ALL A DIVERSION?
Evaluating Progress Toward a Zero Waste Goal in Los Angeles and New York City

by
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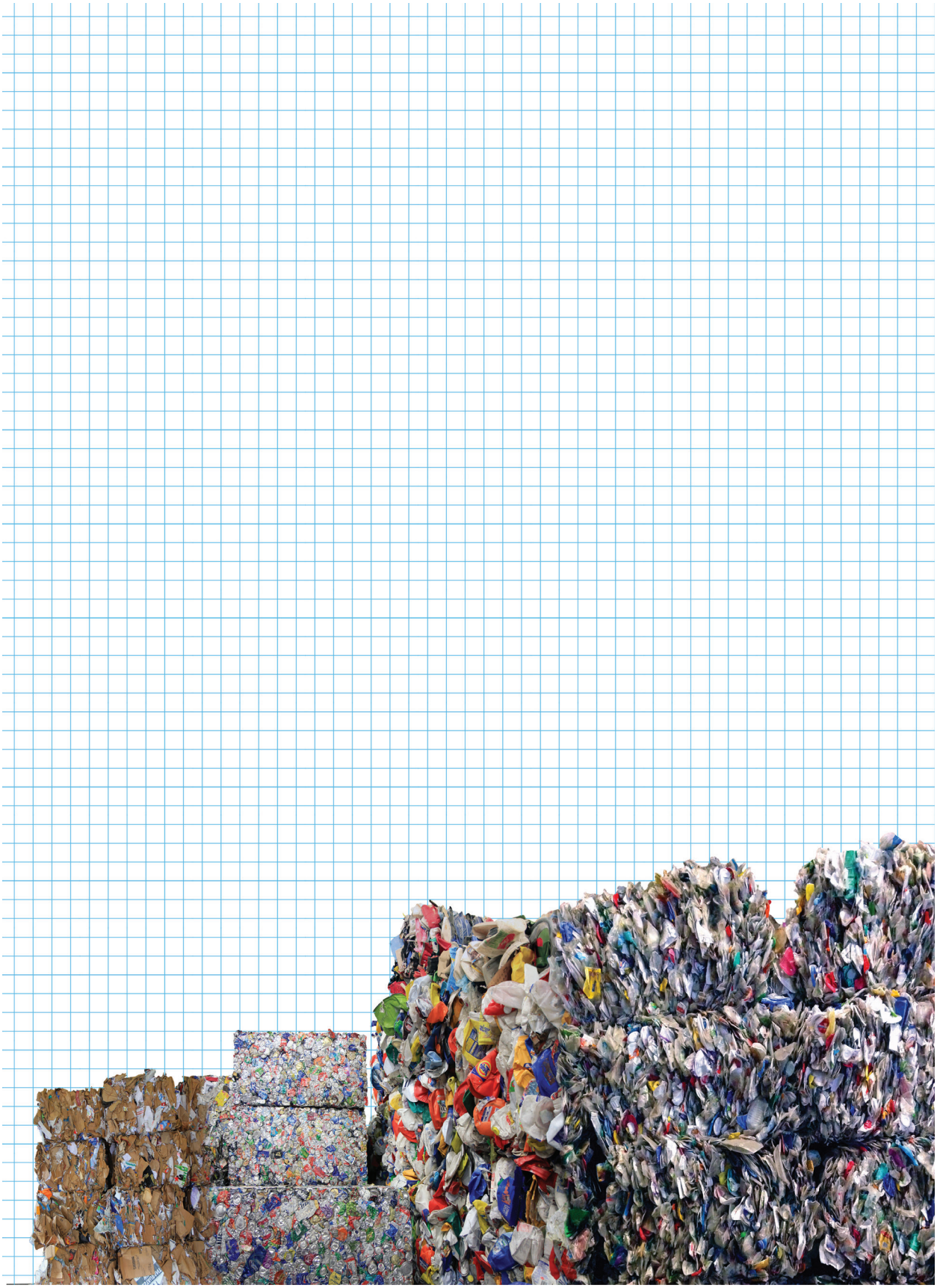

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ABSTRACT

In the last decade, the Zero Waste movement has emerged as a "visionary" approach to sustainable consumption and production. Promoting the transition from the linear system of 'take-make-dispose' to a closed-loop system where materials are reused continuously, Zero Waste advocates aim to conserve resources, protect health through material recovery, and improve the equity of material distribution. While the philosophy of Zero Waste is often commended for its comprehensive consideration of the environmental, social, and economic factors of waste, the movement has largely relied on a single indicator – diversion rate – to measure and guide progress.

Diversion rates quantify the percentage of materials diverted from landfills or incinerators. For Zero Waste advocates, the goal is 90-100 percent diversion, which implies a very closed loop of material recovery. However, the term 'diversion' often describes a range of activities, such as reuse, recycling, and composting without any indication of whether materials are being diverted temporarily or indefinitely. This thesis uses a comparative case analysis to determine the strengths and limitations of the diversion rate as the primary performance indicator for Zero Waste in the management of municipal solid waste.

Using semi-structured interviews with key informants and archival documents, the report compares Los Angeles and New York City, two cities that established diversion rate mandates more than 25 years ago and recently adopted Zero Waste goals. By analyzing the development of diversion activities in these two locations, the thesis establishes the need for more holistic evaluative methods and proposes upstream strategies to help municipalities transition to a sustainable, closed loop system.

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Submitted to the Department of Urban Studies and Planning on May 19, 2016 in partial fulfillment of the requirements for the Degree of Master in City Planning.

Thesis Supervisor: David Hsu, Assistant Professor of Urban Studies and Planning

CONTENTS

FIGURES

ACRONYMS

AB	Assembly Bill
ADC	Alternate Daily Cover
AIC	Alternate Immediate Cover
APWA	American Public Works Association
ARB	Air Resources Board
BIC	Business Integrity Commission
C&D	Construction and Demolition
CAG	Community Advisory Group
CalRecycle	California's Department of Resources Recycling and Recovery
CIWMB	California Integrated Waste Management Board
CRAB	Citywide Advisory Board
DEP	Department of Environmental Protection
DOE	Department of Energy
DRS	Disposal Reporting System
DSNY	Department of Sanitation of New York City
DST	Decision Support Tool
DWLA	Don't Waste Los Angeles
EIP	Environmental Investment Program
ESD	Empire State Development Corporation
EPA	Environmentally Preferable Procurement
EPP	United States Environmental Protection Agency
EPR	Extended Producer Responsibility
GGRF	Greenhouse Gas Reduction Fund
GHG	Greenhouse Gas
HSWA	Hazardous and Solid Waste Amendments
IWM	Integrated Waste Management
ISWM	Integrated Sustainable Waste Management
LA	Los Angeles
LAANE	Los Angeles Alliance for a New Economy
LASAN	City of Los Angeles Public Works, Bureau of Sanitation

Life-Cycle Assessment	LCA
Life-Cycle Thinking	LCT
Landfill Gas	LFG
Local Law	LL
Municipal Solid Waste	MSW
Marine Transfer Station	MTS
National Environmental Policy Act	NEPA
Natural Resources Defense Council	NRDC
New York City	NYC
Office of Recycling Market Development	ORMD
Pay-As-You Throw	PAYT
Pollution Prevention Act	PPA
Resource Conservation and Recovery Act	RCRA
Radio-Frequency Idenitfication	RFID
Request for Proposal	RFP
Renewable Natural Gas	RNG
Resource Recovery Act	RRA
Short-Lived Climate Pollutant	SLCP
Source Reduction and Recycling Element	SRRE
Solid Waste Disposal Act	SWAB
Solid Waste Advisory Board	SWDA
Solid Waste Integrated Resources Plan	SWIRP
Solid Waste Management Plan	SWMP
Total Quality Management	TQM
United States Public Health Service	USPHS
United Nations Environmental Program	UNEP
Waste Reduction Model	WARM
Women’s Health Protection Association	WHPA
Zero Waste International Alliance	ZWIA

DEFINITIONS

Anaerobic digestion: natural process that converts biomass to energy under oxygen free conditions; bacteria the most important factor; net energy gain and useful byproducts (EPA)

Composting: biological decomposition of organic materials such as leaves, grass clippings, brush, and food waste into a soil amendment (CalRecycle)

Demonstration: the initial exhibition of a new technology process or practice or a significantly new combination or use of technologies, processes or practices, subsequent to the development stage, for the purpose of proving technological feasibility and cost effectiveness (EPA)

Disposal: the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters (EPA)

Diversion: combined efforts of waste prevention, reuse, and recycling practices (CalRecycle)

Energy recovery: 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 recovery (EPA)

Hazardous waste: a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical,

or infectious characteristics may (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed (EPA)

Industrial process waste: residues produced during manufacturing operations and is excluded from municipal solid waste (EPA)

Industrial waste: refers to nonhazardous wastes discarded at industrial sites from packaging and administrative sources (EPA)

Leachate: liquid that escapes from a landfill site that, if not collected properly, will contaminate natural water resources (CalRecycle)

Municipality: (A) a city, town, borough, county, parish, district, or other public body created by or pursuant to State law, with responsibility for the planning or administration of solid waste management, or an Indian tribe or authorized tribal organization or Alaska Native village or organization, and (B) includes any rural community or unincorporated town or village or any other public entity for which an application for assistance is made by a State or political subdivision thereof (EPA)

Open dump: any facility or site where solid waste is disposed of which is not a sanitary landfill which meets the criteria promulgated under section 4004 and which is not a facility for disposal of hazardous waste (EPA)

Procurement item: any device, good, sub- stance, material, product,

or other item whether real or personal property which is the subject of any purchase, barter, or other ex- change made to procure such item (EPA)

Recovered resources: material or energy recovered from solid waste (EPA)

Resource conservation: reduction of the amounts of solid waste that are generated, reduction of overall re- source consumption, and utilization of recovered resources (EPA)

Resource recovery: the recovery of material or energy from solid waste (EPA)

Reuse: using an object or material again, either for its original purpose or for a similar purpose, without significantly altering the physical form of the the object or material; distinct from recycling, because recycling alters the physical form of an object or material (CalRecycle)

Sanitary landfills: controlled sites where contact between waste and the environment is significantly reduced (Luton)

Secondary material: traditionally refers to industrial byproducts of a manufacturing process that are used as an ingredient of another manufacturing process to create another product; traditional usage of the term does not refer to scrap or fragments generated by a manufacturing process and subsequently returned to the same manufacturing process (CalRecycle)

Solid waste: any garbage, refuse, sludge from a waste treatment

plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dis- solved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act (EPA)

Sludge: any solid, semisolid or liquid waste generated from a municipal, commercial, or industrial waste- water treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effects (EPA)

Virgin material: a raw material, including previously unused copper, aluminum, lead, zinc, iron, or other metal or metal ore, any undeveloped resource that is, or with new technology will become, a source of raw materials (EPA)

Waste prevention: any action which causes a net reduction in the generation of solid waste; includes, but is not limited to, reducing the use of nonrecyclable materials, replacing disposable materials and products with reusable materials and products, reducing packaging, reducing the amount of yard wastes generated, establishing garbage rate structures with incentives to reduce the amount of wastes that generators produce, and increasing the efficiency of the use of paper, cardboard, glass, metal, plastic, and other materials; does not include steps taken after the material becomes solid waste or actions which would impact air or water resources in lieu of land, including, but not limited to, transformation (CalRecycle)

This thesis is dedicated to Judy, who continues to be a source of inspiration and motivation each and every day. In reference to issues of climate change and environmental justice, she once said, “We’ve done so much bad stuff that we have to do everything, everywhere, all the time, starting now.”

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PROLOGUE 01

Sustainable Consumption

"Consumption clearly contributes to human development when it enlarges the capabilities and enriches the lives of people without adversely affecting the well-being of others ... But the links are often broken, and when they are, consumption patterns and trends are inimical to human development. Today's consumption is undermining the environmental resource base. It is exacerbating inequalities. And the dynamic of the consumption-poverty-inequality-environment nexus are accelerating. If the trends continue without change – not redistributing from high-income to low-income consumers, not shifting from polluting to cleaner goods and production technologies not promoting goods that empower poor producers, not shifting priority from consumption for conspicuous display to meeting basic needs – today's problems of consumption and human development will worsen."

United Nations' 1998 Human Development Report

Sustainable Consumption

In the last decade, the Zero Waste movement has emerged as a "visionary'" approach to sustainable consumption and production. Promoting the transition from the linear system of ***take-make-dispose*** to a closed-loop system where materials are reused continuously, Zero Waste advocates aim to conserve resources, protect health through material recovery, and improve the equity of material distribution (see Figure 1.1). While the philosophy of Zero Waste is often commended for its comprehensive consideration of the environmental, social, and economic factors of waste, the movement has largely relied on a single indicator – diversion rate – to measure and guide progress.

Diversion rates quantify the percentage of materials diverted from landfills or incinerators. For Zero Waste advocates, the goal is 90-100 percent diversion, which implies a very closed loop of material recovery. However, the term ***diversion*** often describes a range of activities, such as reuse, recycling, and composting without any indication of whether materials are being diverted temporarily or indefinitely. This thesis uses a comparative case analysis to determine the strengths and limitations of the diversion rate as the primary performance indicator for Zero Waste in the management of municipal solid waste. By analyzing the development of diversion activities in two Zero Waste Cities, the thesis establishes the need for more holistic evaluative methods and proposes upstream strategies to help municipalities transition to a sustainable, closed loop system.

Agenda for Sustainable Development

World leaders of the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development in 2015 – a plan of action to shift the world onto a resilient path toward responsible stewardship and inclusive development. One of the Agenda's goals is to ensure

sustainable consumption and production patterns by promoting the efficient and environmentally sound management of shared natural resources. It compels developed countries to take the lead in decoupling economic growth from environmental degradation (United Nations, 2015).

The economic growth of the 20th century was closely linked to the increased extraction and consumption of natural resources; waste generation rates grew alongside growth in Gross Domestic Product (Krausmann et al., 2009). Still to this day, the per capita consumption rate in wealthy nations is up to ten times the rate of consumption in poorer nations (GLOBAL 2000, Friends of the Earth, & SERI, 2009). Although they consume less, the global poor are disproportionately affected by the consequences of the current consumptive paradigm. As the result of historical land use decisions and development policies, there is unequal exposure to the pollution associated with our current management of materials (United States Commission on Civil Rights, 2003). People living in poverty are also at greater risk for the impacts of climate change (Hallegatte et al., 2016). In order to address these trends that are "inimical to human development," many argue that we collectively need to move from a linear system of take-make-dispose to a more sustainable and just framework (United Nations Development Programme, 1998).

The imperative to transform the consumptive paradigm has also grown with our understanding of anthropogenic climate change and environmental degradation (Krausz, 2012). According to the United States Environmental Protection Agency (EPA), 42 percent of greenhouse gas emissions in the United States result from our

current methods of production and consumption[1] (United States Environmental Protection Agency, 2009). Raw material extraction, processing, and distribution often require extensive use of energy, chemicals, and water; result in soil degradation, biodiversity loss, and damaged ecosystem functions; and emit greenhouse gases (Zimring & Rathje, 2012). Even at the end of the material life cycle, the impact on the environment is significant. Solid waste is combusted or disposed in dumps or landfills – all processes that emit greenhouse gases and can contribute to water pollution and land degradation, if not properly managed (Murray, 2002).

