions on packaging, etc. to reduce waste/create more of an SMM framework
5	Environmental concerns			
5.1		Pollution		This includes climate change concerns, PM, GHGs, smell (OR activities that have lowered pollution)
5.2		Material and energy recovery		The idea that recovering materials and energy is good for the environment and lowers environmental concerns
6	Innovative practices			City-specific innovative program or service (including alternative strategies)
7	Interviewee experience			Includes background on their current job and their organization/department's duties
8	Other waste management considerations			This could be medical, C&D waste, etc. – potentially out of scope for us, but worth noting