Promise of Zero Waste

The concept of Zero Waste has gained prominence as an opportunity to decouple economic growth from environmental degradation. By moving toward a circular system of consumption where "all discarded materials are designed to become resources for others to use," Zero Waste offers a transformative framework for sustainable development (Zero Waste International Alliance, 2009). It redefines the materials and relationships once regarded as worthless, highlighting their potential value (Murray, 2002). Zero Waste advocates also affirm that the philosophy helps address issues of social and environmental justice because it limits the potential of resource-fueled conflicts and eliminates discharges to land, water and air that are a threat to human health (Eco-Cycle Solutions, 2016a). Advocates also extend the framework beyond the conservation of natural resources to also

[1] This rate only accounts for emissions associated with domestic production. The figure would be much larger if it also measured emissions from the international production of goods consumed in the United States (United States Environmental Protection Agency, 2009).

include human capital as a resource that should not be wasted[2] (Tegnell & Bauer-Leeb, 2013).

In order to retain the energy embodied in primary materials, Zero Waste advocates promote the reconceptualization of consumption in terms of cyclical uses. Rather than the segmented means of linear production, a circular, industrial metabolism can conserve and/or recover resources indefinitely. (See Figure 1.1 for conceptual diagram of material flows.) In addition to material reuse, Zero Waste advocates also promote the substitution of renewable energy sources for fossil fuels in the remanufacturing processes. Finally, they stand in opposition to the relentless growth of development, advocating for the overall reduction of material consumption. This shifts the emphasis from efficiency to sufficiency in order to reduce the overall quantity of material flows (Murray, 2002).

$$\text{diversion rate} = \frac{\text{diverted materials (weight or volume)}}{\text{generated materials (weight or volume)}}$$

How to Measure Progress?

The concept of Zero Waste has existed for over forty years at the grassroots level, and only recently found some propulsion into the political mainstream. As it begins to move from an activity at the margins and into municipal plans and policies,[3] there is some disparity between the core philosophies and the actual implementation of those concepts (Silva & Stocker, 2016). Cities that have adopted the Zero

[2] According to the Good Tribe, a Zero Waste advocacy group, "human capital refers to not only to the output and product of employee labor, but the total innovation potentially of the employee workforce within an organization. Maximizing yield on human capital investment involves employee motivation, continued learning, and resource development, and an organized management philosophy and practice."

[3] Some companies are also embracing the concept of Zero Waste, but it has yet to become part of conventional practice.

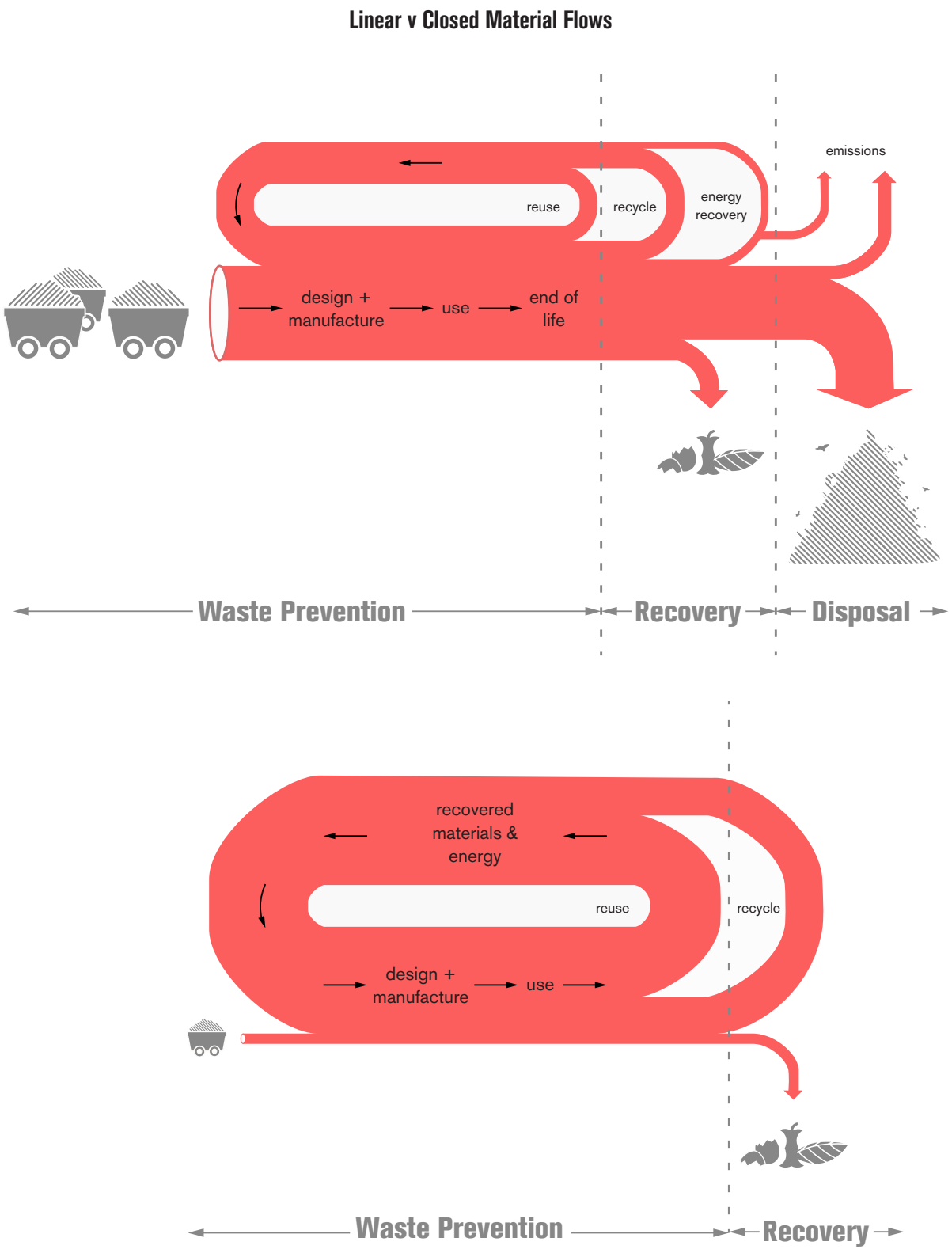


Figure 1.1
Conceptual diagram of material flows (ZWIA, 2013)

Waste moniker typically use the ***diversion rate*** metric as the primary way to measure the performance of their waste management system.[4] The theory is that a diversion rate expresses the percentage of materials that recirculate back through the production cycle – a proxy measurement of how closed the material loop is. The problem is that not all diversion activities are created equal. Some processes direct materials only temporarily back into the cycle, consume additional resources, or emit pollutants not factored into the diversion rate.

Through a comparative analysis of New York City and Los Angeles, this thesis demonstrates the need for additional evaluative frameworks to guide and measure the transition to a closed loop system. Using semi-structured interviews with key informants and archival documents, the report analyzes the historical context of two locations that established diversion rate mandates more than 25 years ago when the main objective of diversion was to extend landfill capacity. It explores the shortcomings of the diversion rate indicator in upholding the central tenets of Zero Waste or addressing issues of social, economic, and environmental justice. Finally, the thesis proposes upstream strategies and measurement tools that promote responsible stewardship and inclusive development as new indicators for Zero Waste.

[4] *Diversion rates* quantify the percentage of materials diverted from landfills or incinerators. In theory, the metric is a ratio of all diverted materials, by weight or volume over all materials generated, by weight or volume. However, there is extensive variability in how the rate is calculated in practice.

"We have always been one in purpose; although our methods of achieving results have been somewhat different. We deal more with the little things that make up the sum of universal misery, and are pressing forward to an ideal condition, by seeking to awaken the inhabitants of our city to the thought that each and every one is individually responsible for the peace and prosperity of a community."

J. E. Scrimgeour, President of the Women's Health Protective Association of Brooklyn, addressing delegates at the WHPA's first convention in 1896

ORIGINS 02

From Refuse to Solid Waste Management

Figure 2.1 / Figure 2.2
Photographs from the front of 9 Varick Place in NYC in 1893 / 1895 (Waring, 1898)

Figure 2.3
Waring's "White Ducks" cleaning up NYC streets in the 1890s (Collectors Weekly, 2013)

Apostle of Cleanliness

In 1895, George E. Waring Jr. became NYC's street cleaning commissioner. He subscribed to the filth theory of disease, believing that pure air, pure water and sanitary surroundings were essential to human health and well-being. He established the ***White Ducks,*** a corps of workers who were tasked with clearing NYC's streets and hauling the source-separated refuse (garbage, rubbish, and ashes) from households to different methods of disposal.

From Refuse to Solid Waste Management

Municipal solid waste management in the United States is now a system comprised of regulatory, administrative, technological, market-based, and social subcomponents (Louis, 2004). However, the system we know today in the United States largely developed in just the last century. As a component of sanitation reform at the end of the 20th century, early solid waste management efforts were largely concerned with controlling contagious epidemics. Over time, as cities grew and science advanced, issues of public and environmental health related to waste collection and disposal also expanded. Federal government regulations forced municipalities to overhaul their practices and states required local agencies to develop plans to manage their waste more responsibly. This chapter provides a view of the formative moments in the history of municipal solid waste management in the United States.

Sanitation Reform

Until the mid 19th century, it was customary practice in American cities to dispose of ***refuse*** on the streets or in open lots. At the time, the composition of disposed materials could be consumed by animals[5] or would decompose in the sun (Phillips, 1998) Materials such as glass and rags were not left among the strewn waste piles, but collected by peddlers for their value in secondary markets (MacBride, 2012). However, as populations grew in cities, odor nuisances and public health concerns like communicable disease epidemics became emergent issues for municipalities (Melosi, 2000). Sanitation reform, initially concerned with water and sewage infrastructure, began to focus on the removal of municipal refuse from city streets. Groups like the Ladies' Health Protective Association of New York emerged in the

[5] Pigs, goats, dogs, and vultures would consume waste disposed on the streets (Dunson, 1999).

1880s, leading public education campaigns and advocating for reform. Their efforts were effective, but reform primarily meant the collection and removal of waste from one location to another (Louis, 2004).

In New York City, major reforms to refuse operations emerged through the work of Colonel George E. Waring Junior. During his short tenure as sanitation commissioner of New York City at the turn of the century, Waring implemented what would become the model for municipal solid waste collection in the United States. He formalized the practice of curbside collection and source separation of refuse for materials recovery. However, the philosophy of 'out of sight, out of mind' prevailed at this time (Louis, 2004). A substantial portion of New York City's managed refuse was loaded on barges and dumped in the ocean.[6] Although refuse collection methods had positive impacts on public health concerns (Phillips, 1998), the environmental degradation from disposal would not be substantially addressed for another 50 years.

At the turn of the 20th century, if a municipality had a disposal system in place, the refuse was applied to land, used on farms, discharged into nearby waterways, or incinerated. As shown in Figure 2.4, land application was the most popular disposal practice of 1880, used by a third of the larger cities and almost half of the smaller cities (Louis, 2004). At the time, there were no state environmental programs or regulations to guide disposal practices (Hickman, 2003). In general, municipalities applied waste to land on forlorn sites at the edge of cities – frequently a natural ravine, abandoned quarry, or section of wetlands. Once filled, the disposal sites would be covered with earth

[6] New York City continued its ocean dumping practice until 1934 when New Jersey filed and won a lawsuit against the City (Gandy, 1994).

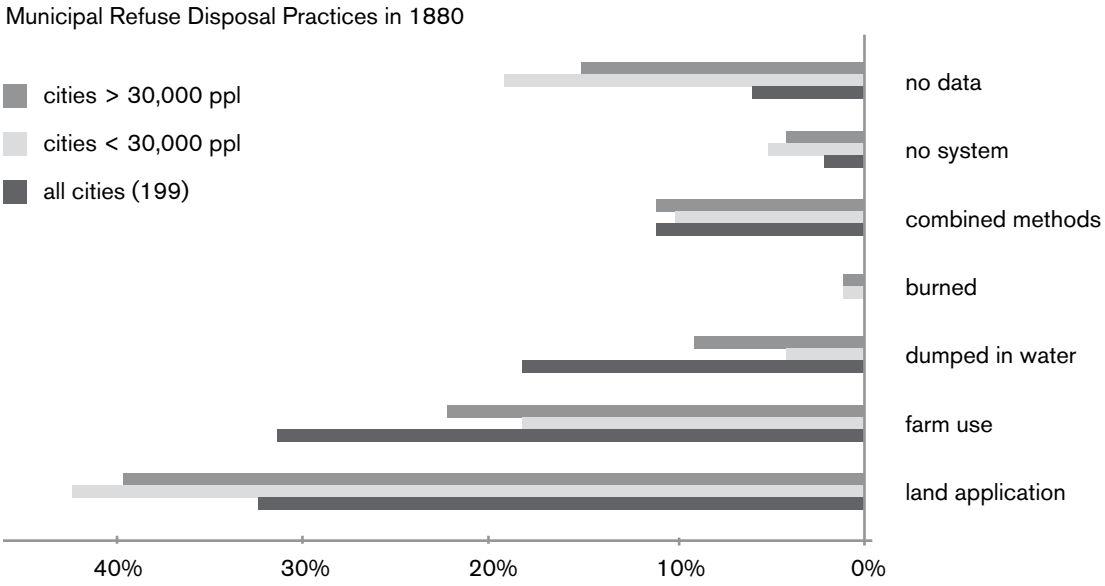


Figure 2.4
Municipal refuse disposal practices from 1880 (US Dept of Interior, 1886)

Figure 2.5
A view of New York City's Fresh Kills landfill on Staten Island (Collectors Weekly, 2013)

and often converted to a park or playground (Nebel & Wright, 1993).

By the 1920s, the composition and amount of municipal refuse generated[7] in American cities rapidly changed in parallel with the surging economy. Industries targeted increasingly affluent consumers with new disposable products and methods of producing and packaging goods. The waste stream changed to include more paper, plastics, toxic chemicals and durable synthetic materials. These changes coincided with urban growth and an increasing scarcity of available land for new dumping areas (Louis, 2004). In order to alleviate these pressures, waste was often burned at dump sites to reduce the volume and lengthen the life span of the site (Nebel & Wright, 1993). However, with the passage of federal water and air pollution legislation in the 1950s, the open, burning dump became a serious concern for state health departments (Hickman, 2003).

National Management

Congress enacted the first federal statute to improve waste disposal technology in the United States in 1965[8] (Robinson, 2004). Two decades prior to the Act's passage, the United States Public Health Service (USPHS) began efforts to document the ties between public health impacts and solid waste[9] management practices. There was

[7] One estimate put the increase in the generation rate of refuse between 1920 and 1970 at five times the rate of population growth (Melosi, 2000).

[8] In 1899, Congress enacted the Rivers and Harbors Appropriation Act. Section 13 prohibited the dumping of refuse into navigable waters, except by permit. This is sometimes cited as the first national statue to manage solid waste in the United States, but the legislature is actually a precursor to the Clean Water Act rather than Solid Waste Disposal Act (Kenney, 2006).

[9] The term *refuse* was predominantly used to describe municipal solid waste until the 1960s when it was replaced by the term solid waste.

growing concern that the open-burning dump was not just a significant contributor to air pollution, but also a potential agent for communicable diseases like polio. Through collaborative efforts with the American Public Works Association (APWA) and other research institutions, the USPHS expanded the solid waste management knowledge base through literature research, surveys, conferences, and applied research (Hickman, 2003).

The research proved effective at raising awareness that the United States had a national solid waste management problem. In a manual published in 1961, the APWA reported that 63 percent of U.S. landfills were operating with public nuisances or health hazards, using inadequate daily cover practices, and/or practicing open burning. At a national Conference on Solid Waste Research in 1963, three key findings were presented: the need for more dependable and uniform data on the quantities and characteristics of solid waste between cities; the need for improved equipment specifications for storage, collection, and transportation; and the need for safe treatment and disposal practices. Shortly after the conference, the Surgeon General's Advisory Committee issued a report outlining the public health implications of improper storage, collection, and disposal; the occupational hazards of solid waste handling; and the potential disposal siting issues with projected waste generation rates and urban development. The report also listed institutional deficiencies, including a lack of clarity on the role of local health agencies and of local, state, and federal governments. It also noted the lack of understanding how private solid waste operations should be regulated (Hickman, 2003).

Solid Waste Disposal Act 1965

To initiate and accelerate a national research and development program for new and improved methods of proper and economic solid-waste disposal, including studies directed toward the conservation of natural resources by reducing the amount of waste and unsalvageable materials and by recovery and utilization of potential resources in solid wastes.

To provide technical and financial assistance to State and local governments and interstate agenices in the planning, development, and conduct of solid waste disposal programs.

When the Solid Waste Disposal Act was passed in 1965, local governments were the principal provider of collection and disposal services and often lacked planning efforts (Phillips, 1998). There were only six federal solid waste staff members at the USPHS, less than 10 full-time employees in state programs, and no significant solid waste legislation enacted by states. The SWDA was designed to increase national research and development for solid waste disposal practices in order to assist states and local agencies in the planning and development of their disposal programs (Hickman, 2003). By the end of its 5-year duration, the USPHS had issued planning grants to all states, started intramural research, and funded ***demonstration***[10] projects like the conversion of Washington, D.C.'s Kenilworth dump to a sanitary landfill (Phillips, 1998). Reflective of the federal government's role in solid waste management still to this day, the USPHS largely provided assistance to state agencies rather than local jurisdictions even though the majority of solid waste management occurred at the local level.

During the debate to extend and amend the SWDA, there were several issues raised that needed further consideration by the federal government, including a lack of trained personnel and resources to plan or implement improvements; barriers to recycling; and growth in generation rates (Hickman, 2003). When the Resource Recovery Act (RRA) was approved in 1970, the amendments expanded the focus to include recycling, resource recovery and the conversion

[10] According to the EPA, *demonstration* means the initial exhibition of a new technology process or practice or a significantly new combination or use of technologies, processes or practices, subsequent to the development stage, for the purpose of proving technological feasibility and cost effectiveness.

Figure 2.6
Open burning at Washington D.C.'s Kenilworth dump
(National Park Service, 1967)

Resource Recovery Act 1970

To promote the demonstration, construction, and application of solid waste management and resource recovery systems which preserve and enhance the quality of air, water, and land resources.

To provide technical assistance to States and local governments and interstate agencies in the planning and development of resource recovery and solid waste disposal programs.

To promote a national research and development program for improved management techniques, more effective organizational arrangements and new and improve methods of collection, separation, recovery, and recycling of solid wastes, and the environmentally safe disposal of non-recoverable residues.

To provide for the promulgation of guidelines for solid waste collection, transport, separation, recovery, and disposal systems.

To provide for training grants in occupation involving the design, operations, and maintenance of solid waste disposal systems.

1963 **Clean Air Act** allocates $95 million to air pollution control.

1965 **Solid Waste Disposal Act** launches a federal MSW research and development program and sets up grants to states and municipalities for new disposal programs.

1969 **National Environmental Policy Act** (NEPA) creates the Council of Environmental Quality, with responsibility for national policy on solid waste generation and disposal.

1970 The **United States Environmental Protection Agency** (EPA) is established.

The **Clean Air Act** grants the federal government broad regulatory powers to protect and enhance air quality. The law has tremendous impact on incinerator operations.

The **Resource Recovery Act** amends the Solid Waste Disposal Act, shifting emphasis in the federal program from disposal to resource recovery. It gives federal jurisdiction over hazardous waste and helps municipalities improve landfill practices.

1972 The **Water Pollution Control Act** creates a program to protect and enhance the nation's ground and surface waters. It impacts most waste management methods, including landfilling, composting, recycling, and energy recovery.

1976 The **Resource Conservation and Recovery Act** (RCRA) establishes a federal involvement in solid waste management and emphasizes aid to states and municipalities in resource recovery and planning.

1977 Congress creates the **U.S. Department of Energy** (DOE) to broaden federal control over energy, including energy from waste.

1984 The **Hazardous and Solid Waste Amendments** to RCRA (HSWA) direct EPA to revise regulations for MSW landfills.

1988 The **Ocean Dumping Ban Act** mandates the end of ocean dumping.

1989 EPA publishes **The Solid Waste Dilemma: An Agenda for Action**.

1990 The **Clean Air Act Amendments** mandate that EPA develop stricter regulations for landfills and waste-to-energy facilities.

1992 The **Energy Policy Act** continues support for energy recovery technologies, including the recovery of methane from solid waste and the development of refuse-derived fuel for co-firing with coal in industry and utility boilers.

Figure 2.8
Concise history of federal MSW programs (NREL, 1996)

of waste to energy (Melosi, 2000). For example, the RRA required federal reporting on strategies to promote recycling and reduce waste generation. It also authorized grants for demonstrating new resource recovery technology. However, the real expansion of the federal government's role in solid waste management would occur in 1976 with the passage of the Resource Conservation and Recovery Act (RCRA) (Louis, 2004).

In 1970, the same year the RRA was enacted, the United States Environmental Protection Agency (EPA) was created by executive order as the lead agency to establish and enforce environmental protection standards. All environmental programs from the USPHS were assigned to the EPA – which represented a shift from an assessment-focused agency to a regulatory one. Initially, the EPA's commitment to pollution control remained focused on air and water resources. However, with the passage of the RCRA, the EPA had to establish strict requirements for states and local agencies to handle and dispose of solid waste (Hickman, 2003).

The objectives of the RCRA are to "promote the protection of health and environment and to conserve valuable material and energy resources." One of the most significant provisions of the Act is the formal classification of materials as ***solid waste***[11] or ***hazardous***

[11] According to the EPA, *solid waste* means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act.

Gar-Barge

Seeking a cheap place to offload Long Island's solid waste, a trash hauler loaded the Mobro 4000 barge with more than 3000 tons of solid waste in the spring of 1987. After a 6000 mile voyage down the eastern coast of the United States and rejection at every docked location, the barge returned to New York Harbor. Its infamous journey was a defining moment in the management of MSW in the US because the barge became a symbol for the nation's "garbage crisis." The real reason no local jurisdiction would accept the waste was not a landfill capacity issue, but rather a miscalculation of the inexperienced hauler who was trying to make a fast profit from the sizeable tipping fee of the town of Islip (Hickman, 2003).

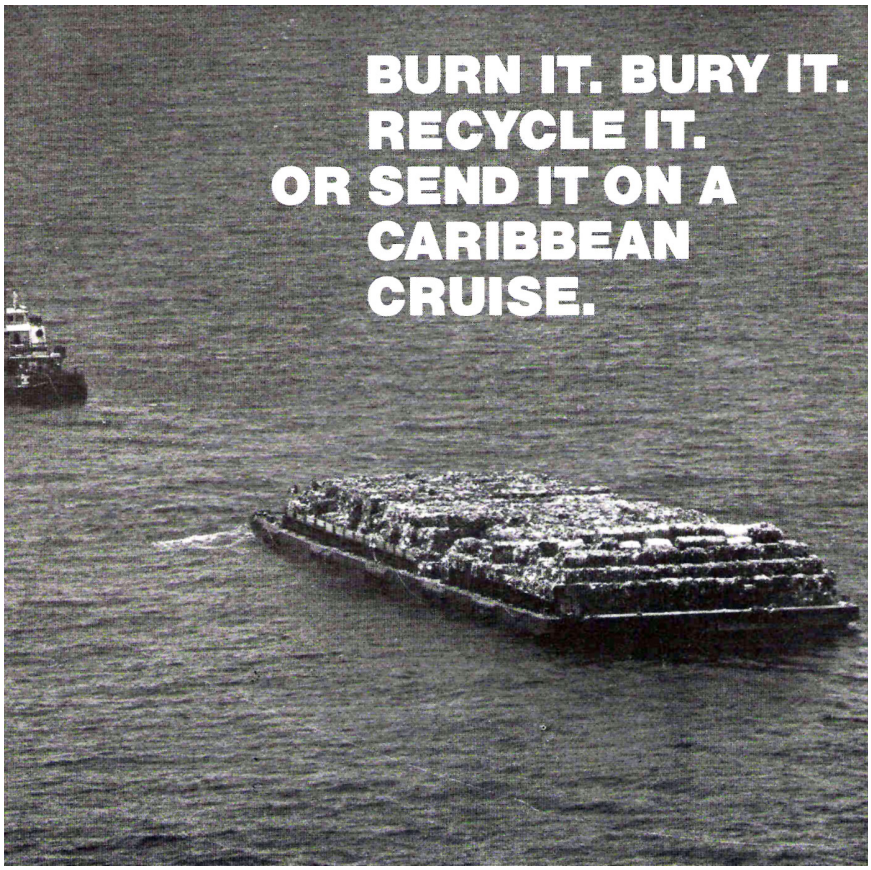


Figure 2.9
Advertisement sponsored by the
Steamfitting Industry Promotion Fund
(Wall Street Journal, 1987)

waste.[12] The Act outlines different management standards for each class of material. For non-hazardous solid waste (classified as subtitle D), the RCRA establishes standards for ***sanitary landfills***[13] and guidelines for upgrading open dumps (U.S. Congress, 1989). Through its amendments in 1984, the RCRA also establishes liner and ***leachate***[14] collection requirements for land disposal facilities and deadlines for closure of facilities not meeting these standards (Melosi, 2000). What is significant about the RCRA, compared to legislature in other countries, is that the Act does not establish a national policy nor provide any guidelines about which municipal solid waste (MSW) management options are preferable (U.S. Congress, 1989).

When the United States Congress passed the RCRA in 1976, states were also encouraged through federal incentives to develop solid waste plans according to the Act's requirements. Part of the minimum requirements included provisions for resource recovery and conservation. While many state agencies began preparing plans, the change in presidential administrations in 1980 resulted in significant budget cuts to the EPA. To adjust to the drastic staff reductions,[15] the

[12] According to the EPA, *hazardous waste* means a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

[13] *Sanitary landfills* are controlled sites where contact between waste and the environment is significantly reduced. In the early days, the definition of sanitary landfill was not very precise. Some were very similar to the open dumping method of land disposal well into the 1970s (Luton, 1996).

[14] *Leachate* is the liquid that escapes from a landfill site that, if not collected properly, will contaminate natural water resources.

[15] The Office of Solid Waste Management staff was reduced from 128 employees to just 1 after President Reagan's election (Newsday Inc., 1989).

EPA's Office of Solid Waste Management stopped funding solid waste planning efforts. Instead, it shifted its focus to meeting the mandates of the hazardous waste program and establishing regulations and permitting procedures for MSW disposal sites (U.S. Congress, 1989).

State and Local Programs

The SWDA of 1965 provided grant funding and technical assistance for each state to develop a governing agency and plan for its solid waste management activities. Harnessing the resources provided by the SWDA, both New York State and California published Solid Waste Management Plans (SWMPs) in 1970 to establish objectives and procedures for future planning and policy development at the state and local level. Both plans expressed concerns about the increasing generation rates of MSW and decreasing disposal capacity. For example, New York State's SWMP suggested the provision of research and development assistance to consider waste reduction and reuse options (California State Department of Public Health, 1971; New York State Department of Health, 1971). However, in both states, reducing the amount of disposed waste was not an explicit goal until the end of the 1980s when there was a national movement to establish source reduction and recycling goals.[16]

Although the human and environmental health impacts of solid waste management were central to the thinking of federal legislators in the 1970s, local stakeholders were primarily concerned about the economic factors associated with limited disposal capacity. In 1973, the National League of Cities and the US Conference of Mayors

[16] The NYS SWMP of 1987 cited a lack of federal funding for solid waste planning as the culprit for delayed progress (New York State Department of Environmental Conservation, 1986).

issued a report[17] to highlight the nation's "garbage crisis" from their perspective, stating:

> The disposal of wastes and the conservation of resources are two of the greatest problems to be understood and solved by this nation in the latter third of this century. With almost half of our cities running out of current disposal capacity in from one to five years, America's urban areas face an immediate disposal crisis (Melosi, 2000).

After the passage of the RCRA, there was mounting pressure on local waste management authorities to comply with the new health and safety regulations. While they were trying to manage an ever-increasing volume of disposed waste with limited disposal capacity, the strict environmental regulations of the 1970s often exacerbated their concerns. Urban populations and per capita disposal rates continued to increase,[18] and in some regions, as disposal capacity diminished, tipping fees steadily climbed (Melosi, 2000).

For example, there were a limited number of waste combustion operations that could comply with the new air-quality directives. Open burning operations were effectively prohibited and more than 80 percent of incinerators closed within a decade (Hess, 2007). Facility operators also began converting dump sites to sanitary landfills, an expensive undertaking if done to compliance standards[19] (SCS

[17] The report was titled Cities and the Nation's Disposal Crisis (Melosi, 2000).

[18] Franklin Associates, Ltd analyzed trends in MSW generation between 1972 and 1987, finding that the US population grew by 16 percent and the per capita disposal rate also grew by 16 percent (Melosi, 2000).

[19] Because of cost, most dump sites were simply covered with soil to eliminate the nuisance problems, but failed to address issues of groundwater contamination.

Engineers, 1978). In large urban cities in the Northeast, existing dumps were already nearing capacity and siting new disposal facilities proved cumbersome. The availability of physically or environmentally marginal land was limited by urban sprawl, competing land uses, and the growth of citizen opposition to the polluting infrastructure (Melosi, 2000). A 1978 study published by EPA revealed that two-thirds of contacted localities reported "moderate" or "severe" public opposition to new disposal sites (SCS Engineers, 1978). As a result, MSW in the Northeast began moving over state lines to available sites where tipping fees were much lower (Melosi, 2000).

Because of the growing complexity of the solid waste management sector, most States continued developing plans in the 1970s without federal funding or oversight. Given the voluntary nature of the process, substantial variation existed among State plans. However, most of the plans provided an overview of the State's current MSW situation in addition to explaining the proposed objectives and programs. By the mid-1980s, the ***integrated waste management framework***[20] also emerged in many of the plans because States acknowledged the importance of employing some combination of methods (recycling, landfilling, incineration) to manage the growing tonnages of MSW. By 1988, at least twelve states had legislation requiring recycling and many more established diversion rate goals (U.S. Congress, 1989).

[20] The concept of integrated waste management is explained in detail in Chapter 3.

"Waste has been seen as the dark side, as that against which we define the good. It has been the untouchable in the caste system of commodities. The idea that waste could be useful, that it should come in from the cold and takes its place at the table of the living, is one that goes far beyond the technical question of what possible use could be made of this or that. It challenges the whole way we think of things and their uses, about how we define ourselves and our status through commodities, by what we cast out as much as by what we keep in."

Robin Murray, 2002

THEORY 03

Conceptual Frameworks

Conceptual Frameworks

During the 1970s, states and local governments in the US began to develop solid waste management plans. These agencies had to consider "the systematic administration of all of the activities which provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of solid waste" (United States Environmental Protection Agency, 1976). Rather than develop and disseminate a rigid, uniform plan, the EPA proclaimed that "waste management methods, equipment, and practices should not be uniform across the country since conditions vary, and it is vital that procedures be varied to meet them" (McDougall, White, Franke, & Hindle, 2001). Therefore, states and local agencies created tailored plans to fit their needs, resources and economies (United States Environmental Protection Agency, 2002a). They often employed conceptual frameworks for understanding and analyzing the emergent issues of solid waste management. This chapter will provide details about the evolution of solid waste management frameworks from the late 1970s to the present day.

Pollution Prevention

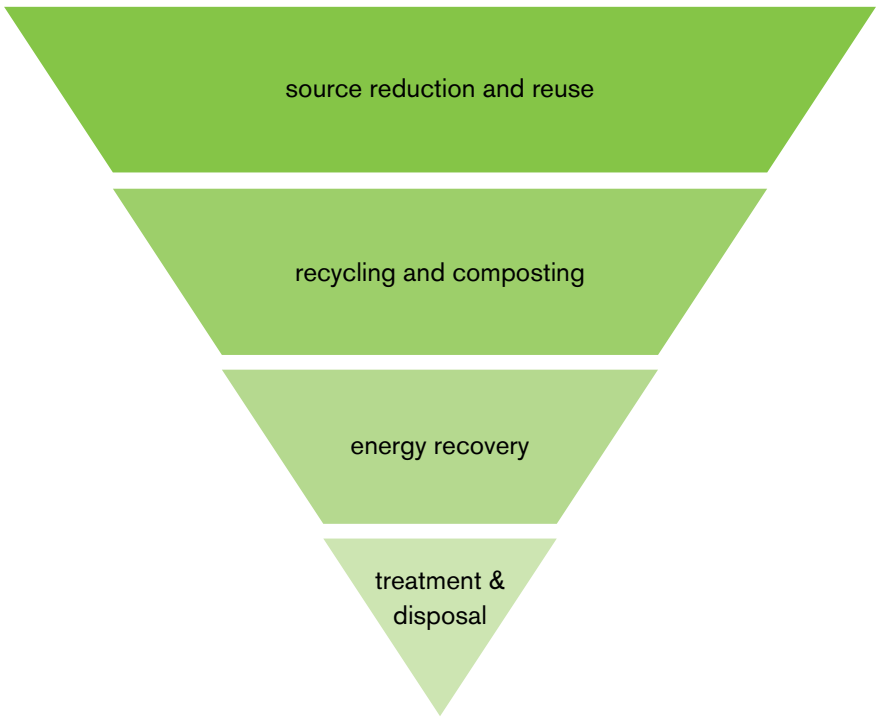
One of the initial concepts of environmental protection was ***pollution prevention***. Its underlying principle is based on limiting or eliminating the pollutant up-front, rather than developing extensive processes ***downstream*** to ensure that it poses no threat to human health or the environment (Thodore, Dupont, & Ganesan, 1999). Although the term had been used since the 19th century to protect water and air resources,[21] pollution prevention was improperly applied to pollution control rather than prevention at the source. At the time, environmental

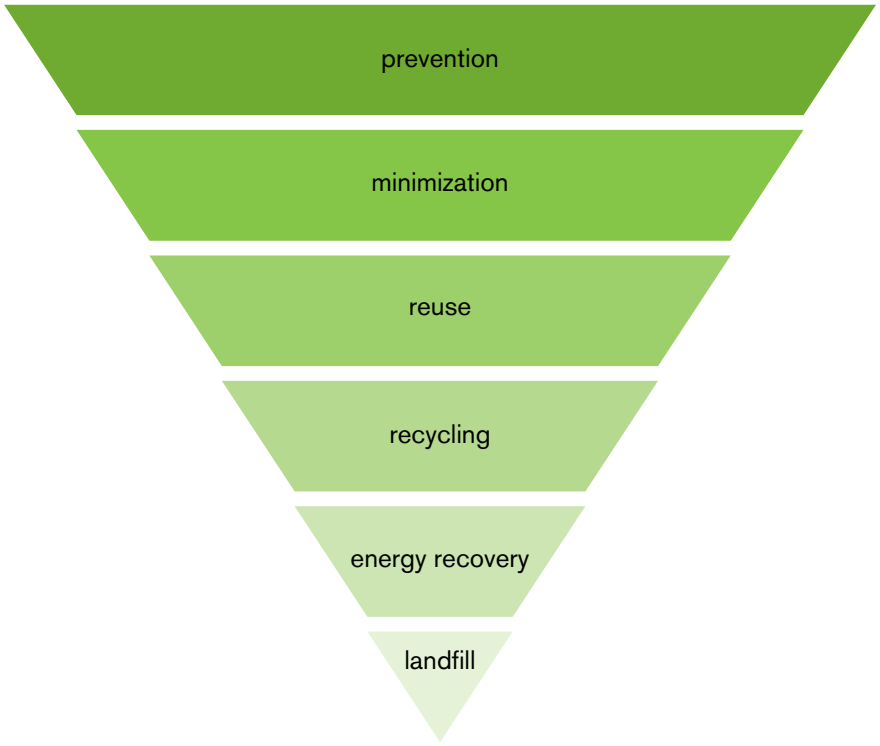
[21] The Rivers (Pollution Prevention) Act of 1876 placed a prohibition on dispensing pollutants into rivers and other inland or coastal waters of Great Britain (Elworthy & Holder, 1997).

protection was a burgeoning effort to support standards of purity. Pollution dilution and/or diversion were still the common approaches to render pollutants harmless. With the growing concern about the appreciable impact of pollutants from sewage, mining, and other industrial processes near inhabitants (Elworthy & Holder, 1997), the United States Congress passed pollution-control laws such as the Clean Air Act or Clean Water Act. These legislative measures indirectly promoted pollution prevention through increased liabilities rather than explicitly promoting preventative practices (Higgins, 1995).

The first policy to shift the national framework from pollution control to pollution prevention was the RCRA because one of its goals was the minimization of waste. This objective was strengthened with the passage of the Pollution Prevention Act (PPA) in 1990. The PPA established a pollution prevention hierarchy for managing wastes, explicitly prioritizing source reduction over other practices (Thodore et al., 1999). Source reduction strategies included equipment or technology modifications; process or procedure modifications; reformulation or redesign of products; substitution of raw materials; and improvements in housekeeping, maintenance, training, or inventory control (United States Environmental Protection Agency, 2016d). The PPA went beyond simply encouraging pollution prevention with goals or regulatory instruments. Congress concluded that many institutional and economic barriers prevented source reduction opportunities from transpiring. Therefore, the PPA actually promoted source reduction activities through matching grant funds and technical assistance programs (Thodore et al., 1999).

Figure 3.1
Diagrams of waste hierarchies





Waste Hierarchy

Although not introduced formally in the United States until 1990, a politician named Ad Lansink first introduced the concept of ***waste hierarchy*** in Dutch Parliament in 1979. A decade later, it was formalized by the European Commission into a hierarchy of waste management options – reduce, reuse, recycle, and disposal (Van Ewijk & Stegemann, 2014). Waste reduction is the most preferred option while landfill disposal is the least preferred option. Through the enactment of the PPA, the United States EPA delineated a waste hierarchy similar to that of the European Union. It includes source reduction and reuse in the first tier, followed by recycling and composting, then energy recovery,[22] and finally treatment[23] and landfill disposal (United States Environmental Protection Agency, 2015). The purpose of a waste hierarchy is to provide policymakers, planners, managers, and the general public with a relative ranking of the most environmentally preferable ways to manage solid waste.

Integrated Waste Management

The EPA currently defines Integrated Solid Waste Management (IWM) as a comprehensive program that evaluates and selects the most appropriate strategies to manage solid waste while also effectively protecting human health and the environment (United States Environmental Protection Agency, 2002b). This framework was an

[22] *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 (United States Environmental Protection Agency, 2015).

[23] Prior to disposal, treatment can help reduce the volume and toxicity of waste. Treatments can be physical, chemical, or biological (United States Environmental Protection Agency, 2015).

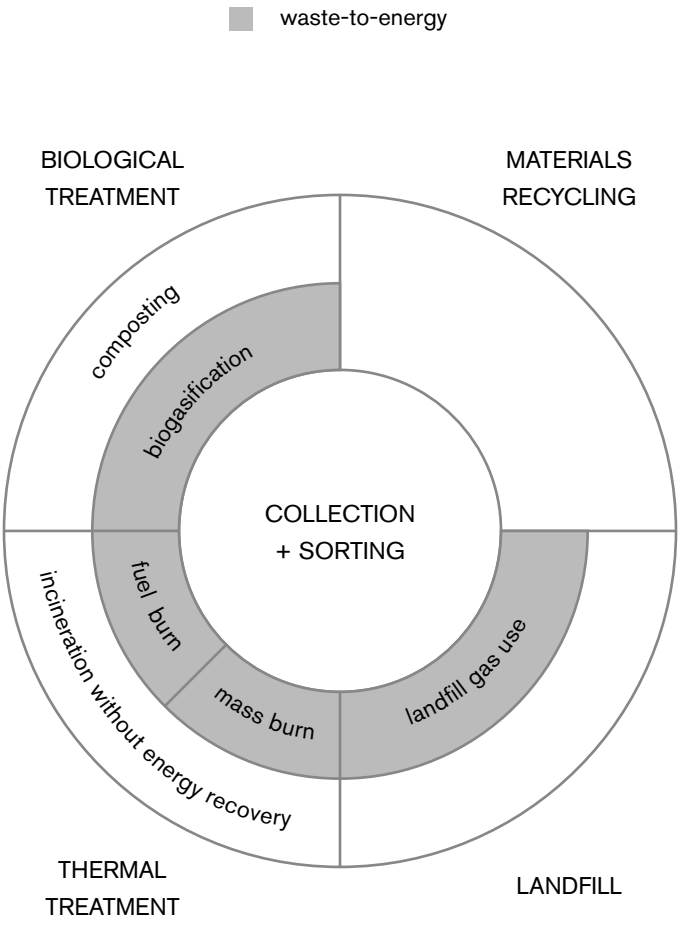
emergent concept at the end of the last century. Sanitary engineer Walter R. Lynn first described a system approach to waste management in 1962 as "viewing the problem in its entirety as an interconnected system of component operations and functions." The concept further evolved with the issuance of a mission statement by the Solid Waste Authority of Palm Beach County (SWAPBC) in 1975. The recently-established regional Authority stated it would "Develop and implement programs in accordance with its Comprehensive Plan by integrating solid waste transportation, processing, recycling, resource recovery, and disposal technologies" (McDougall et al., 2001).

By 1991, the term ***integrated*** became a common precursor to the systems approach to waste management. A European task force defined integrated waste management (IWM) as a "process of change in which the concept of waste management is gradually broadened to eventually include the necessary control of gaseous, liquid, and solid material flows in the human environment. A few years later, Proctor and Gamble issued their vision of IWM. They added clear objectives to the interconnected system of operations – to achieve environmental benefits, economic optimization, and societal acceptability. They also specified that such a system would handle all types of solid waste materials rather than focusing on specific profiles or generator sources.

The idea of IWM is not to evaluate individual tradeoffs or synergies, but consider the entire range of collection and treatment methods in order to optimize the system as a whole (McDougall et al., 2001). The IWM framework abandons the waste management hierarchy because of its prescriptive and narrow approach. (Figure 3.3 outlines the common limitations of the hierarchy of waste management.) The United Nations Environmental Program (UNEP) stated that, "the hierarchy cannot be

Figure 3.2
Elements of Integrated Waste Management, according to Proctor & Gamble (McDougal, et al., 2001)

Figure 3.3
Limitations of waste management hierarchy according to Proctor & Gamble's Integrated Solid Waste Management framework (McDougal, et al., 2001)



Limitations of Waste Hierarchy

Has little scientific or technical basis. For example, there is no scientific reason why material recycling should always be preferred to energy recovery.

Is of little use when a combination of options is used. For example, it cannot predict whether biological treatment combined with thermal treatment of the residues would be preferable to material recycling plus landfilling of residues.

Does not address costs. For example, it cannot help assess the economic affordability of waste systems.

Cannot account for the wide variety of specific local situations. For example, it does not account for conditions such as small islands, sparsely populated areas, or popular tourist destinations.

followed rigidly, since in particular situations the cost of a prescribed activity may exceed the benefits, when all financial, social, and environmental considerations are taken into account."

Life Cycle Thinking

Until recently, the traditional approach of assessing a product's environmental impact was to focus exclusively on the flows at the manufacturing stage, rather than considering its total life-cycle (Graedel & Allenby, 2010). The first studies to take a more comprehensive approach to evaluation began in the late 1960s.[24] However, it was not until the 1990s that the concept of Life-Cycle Thinking (LCT) really emerged and adopted a more sophisticated methodology (European Environment Agency, 1997). LCT considers the impact of a product (or activity) on human and environmental health from cradle to grave, including all of the activities that go into acquiring, making, transporting, using, and disposing the product. In order to evaluate its impact, a Life-Cycle Assessment (LCA) compiles an inventory of all of the material, energy, and pollutant inputs and outputs throughout the life cycle.[25] (See Figure 3.4 for a representation of a generic life cycle.)

Extending beyond the analysis of a product, Life-Cycle Thinking has been applied to solid waste management to evaluate strategies in terms of environmental and economic sustainability. Although most of the initial LCA solid waste studies were produced in Europe, the

[24] In 1969, the Coca Cola Company conducted a comparative study of the resource consumption and emissions associated with the production of glass or plastic beverage containers (European Environment Agency, 1997).

[25] LCAs traditionally measure environmental impact, but can also be used in relation to social and economic aspects (European Environment Agency, 1997).

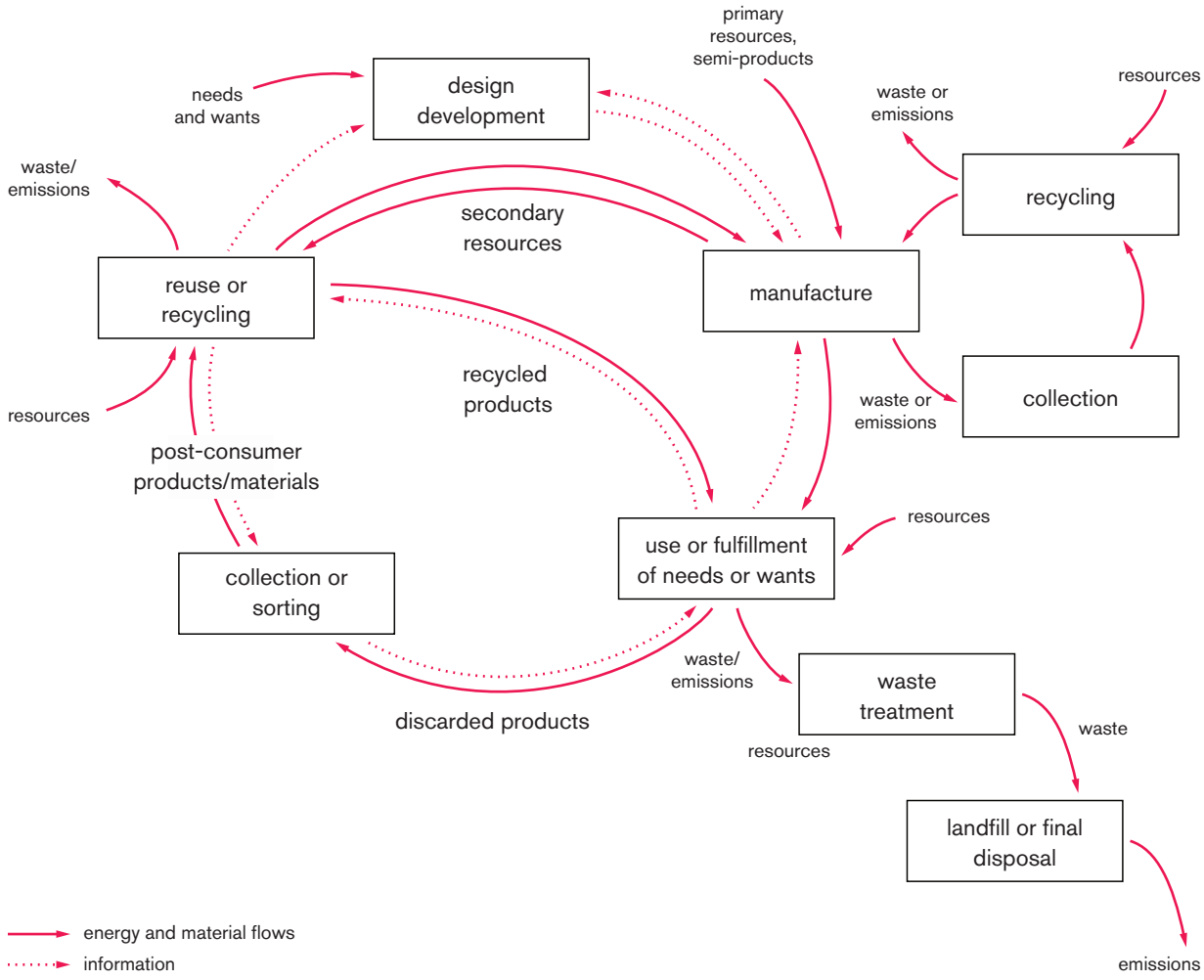


Figure 3.4
Diagram of the life cycle of a product
(Graedel and Allenby, 2010)

EPA developed a decision-support tool (MSW-DST) based upon LCT in 1999. The interactive tool allows users to perform cost and environmental modeling for MSW practices (Abeliotis, 2011; United States Environmental Protection Agency, 2001). It can model multiple design options for waste collection, transfer, materials recovery, composting, waste-to-energy, and landfill disposal. Designed for site-specific applications, MSW-DST can help address the following:

- identify costs and environmental aspects of proposed strategies such as those designed to meet recycling and waste diversion goals;
- quantify potential environmental benefits associated with recycling;
- identify strategies for optimizing energy recovery from MSW; and
- evaluate options for reducing greenhouse gases, air pollutants, and environmental releases to water-bodies or ecosystems (RTI International, 2012).

Local and state agencies have used the MSW-DST tool to compare the tradeoffs of alternative MSW management strategies (United States Environmental Protection Agency, 2001). California conducted a study to identify cost-effective strategies that would meet the state's greenhouse gas (GHG) emission reduction goals. They used the MSW-DST tool to identify and quantify GHG emissions associated with various organic waste diversion alternatives (California Integrated Waste Management Board, 2009).

The EPA has developed two additional tools based on a life-cycle approach, ReCon and WARM. ReCon calculates the benefits of alternative recycled content purchasing decisions. For example, the tool will calculate the difference in emissions and energy impacts

of office paper with 35 percent recycled content versus 25 percent recycled content. WARM calculates the benefits of alternative end-of-life waste management decisions, explicitly in terms of GHG emissions (United States Environmental Protection Agency, 2016c).

Zero Waste

The term Zero Waste implies an absence or elimination of waste, but the philosophy tends to hold other meanings and functions, interpretations that have emerged from around the world. Although there is no consensus, many view Zero Waste as a paradigm shift in philosophy from a linear system of pollution control to a circular system of materials management (Russell, 2009). A commonly cited definition of Zero Waste comes from the organization Zero Waste International Alliance (ZWIA) as developed by its international membership:

> 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. Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health.

The term Zero Waste was first publicly used in the 1970s with the formation of a chemical reuse business called Zero Waste Systems, Inc. (ZWS). Under the leadership of chemist Paul Palmer, ZWS provided a collection, storage, and re-distribution service for many excessed chemicals in northern California, including that of the nascent

electronics industry in Silicon Valley. At some point, ZWS arguably had the largest inventory of laboratory chemicals in California, which were sold at deep discounts to other companies. ZWS achieved international acclaim for their pioneering approach to pollution prevention, including affirmations from the EPA who labeled their business as an "active waste exchange" (Vaughn, 2009).

Some historians have also attributed Zero Waste's origins to the industrial concept of Total Quality Management (TQM) – an organizational approach to long-term success through customer satisfaction. Developed at the Toshiba plant in Japan in the 1950s to limit the number of lemon automobiles, the TQM framework aimed to achieve ***zero defects***. This approach started a "revolution in production" because it broadened the focus to include quality in all aspects of operations (McDonough, 1998) much like Zero Waste redirects attention to the whole lifecycle of products (Murray, 2002). After the TQM concept spread, the concept of ***zero*** became a prevalent framing tool of initiatives for its idealism and subjectivity. As John Elkington describes in his book the Zeronaughts, "whether it applies to toxics, greenhouse gases, or poverty (they) start from the assumption that there is a fundamental design fault" to growth and production and zero is the guiding counterpoint to the prevailing paradigm (Elkington, 2012).

Zero-Based Targets

zero accidents
zero carbon
zero corruption
zero defaults
zero defects
zero emissions
zero footprint
zero impact
zero injuries
zero pollution
zero povery
zero toxics
zero tolerance
zero waste

Although the term Zero Waste emerged in the 1970s, it was not applied to municipal waste planning until 1996 in Canberra, Australia. Their ***No Waste*** campaign launched the first adoption of a zero waste to landfill goal with a fixed deadline (rate-with-date goal). Only two other local governments adopted Zero Waste initiatives in New Zealand at the end of the 1990s, but many other local and regional agencies

followed suit in the 21st century (Krausz, 2012). (See Figure 3.6 for the jurisdictions in the United States that have established Zero Waste goals and plans.)

The Zero Waste International Alliance formed in 2002 to establish universally accepted principles and practical steps to develop Zero Waste businesses and communities. As part of their Zero Waste Recognition Program for communities, ZWIA requires jurisdictions to adopt their definition of Zero Waste and meet their national, state, and local laws and regulations. Both of these stipulations provide room for context-specific consideration because ZWIA's definition of Zero Waste is largely open for interpretation. It simply describes the paradigm shift from the linear system of pollution control to a circular system of materials management. However, ZWIA offers a very specific waste diversion goal as the final minimum requirement for inclusion in their Recognition Program. They stipulate that Zero Waste communities must be "working towards or (have) achieved 90 percent or more diversion of all discarded resources from landfills, incinerators and the environment" as defined in their global principles:

> Establish benchmarks and a timeline to meet goals for measuring success and monitoring accomplishments: Communities should aim to make significant strides within five years and to invest local resources and leadership in achieving tangible and visible accomplishments that demonstrate to the public this new direction as quickly as possible. Some communities have adopted as a goal diverting at least 90 percent of waste generated from landfills and incinerators within 10-15 years of adoption of a plan. Others have adopted longer timelines such as the goal in the Urban Environmental Accords of achieving Zero Waste by 2040. A key part of the planning process is

Figure 3.5
Canberra's *No Waste* Plan
(Australian Capital Territory, 1996)

Zero Waste Cities

US Cities or Counties

Matanuska-Susitna Borough, AK
Sedona, AK
Alameda, CA
Berkeley, CA
Burbank, CA
Capitola, CA
Culver City, CA
Del Norte County, CA
El Cajon, CA
Fairfax, CA
Fresno, CA
Glendale, CA
Los Angeles, CA
Marin County, CA
Mountain View, CA
Novato, CA
Oakland, CA
Ocean Beach, CA
Oceanside, CA
Pasadena, CA
Palo Alto, CA
San Bernardino County, CA
San Diego County, CA
San Francisco, CA
San Jose, CA
San Juan Capistrano, CA
San Luis Obispo County, CA
Santa Cruz County, CA
Santa Monica, CA
Scotts Valley, CA
Sunnyvale, CA
Watsonville, CA
Boulder County, CO
City of Boulder, CO
Summit County, CO
Telluride, CO
Middletown, CT
County of Hawai'i, HI
County of Kaua'i, HI
Carrboro, NC
Nantucket, MA*
Albuquerque, NM
New York City, NY
Logan County, OH
Austin, TX
Central Vermont Solid Waste Management, VT
Seattle, WA
Washington D.C.

US States

State of California
State of Delaware
State of Maryland
State of Massachusetts
State of Vermont

Internationally

Australia - 6 jurisdictions
Canada - 15 jurisdictions
Croatia - 15 jurisdictions
Hungary - 18 jurisdictions
India - 2 jurisdictions
Italy - 181 jurisdictions
New Zealand - 51 jurisdictions
Philippines - 5 jurisdictions
Romania - 6 jursidictions
Slovenia - 6 jurisdictions
Spain - 90 jurisdictions
United Kingdom - 5 jurisdictions

State of South Africa

Buenos, Aires, Argentina
Kamikatsu, Japan

Figure 3.6
Jurisdictions that have adopted Zero Waste plans, goals, or programs (Eco-Cycle Solutions, 2016b; Russell, 2009; Hawaii Zero Waste, 2016; Zero Waste Europe, 2016; LASAN, 2013)

> establishing what is a reasonable goal for your community while recognizing the urgency of moving quickly to address climate change.

While ZWIA offers many other specific practical steps[26] for communities to work toward Zero Waste, the diversion goal is regarded as a fundamental requirement (Zero Waste International Alliance, 2015a, 2015b). Likewise, jurisdictions promoting Zero Waste may embrace a range of frames and drivers – including social justice ambitions, community development initiatives, economic efficiency goals – but the rate-and-date diversion goal is almost always a central tenet.

[26] ZWIA currently lists 14 guiding principles for Zero Waste communities, but it is not clear if there have been any revisions to that list since ZWIA's formative days. The website does note, "This is a living document" so it is assumed that at least some of the details have changed (Zero Waste International Alliance, 2015a).

METHODOLOGY 04

Methodology

The research for this thesis began with a literature review of journal articles, agency publications, and statistical reports to understand how American municipalities currently define and measure sustainability in MSW management. The concept of ***Zero Waste*** emerged as the leading framework and ***diversion rate*** as the leading indicator for measurement. Initially, I hoped to triangulate my qualitative research with quantitative analysis, but quickly realized there were a number of limitations with the available statistical data. Instead of performing a longitudinal analysis of waste diversion rates, I decided to select two municipal cases that reported remarkably different diversion rates in order to explore the reasons for that variability. After I selected the cases, I used archival documents and unstructured interviews with key informants as data to support my analysis.

Selection of Boundaries

Of the various waste streams, municipal solid waste (MSW) was selected as the unit of analysis for this research. According to the EPA, MSW refers to wastes such as "durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources." It excludes solid wastes such as construction and demolition (C&D) debris, wastewater biosolids, combustion ash, hazardous waste, and industrial process waste.[27] Although the EPA sets standards for what materials are considered MSW, states and local jurisdictions may classify MSW differently. For example, Los Angeles and New York City both included C&D debris and sewage sludge in their MSW diversion rate calculations.

[27] *Industrial waste* included in MSW refers to nonhazardous wastes discarded at industrial sites from packaging and administrative sources. *Industrial process waste* refers to residues produced during manufacturing operations and is excluded from MSW.

While it is certainly true that sustainable consumption should examine all waste streams in a comprehensive manner, the varying rules and regulations across those streams make it difficult for analysis. From an impact point of view, hazardous waste and industrial waste probably deserve more attention than MSW because their toxicity and tonnage are respectively orders of magnitude greater than MSW. However, given the contentious environment at the national level and the variation in state politics across the country, local jurisdictions may be the most likely level of government to address issues of sustainability in solid waste management. MSW is place-bound and still the most visible manifestation of the consumptive paradigm that constituencies can comprehend. Throughout the development of solid waste management frameworks in the United States, the physical nature of municipal solid waste (and its discernible odors, vectors, smoke plumes, etc.) has helped expand public consciousness around issues of public and environmental health. While hazardous waste and industrial waste are more harmful for the environment, their production is largely driven by behavioral demands that arise from municipal patterns of consumption. Therefore, a radical transformation of MSW, as the Zero Waste movement promotes, will also have profound effects on these other waste streams.

Selection of Cases

The Cities of New York and Los Angeles were selected for comparative analysis. In both cases, the jurisdictional boundaries defined the local area of inquiry. These municipalities were selected because they are the nation's most populous cities,[28] two of the densest urban areas,

[28] According to the U.S. Census Bureau's 2014 population estimates, New York City is ranked first with 8.49 million people and the City of Los Angeles is ranked second with 3.93 million (United States Census Bureau, 2015).

and located in close proximity to two of the largest ports in the United States. Both cities have also had a public-private partnership for managing MSW for several decades. Finally, both jurisdictions encountered a similar diversion rate mandate in 1989, establishing the foundations for their more recent Zero Waste visions. Because federal and state plans, policies and programs impact local jurisdictions, MSW management policies under the U.S. EPA and within New York State and California were also reviewed.

Data Sources

In order to answer the developed research question, two different methods were employed for data collection and analysis: semi-structured interviews with key informants and archival documents from government agencies or other research institutions. A representative sample of stakeholders was identified for each case at the local and state level, consisting of experts in the public, private, and social sectors of MSW. Figure 4.1 lists the interviewees by case and sector. While this was not an exhaustive list, the selected stakeholders represented a range of perspectives in the field of MSW. Interviewees included policymakers, lobbyists, activists, lawyers, industry consultants, environmental scientists, private haulers, economic developers, reuse outlet operators, among others. Because of the diversity of experience of the stakeholders, the interviews were semi-structured around an interview guide. Each interview was conducted in person (with a couple of exceptions) in January 2016 and lasted about an hour. The archival documents used for analysis consisted of relevant plans, policies, reports, and guides produced by planning agencies, policymakers, and their consultants.

The initial objective of the interviews was to determine the value of metrics and data-driven analysis in addressing issues of sustainability within MSW management. Through a literature review in the fall of 2015, sustainability in MSW was defined around four key criteria: inclusive, institutionally responsive, protects health, and financially sound. (Refer to Figure 4.2 for more details about each criterion.) The interview guide included open-ended questions, largely structured around these criteria.

Through the interviews, the diversion rate metric emerged as a primary indicator of progress, although interviewees generally described principles of sustainability that were not measured by the diversion rate. Several principles of sustainability emerged from the interviews and were summarized as:

- minimizes negative impact on air, water, and soil
- follows waste management hierarchy
- avoids waste of energy, water, and virgin materials
- provides reliable, efficient service
- promotes safe jobs with prevailing wage salaries
- fosters public participation
- promotes inter-agency cooperation

Using the qualitative data from the interviews, the focus of the thesis shifted from a broad analysis of “Data’s Role in Sustainable Waste Management” to a more focused inquiry of the diversion rate indicator. The research developed into an analysis of the diversion rate in tracking progress toward the outlined objectives of Los Angeles and New York City. Using archival documents to first establish the historical objectives in each case, the interview data was used to confirm those

New York City

PUBLIC

Salvador Arrona, Director of Policy, Business Integrity Commission

Brenda Grober, Director of Industry Development, Strategic Business Development, Empire State Development; formerly Environmental Project Developer, New York State Department of Economic Development

Robert Lange, Director of Bureau of Solid Waste Management Beneficial Reuse Planning, Infrastructure Development and Management, New York City Department of Sanitation

Samantha MacBride, Director of Research, Bureau of Recycling and Sustainability, New York City Department of Sanitation

Brett Mons, Senior Program Manager, Commercial and Residential Organics Collection, Bureau of Recycling and Sustainability, NYC Department of Sanitation

Peter Pettit, Director of Bureau of Waste Reduction & Recycling, Division of Materials Management, New York State Department of Environmental Conservation

David Vitale, Director of Division of Materials Management, New York State Department of Environmental Conservation

PRIVATE

Justin Green, Co-founder and Director, Big Reuse

Andy Moss, Regional Government Affairs Manager, Progressive Waste Solutions

Thomas N. Toscano, Chief Financial Officer, Mr. T Carting Corporation

SOCIAL

Marjorie Clarke, Zero Waste Consultant, Maggie Clarke Environmental; formerly co-chair of the Manhattan Citizen's Solid Waste Advisory Board

Brigid Flaherty, Organizing Director, Alliance for a Greater New York

Eric Goldstein, New York City Environment Director, Natural Resources Defense Council

Laura Rosenshine, Founder, Common Ground Compost

Justin Wood, Environmental Justice Community Organizer, New York Lawyers for the Public Interest

Figure 4.1
Stakeholder interviews by case and sector

Los Angeles

PUBLIC

Nancy Carr, Karen Morrison, et al., Senior Environmental Scientists, Policy Development and Analysis, CalRecycle

Ralph Chandler, formerly Executive Director of California Integrated Waste Management Board

David Coscia, Zone Administrator, Los Angeles County Recycling Market Development Zone, Los Angeles County Department of Public Works

Khalil Gharios, Division Manager, Solid Resources Processing and Construction, City of Los Angeles Bureau of Sanitation

Howard Levenson, Deputy Director, Materials Management and Local Assistance Division, CalRecycle

Reina Pereira, Senior Environmental Engineer, Solid Resources Support Services, City of Los Angeles Bureau of Sanitation

PRIVATE

Stephanie Barger, Executive Director, U.S. Zero Waste Business Council

Evan Edgar, Chief Executive Officer, Edgar & Associates, Incorporated

David McKechnie, Vice President of Retail Operations, Habitat for Humanity Greater Los Angeles

Veronica Pardo, Regulatory Affairs Director, California Refuse Recycling Council

Lorenz Schilling, President, Deconstruction and ReUse Network

SOCIAL

Jackie Cornejo, formerly Director of the Don't Waste LA Project

Nick Lapis, Legislative Coordinator, Californians Against Waste

Nationally

PRIVATE

Charlie Scott, Owner, Cascadia Consulting Group

Shannon Donegan, Senior Associate, Cascadia Consulting Group

Institutionally Responsive

- clarity of vision
  - development of formal plans
  - development of goals, targets, mandates
- clarity of management
  - lines of accountability
  - mechanisms for cooperation and collaboration

Protects Health (Human and Environment)

- pollution prevention
  - air emissions (methane, carbon dioxide, nitrogen dioxide)
  - groundwater leachate
- resource and energy conservation
  - life-cycle thinking
  - conservation frameworks
- environmental justice
  - equity of burden/risk
  - tools of engagement

Inclusive

- accessibility of services
  - equitable provision of services
  - accessibility of cost
- accessibility of information
- accessibility of non-state actors
  - support for providers
  - support of informal actors
- level of community engagement
  - participatory planning
  - program participation
- level of customer satisfaction

Financially Sound

- asset management (ability to cover current and future costs)
  - accounting of revenue stream
  - accounting of system costs
- incentives (fine-tuning)
  - cross-subsidies
  - market development
  - fines
- risk management (contingencies)

Figure 4.2
Key criteria of sustainability in MSW, as identified from literature review

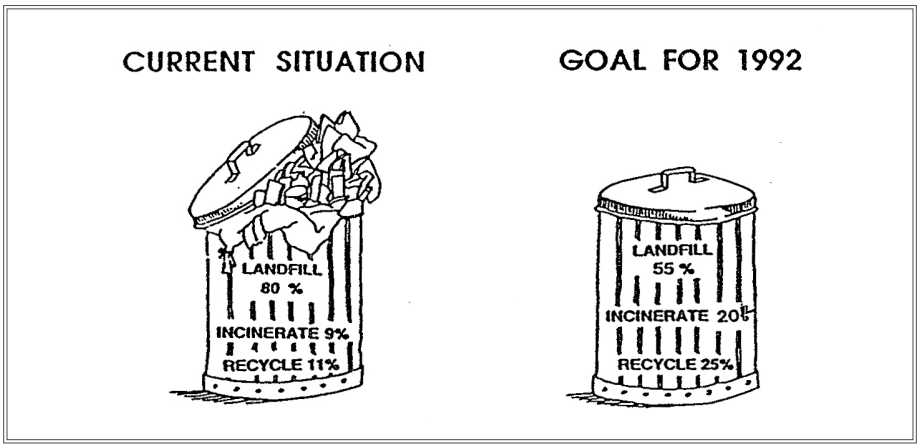
objectives. Additional principles of sustainability – according to data collected from interviewed stakeholders – were used as a supplement to the formal objectives listed in plans and policies.

The analysis of the indicator's performance required data from archival documents and interviews. One of the limitations of this investigation was the inability to revisit interviewees after the topic was narrowed. The interview guide did not explicitly target the diversion rate indicator. Therefore, some of the collected data was not directly applicable to the revised scope of analysis and/or did not always substantiate the indicator's value as objectives changed over time.

FINDINGS 05

From Diversion Rate to Zero Waste


Tide



"The (garbage) crisis will soon intensify unless actions are taken to reduce the amount of waste being generated and to safely manage and dispose of the remainder... The traditional disposal method of relying solely on landfills is no longer viable. Local officials must look at all available solid waste management methods and decide which combination of waste management methods best serves the community. Each method has its pluses and minuses as to environmental and public safety, efficiency, and cost."

NY State's Department of Environmental Conservation, 1987

Figure 5.1
Diagram of EPA's diversion rate goal, as published in *Agenda for Action (EPA, 1989)*

From Diversion Rate to Zero Waste

In 1989, the City of New York and the state of California passed mandatory requirements to increase recycling and diversion tonnages in order to alleviate some of the physical and economic pressures of disposal-related activities. Although measured differently, both Local Law 19 of New York City and Assembly Bill 939 of California had similar waste diversion requirements[31] of 25 percent diversion from landfill and transformation within a five-year deadline. However, the two cities had varying levels of success. In 1995, the City of Los Angeles reported a 45 percent diversion rate whereas New York City was recycling about 11 percent of generated waste (City of Los Angeles Public Works Bureau of Sanitation, 2006; City of New York Independent Budget Office, 2001). Although the City of Los Angeles still reports a much higher diversion rate than the City of New York, both cities recently adopted Zero Waste goals. This chapter will provide some of the contextual information of how these goals were established.

NATIONALLY:

Establishing Diversion Rates

At the end of the 1980s after the infamous Mobro garbage barge triggered national public discourse about limited waste disposal capacity, the EPA created a Municipal Solid Waste Task Force to develop a new strategy for the management of MSW. They published an *Agenda for Action*, a report that established actionable suggestions for government, industry, and the public to partner in the management of MSW. Taking a systems approach, the EPA recommended using an

[31] New York City's Local Law 19 mandated that the Department of Sanitation collect 4250 tons per day of recyclable material within 5 years. Once converted to a ratio, this tonnage equaled 25 percent of the estimated daily disposal tonnage of 1989 (New York Legal Publishing Corporation, 1990).

25% Goal

This report reiterates EPA's stated goal of diverting 25 percent of the nation's MSW from landfills and combustors through source reduction and recycling by 1992. Much of this goal will be met increased recycling with a special emphasis on composting of yard waste. But EPA believes that implementing source reduction, by not increasing our present per capita generation of MSW, is vitally important. In the longer term, the Agency anticipates that the 25 percent goal will be exceeded as capital-recycling equipment comes on line. This will be especially true in the paper industry, where planning today will be essential to increasing domestic paper recycling in the mid-1990s. Another crucial long-term goal is to reduce the per capita generation of MSW. Some proposals, such as government incentives to encourage the production of long-lasting products that can be reused or recycled, will be controversial; but the solid waste problem is serious, and controversy is not sufficient reason to ignore workable solutions.

Agenda for Action Objectives

Increase the waste planning and management information (both technical and educational) available to states, local communities, waste handlers, citizens, and industry, and increase data collection for research and development.

- *Develop education materials;*
- *Develop technical materials;*
- *Collect data and establish research and development agenda;*
- *Establish a clearinghouse; and*
- *Establish a peer matching program.*

Increase effective planning by waste handlers, communities, and states.

- *Develop state strategies.*

Increase source reduction activities by the manufacturing industry, government, and citizens.

- *Minimize toxic constituents and materials in waste;*
- *Minimize amount of waste generated;*
- *Increase procurement of products with source reduction attributes; and*
- *Study ongoing or potential source reduction policies.*

Increase recycling by government and by individual and corporate citizens.

- *Stimulate markets for secondary materials;*
- *Promote better separation, collection, processing, and recycling of waste;*
- *Facilitate formation of national recycling council; and*
- *Review incentive and disincentives of liability.*

Reduce risks from municipal solid waste combustion in order to protect human health and the environment.

- *Upgrade combustor performance standards and ash management;*
- *Research operator certification program; and*
- *Implement bans on certain materials from incinerators.*

Reduce risks from landfills in order to protect human health and the environment.

- *Research operator certification program;*
- *Increase design and operation standards;*
- *Provide education and technical assistance; and*
- *Implement bans on certain materials from landfills.*

Figure 5.2
Excerpts from EPA's Agenda for Action (EPA, 1989)

integrated waste management framework, custom designed for each context to meet local environmental, economic, and institutional needs. However, they explained that source reduction and reuse should be prioritized above recycling and composting. The report explained that "landfills and combustors will be necessary for the foreseeable future," but are lower on the hierarchy than the other MSW management options (United States Environmental Protection Agency, 1989).

The report outlined its national framework, goals, and key objectives to address many of the associated problems with MSW (see Figure 5.2). Along with each objective's summary, the *Agenda for Action* also recommended specific actions for stakeholders and outlined next steps with key dates for fulfillment (United States Environmental Protection Agency, 1989). Following the lead of other states,[32] the EPA established quantifiable goals for material diversion nationwide. They presented a 25 percent diversion rate goal with a three-year target (United States Environmental Protection Agency, 1989).

Since the 1960s, the EPA (and the former USPHS) had promoted the environmental importance of resource conservation and recovery. The *Agenda for Action* reinforced these principles through its advocacy for: increasing the useful life of products, slowing the depletion of nonrenewable natural resources, conserving energy, and reversing the ever-increasing per capita generation rate (United States Environmental Protection Agency, 1989). However, when the report established the diversion rate as a goal and states subsequently followed suit, many

[32] Five states passed recycling goals prior to the EPA's 25 percent diversion goal. Rhode Island was the first in the nation, passing a 15 percent mandatory recycling goal in 1986 (National Solid Wastes Management Association, 1991).

local jurisdictions accepted the challenge for economic reasons rather than environmental ones. Because limited disposal capacity equated to increasing disposal costs, many MSW agencies were struggling to make their programs financially sound in the 1980s. Diversion was a promising approach to reduce disposal costs. It is within this context that the diversion rate became a mandated goal for both the City of Los Angeles and New York City.

NEW YORK CITY:

Establishing Diversion Rates

As part of the national movement to establish local planning efforts for the management of solid waste, New York State moved relevant responsibilities from the Department of Health to the newly formed Department of Environmental Conservation (DEC). The state outlined the existing conditions of solid waste in New York State, including an inventory of facilities, waste collection rates, and associated costs in its initial Solid Waste Management Plan (SWMP) of 1970. As part of the Plan's executive summary, the DEC also highlighted what they believed were the emergent issues of solid waste at the time: the increasing costs of disposal and the scarcity of safe disposal sites. In order to tackle these issues, the SWMP established objectives, goals, and tasks as part of its "dynamic planning concept." The first three objectives of the SWMP aimed to achieve and maintain effective, efficient, and economical disposal of all solid wastes in the state. The final objective aimed to conserve resources and minimize environmental damage. Figure 5.3 includes a chart from the 1970 Plan about the goals and tasks the DEC established in order to attain their environmental objective (New York State Department of Health, 1971).

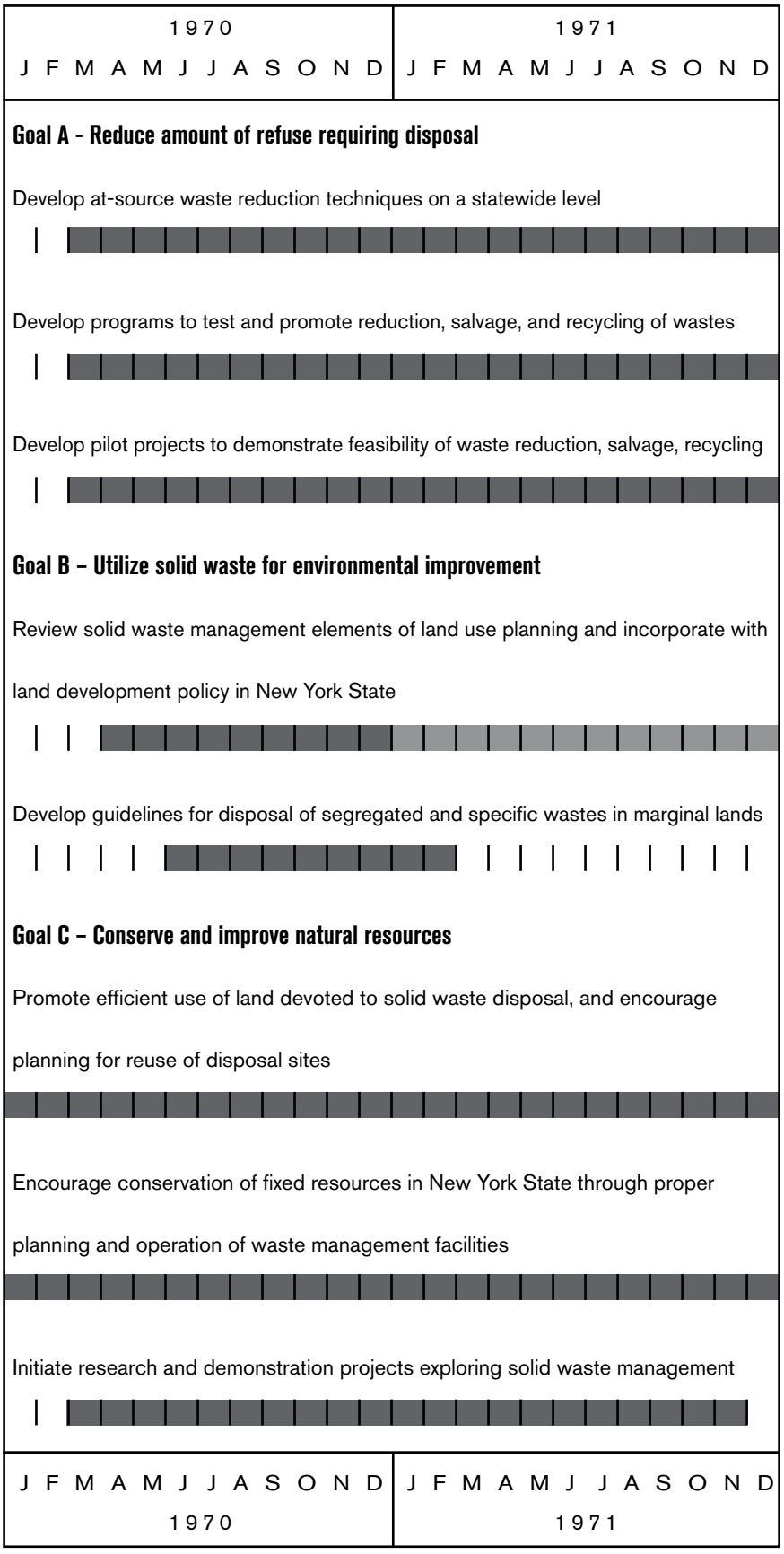


Figure 5.3
Goals and tasks the DEC established in order to "conserve resources and minimize environmental damage" (DEC, 1970)

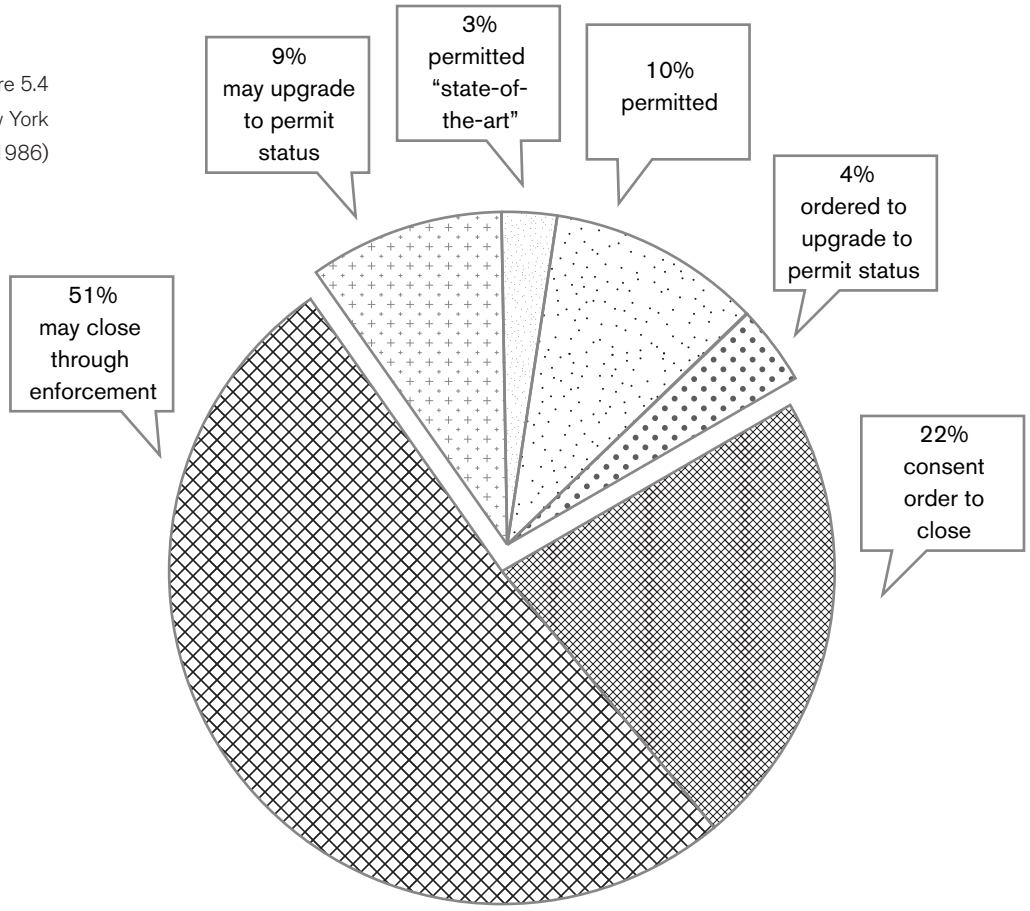


Figure 5.4
Landfill status in New York State in 1986 (DEC, 1986)

NY State's 1987 Goals

Over the next ten years, to 1997, the State's goal is to have the waste stream reduced up to 50 percent through waste reduction, recycling, and reuse of waste materials (with 8 to 10 percent waste reduction). Although not a regulatory requirement, this figure represents what DEC believes to be a reasonable and achievable recycling objective. Only wastes that cannot be recycled, reused, combusted or incinerated, such as construction and demolition debris, residues from waste-to-energy facilities and incinerators, some sewage sludge and, in some cases, wastes from rural areas, will be landfilled.

Figure 5.5
Excerpt from NY State SWMP (DEC, 1986)

The RCRA initially promised funding to states to develop solid waste management plans in accordance with their provisions. Although this funding was no longer available, New York State decided to commence an ongoing planning process on its own initiative. In the decade following the enactment of the RCRA, the "solid waste disposal capacity crisis" was becoming more urgent.[33] In 1987, DEC published a ten-year SWMP, defining the roles of stakeholders in relationship to the Plan's waste management hierarchy.[34] The SWMP also established the state's waste reduction goal and overall 50 percent diversion goal. (Figure 5.5 contains an excerpt of the goals from the 1987 SWMP.) Because implementing the vision of the SWMP was largely the responsibility of local governing agencies, the New York Solid Waste Management Act of 1988 enacted stipulations for local jurisdictions to help achieve the statewide goals. The Act stated that all "municipalities must adopt a local law or ordinance requiring that waste be separated into components for which economic markets for alternate uses exist" (Pettit, 2016; New York State Department of Environmental Conservation, 1986).

In response to the New York State Waste Management Act, the City Council in New York City passed Local Law 19 in 1989 (hereinafter referred to as NYC's Recycling Law). The Law's intention was to reduce pollution and dangers to health, decrease demand for landfill space, minimize the cost of a proposed resource recovery program, and encourage the conservation of natural resources and energy.

[33] Eighty percent of New York State's waste was disposed in landfills in 1986. See Figure 5.4 for the status of those landfills at the time (New York State Department of Environmental Conservation, 1986).

[34] The hierarchy listed the following prioritization of disposal methods: waste reduction; recycling and reuse; energy recovery; and landfilling.

It stipulated very specific requirements and deadlines in order to achieve its policy objectives, including the establishment of mandatory curbside recycling; city procurement initiatives for products made from recycled materials; the establishment of recycling sorting centers, and the creation of citizen solid waste advisory boards.[35] As shown in Figure 5.6, Local Law 19 also outlined citywide recycling tonnage goals for Department-collected and Department-disposed solid waste. It defined ***recyclable materials*** as nonhazardous waste that may be "separated, collected, processed, marketed, and returned to the economy in the form of raw materials or products" (New York Legal Publishing Corporation, 1990).

Department-collected solid waste	
1991	700 tons
1992	1,400 tons
1993	2,100 tons
1994	3,400 tons
1995	5,200 tons

Department-disposed of solid waste	
1991	1,430 tons
1992	2,870 tons
1993	4,300 tons
1994	5,740 tons
1995	7,180 tons

Figure 5.6
Mandated recycling tonnages, as defined by Local Law 19 (NYLPC, 1989)

Rate-with-Date Progress

Almost immediately, New York City struggled to meet its tonnage mandates for recyclable materials. The City cited two reasons for not achieving the stipulations of NYC's Recycling Law. The first issue was that the ongoing fiscal crisis had resulted in funding reductions for the Department of Sanitation's recycling programs (Gandy, 1994). The second problem was that "the original goals were based on market assumptions that ha(d) not proved true" (Sims, 1992). Throughout the 1990s, the City struggled to comply with the Law's requirements and was sued by the Natural Resources Defense Council for its failure. After years of litigation and appeals, the state's highest court turned away the City's last appeal, stating that the provisions were mandatory. It extended the City's deadline for compliance (Goldstein, 2014).

[35] The Law required the New York City Department of Sanitation to establish a comprehensive recycling program according to the stipulated requirements (New York Legal Publishing Corporation, 1990).

However, even after the final ruling, the City never managed to achieve the recycling tonnage mandates put forward by NYC's Recycling Law. After another fiscal crisis in 2002 in the wake of the September 11th attacks, the City temporarily suspended the recycling of plastic and glass. This had a large impact on the participation rate of DSNY's recycling program. Even after the programs were reinstated, the diversion rate of DSNY's managed stream never quite recovered (Goldstein, 2014).

While the City was scaling back recycling because of budget cuts, it was also confronting escalations in disposal costs and issues of inequitable environmental burden for certain neighborhoods. The Fresh Kills Landfill (Fresh Kills), the City's last disposal site, closed in 2001 and DSNY became dependent upon the private sector's long-haul trucking infrastructure to move the City's solid waste to landfills and incinerators in other cities.[36] The City had previously used barges to deliver waste to Fresh Kills and now relied almost exclusively on diesel trucks. With the change from local disposal to massive export of MSW, DSNY's cost of disposal rose from $42 per ton to prices ranging from $70-$100 per ton (Columbia University's Earth Institute, Earth Engineering Center, 2001). The transition also meant increases in traffic, emissions, noise, and road degradation in neighborhoods where transfer stations were sited, exacerbating issues of environmental justice (Sze, 2007).

When the City Council enacted the 2006 SWMP, the primary focus of the Plan was to establish a barge and rail network for the

[36] Most of the waste from New York City leaves the state, hauled as far as North Carolina.

City's massive export program. The SWMP also acknowledged the importance of reducing DSNY's overall disposal volume, establishing the City's intention to commit to a long-term contract with a metal, glass, and plastic processor. Eventually, the City Council amended the Administrative Code in 2010 to revise NYC's Recycling Law.[37] The amendments established percentage-based goals for diversion: 25 percent diversion for DSNY's curbside and containerized waste streams and 33 percent diversion for the entire DSNY-managed waste streams.[38] Both goals had a final deadline of 2020, but included several prorated targets along the timeline. (Refer to Figure 5.7 for the exact percentage goals.) Distinct from the original Recycling Law, the amended version no longer included tonnage-based goals and removed commercial waste from the scope (New York City Council, 2010; New York Legal Publishing Corporation, 1990).

Department-managed solid waste	
2011	16%
2013	19%
2014	21%
2016	24%
2018	27%
2019	30%
2020	33%

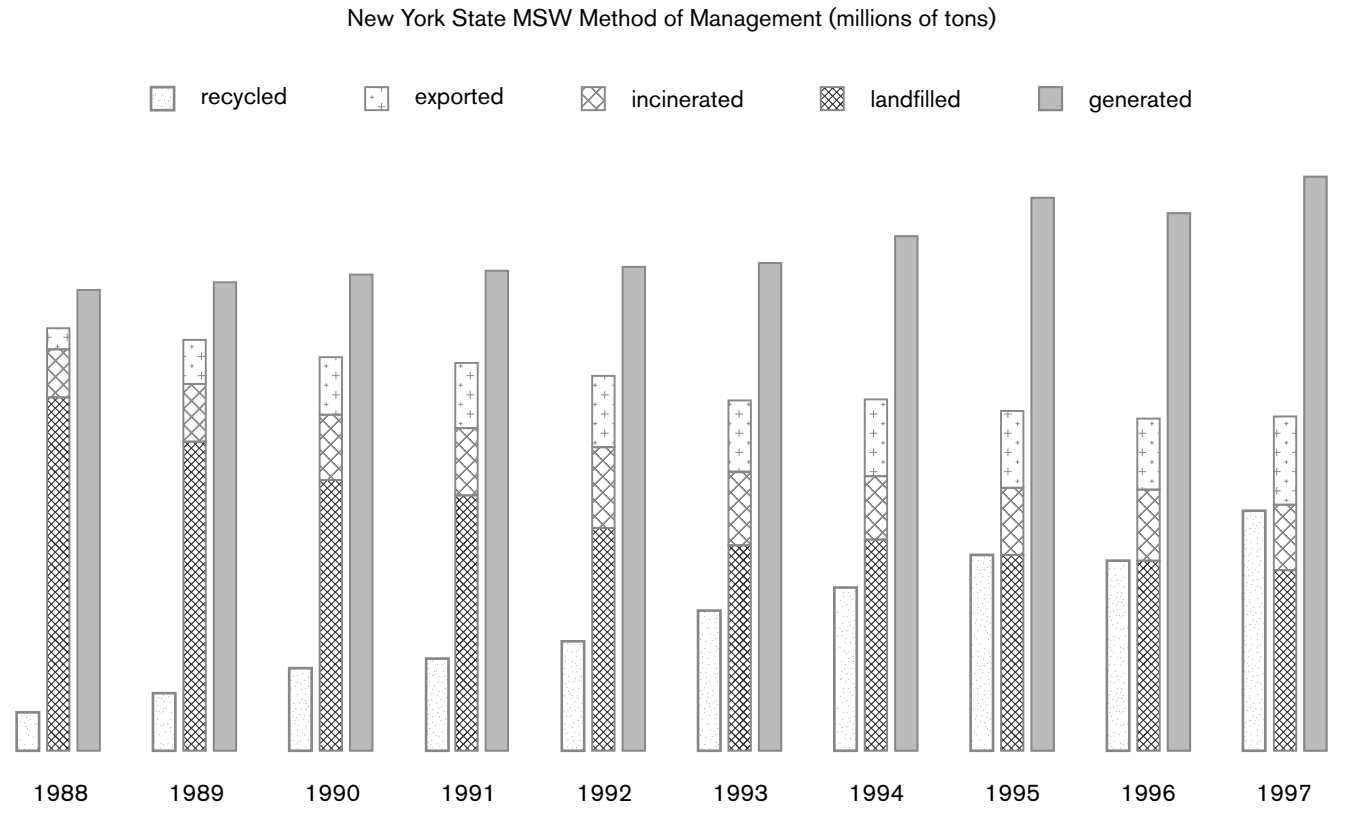
Figure 5.7
NYC's updated recycling goals
(NY City Council, 2010)

Statewide Progress

DEC discussed New York State's progress toward meeting its waste reduction and recycling goals in its Solid Waste Management Plan Update in 1999. According to DEC's estimations, the State recovered 12.5 million tons of recyclable materials in 1997 from the 28.8 million tons generated, surpassing its 42 percent recycling goal. (Refer to Figure 5.8 for the data included in the 1999 Plan Update.)

[37] The 2006 SWMP established percentage-based diversion goals for DSNY-managed solid waste. The rates are nearly the same as the amended administrative code, but the timeline for completion was much shorter (New York City Department of Sanitation, 2006).

[38] In addition to the curbside and containerized waste stream generated by residents and some public and non-profit institutions, DSNY also manages a number of other waste stream categories, i.e. redeemed bottles and cans, street basket refuse, street dirt, lot cleaning, private landscaper waste, textile donations, etc. (New York City Department of Sanitation, 2006).



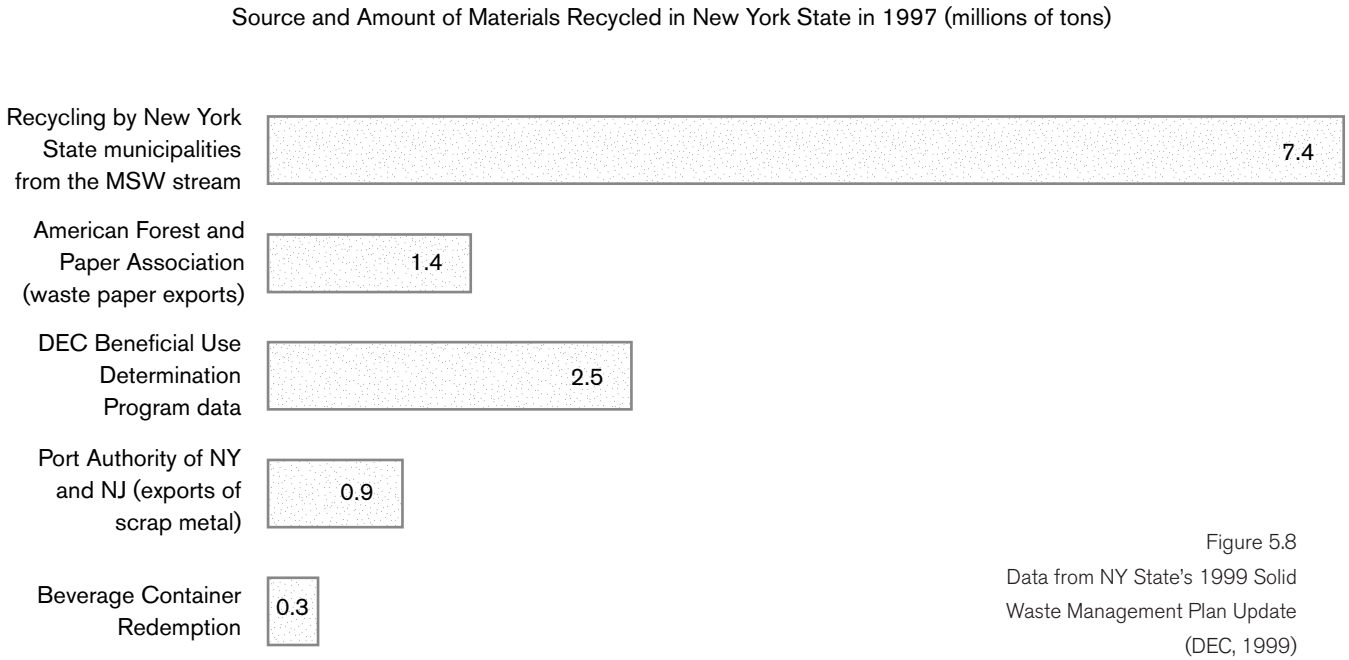


Figure 5.8
Data from NY State's 1999 Solid Waste Management Plan Update (DEC, 1999)

Regarding progress toward its waste reduction goal, DEC stated:

> Progress toward the 8-10 percent goal has not been measured, because it is extremely difficult to quantify waste reduction achieved. This is largely due to inaccuracies and gaps in data, especially data from the base year 1987 and the years immediately following it. Much thought has been given as to how to quantify waste reduction, but all approaches haven fallen short of accurately measuring aggregate waste reduction in the State. Therefore, DEC has focused on advancing waste reduction efforts, rather than attempting to quantify them (New York State Department of Environmental Conservation, 1999).

The Plan Update also included reflections of the major challenges at promoting reduction, reuse, and recycling in the State. Since 1994, the loss of local control over the flow of solid waste[39] and the widespread turnover of local government disposal capacity to private firms had discouraged long-term sustainable development of waste reduction. To counteract those challenges, New York State and local municipalities had invested approximately $176.6 million in waste reduction, recycling, and household hazardous waste programs by 1999[40] (New York State Department of Environmental Conservation, 1999).

[39] In its 1994 ruling in the C&A Carbone v. Clarkstown case, the United States Supreme Court ruled against a Clarkstown, NY law requiring haulers to take all waste collected within the jurisdiction to a privately owned transfer station (United States Supreme Court, 1994).

[40] About half of the investment– $80 million – was made between 1997 and 1999.

A decade later, the DEC published New York State Beyond Waste Plan in 2010 and not only reflected upon its progress, but also explained the challenges of measuring and reporting diversion rates. In this report, the DEC stated that the total recycling rate for the State was 36 percent of the entire materials stream, a decline of 6 points from the 1997 measurement and 14 percent down from the 2002 estimation. The Plan points out that nationally, recycling rates had been static at the turn of the 21st century and communities in New York State were also reporting stagnate or declining recovery rates. However, the Plan further explains "these differences can be attributed most directly to the different methodology used to calculate the rate, not an actual reduction in recycling activity." DEC explains that the previous recycling rate calculation methods were less reliable and likely inflated estimations of progress (New York State Department of Environmental Conservation, 2010).

In order to adjust to some of the identified challenges with calculating a recycling rate, the 2010 Plan outlined new metrics "based on more reliable, available, and accurate data." DEC supported the change to a per capita disposal metric with an incremental timeline to move from 4.1 pounds to 0.5 pounds per person per day by 2030. The rationale behind this metric was two-fold:

> Disposal weights are perhaps the most accurate metric DEC can acquire because disposal facilities are under direct state regulatory control. Normalizing data to a ***per capita*** basis reduces the data anomalies inherent in a state with substantial demographic and geographic disparities.

The DEC also decided to shift from a goal that focused on all sectors[41] to an indicator focused on just the MSW stream – residential, commercial and institutional sources (Pettit, 2016). The 2010 Plan also included qualitative goals for the next 20 years, as shown in Figure 5.9 (New York State Department of Environmental Conservation, 2010).

Establishing Zero Waste Goal

As the 'Sustainable City' movement generated momentum in the 2000s, Mayor Michael Bloomberg's Administration established New York City's first sustainability agenda. PlaNYC 2030, integrated the city's economic development goals with environmental goals. Nearing the end of Bloomberg's third term, his Administration expanded the scope of PlaNYC to include MSW, citing the importance of reducing the annual greenhouse gas emissions from the City's solid waste system. Although the City of New York had still not achieved its amended diversion rate goals,[42] Mayor Michael Bloomberg established his own aggressive citywide goal for solid waste diversion – to increase diversion from landfills to 75 percent by 2030. The report laid out several initiatives to help achieve this goal, but did not establish how the diversion rate would be measured.[43] In the subsequent years, the

[41] In 1987, the diversion goals in the NY State SWMP included residential, commercial, non-hazardous industrial, institutional, construction and demolition debris, sewer sludge, compostable wastes, residue wastes and household toxic wastes (New York State Department of Environmental Conservation, 2010).

[42] In 2010, the New York City Council amended the administrative code of the City, repealing the mandated tonnages and establishing recycling percentage-based goals for DSNY-managed solid waste. Since the City had not met its 2007 diversion projections as proposed in the 2006 SWMP, the target deadline was moved to 2020 with incremental goals along the timeline.

[43] The report does not include the existing diversion rate, what streams would be included in the rate, whether thermal waste-to-energy processing or ADC would be included as diversion activities, or how data would be collected from the commercial sector (City of New York, 2011).

NY State Beyond Waste Goals

Qualitative Goals

- Maximize reuse
- Maximize recycling
- Maximize composting and organics recycling
- Advance product and packaging stewardship
- Minimize waste disposal
- Create green jobs
- Maximize the energy value of materials management
- Minimize the climate impacts of materials management
- Reemphasize the importance of comprehensive local materials management planning
- Minimize the need for long-range export of residual waste
- Engage all New Yorkers — government, business, industry and the public — in Sustainable Materials Management
- Strive for full public participation, fairness and environmental justice
- Prioritize investment in reduction, reuse, recycling and composting over disposal
- Maximize efficiency in infrastructure development
- Foster technological innovation
- Continue to ensure solid waste management facilities are designed and operated in an environmentally sound manner

Quantitative Goal

- Reduce the amount of MSW destined for disposal to 0.6 pounds per person per day according to the following schedule:

2010	4.1 lbs	2018	2.3 lbs
2012	3.8 lbs	2020	1.7 lbs
2014	3.4 lbs	2025	1.1 lbs
2016	2.9 lbs	2030	0.6 lbs

Note: MSW does not include construction and demolition debris, biosolids, or industrial waste.

Figure 5.9
Goals from New York State 2010 Beyond Waste Plan (NYS DEC, 2010)

PlaNYC progress reports indicated that the City had achieved a 56 percent diversion rate in 2012 and a 54 percent diversion rate in 2013, but provided no information of how these rates were calculated[44] (City of New York Mayor Michael R. Bloomberg, 2011).

Zero Waste NYC

Reduce volume of DSNY-collected refuse (excluding material collected for reuse or recycling) by 90 percent relative to 2005 baseline of ~3.6M tons.

Increase curbside / containerized diversion from a rate of 15.4 percent in 2014.

Increase citywide diversion rate (including all streams of waste: residential, commercial, construction and demolition, and fill) from current state of ~52 percent.

Figure 5.10
New York City's Zero Waste goals, as defined by Mayor de Blasio's OneNYC plan
(City of New York, 2015)

Following Mayor Bloomberg's lead to consider MSW as a sustainability issue, the newly appointed Administration of Mayor Bill de Blasio raised the bar even higher on MSW. In the Mayor's OneNYC plan, de Blasio's Administration established a Zero Waste goal defined as a 90 percent reduction, "by volume," of DSNY-collected refuse sent to landfills by 2030.[45] The plan also included goals to increase both DSNY's curbside and containerized diversion rate and the citywide diversion rate.[46] (See Figure 5.10 for the goals, as defined by OneNYC.) Like PlaNYC, the OneNYC plan did not indicate if thermal waste-to-energy processes like incineration would be appropriate reduction strategies (City of New York Mayor Bill de Blasio, 2015; City of New York Mayor Michael R. Bloomberg, 2011). Both Mayors' Plans had ambitious targets and proposed initiatives but neither substantiated their rationale for choosing those figures nor establish any conceptual framework of how those targets would be met.

[44] The 2006 SWMP includes an addendum that shows how DSNY reports disposal and diversion tonnages to DEC in an annual Planning Unit Recycling Report. The data from the 2005 report indicates a 52 percent citywide diversion rate, including C&D, fill, and sewage sludge in addition to MSW (New York City Department of Sanitation, 2006).

[45] OneNYC says reduction by volume, but offers a weight-based baseline unit of 3.6 million tons.

[46] The plan defined all streams as residential, commercial, construction and demolition, and fill (City of New York Mayor Bill de Blasio, 2015).

LOS ANGLES:

Establishing Diversion Rates

At the end of the 1980s California also established a new framework to address its projected shortage of landfill capacity. It aimed to limit the reliance on landfills and waste-to-energy projects, and prioritize source reduction, recycling, and composting activities. The California Integrated Waste Management Act (hereinafter referred to as AB 939) replaced existing provisions regulating solid waste management with a systems approach that reflected the EPA's *Agenda for Action*. Establishing statewide diversion goals of 25 percent by 1995 and 50 percent by 2000, AB 939 also created a robust delegation of responsibilities and sustainable funding mechanisms for planning at the state, county, and city level. As a supplement to the Act, the state legislature also established an extensive list of supplemental programs to support the state's diversion goals (see Figure 5.11).

Each jurisdiction (city and county) was required to prepare, adopt, and submit a Source Reduction and Recycling Elements report (SRRE) that demonstrates how the jurisdiction will meet AB 939's mandated diversion goals. Each jurisdiction was also required to conduct a Solid Waste Generation Study[48] in order to establish baseline data for diversion rate calculations. Each county was required to use those

[47] AB 939 required each city to prepare a Source Reduction and Recycling Elements by 1991 that included the following components: waste characterization; source reduction; recycling; composting; solid waste facility capacity, education and public information; funding; special waste (asbestos, sewage sludge, etc.); and household hazardous waste (California's Department of Resources Recycling and Recovery, 2015b).

[48] Solid waste generation studies quantified the amounts and identified the types of solid waste disposed and diverted from each jurisdiction in its base year (California's Department of Resources Recycling and Recovery, 2000).

Source Reduction Advisory Committee
Created committee to recommend source reduction actions, including: packaging and product design; product durability; increasing the use of recycled feedstock; reducing toxicity in packaging and products; and new technology techniques.

Recycled Market Development Commission
Created the commission to: assist local governments in including recycling in economic development plans; promote utilization of financial resources for expanding recycling industry; review the Board's research and development programs; and review procurement practices and make recommendations for improvements.

Market Development Zone Program
Created to stimulate the recycling of postconsumer waste materials generated in California as raw materials used for feedstock by private business, industry, and commerce.

Recycled-Content Paper Program + Office Paper Recovery Program
Established to ensure that DGS purchases at least 25% of all specified paper made from recycled-content paper; increasing to 40% by 2000. Required the Board to initiate an office paper recovery assistance program for state and local agencies and private businesses, including identification of markets for collected materials.

Compost Market Program
Created to maximize the use of compost, co-compost, and sewage sludge.

Plastic Recycling Program
Established a Board review of DGS procurement guidelines; the development of specifications for the procurement of recycled secondary and postconsumer plastic products; a purchasing preference for recycled plastic products; and Board to identify methods to increase the utilization of recyclable plastics in manufacturing.

Retreaded Tire Program
Required the Board to identify obstacles for an increased market for retreaded tires and required all tires on state vehicles to be equipped with retreaded tires by 1991.

Recycled Lead-Acid Battery Program
Required all batteries purchased by a state agency to be recycled lead-acid batteries.

Technical Assistance Program
Required the Board to: provide training and technical assistance to enforcement agencies; evaluate the costs of IWM program options; and provide technical assistance in the preparation and implementation of SRREs and IWMPs.

Public Information and Education Program
Required the Board to: conduct a statewide information and education program to encourage participation in all phases of IWM; and to develop and disseminate materials to teach the concepts of source reduction, recycling, and IWM in schools.

Figure 5.11
SB 1322 primarily described actions and programs to be developed at the state level to promote integrated waste management. The legislature was enacted in union with AB 939 to form the California Integrated Waste Management Act of 1989. (CalRecycle, 2015)

reports to prepare a Countywide Summary Plan and Countywide Siting Element, showing diversion of all solid waste[49] from landfill or transformation facilities according to the state's deadlines and identifying at least fifteen years of disposal capacity (California's Department of Resources Recycling and Recovery, 2015c). To assist jurisdictions and counties, AB 939 established an Integrated Waste Management (IWM) Board to provide ongoing technical and regulatory assistance for the development and review of local plans.

To facilitate these planning efforts, AB 939 authorized local jurisdictions to impose fees on generated solid waste to pay for the costs incurred in preparing, adopting or implementing plans. Fees from disposed waste tonnages at landfills funded the budget for the IWM Board (and later CalRecycle). One of the Act's most significant distinctions from other state recycling laws was that it carried civil penalties of up to $10,000 per day for jurisdictions that were not in compliance with the planning and/or implementation schedule (California Integrated Waste Management Board, 1993).

The City of Los Angeles was already developing a recycling goal when AB 939 was passed. In anticipation of the projected closure of the Toyon Canyon Landfill, the City Council instructed the City's Bureau of Sanitation (LASAN) to evaluate waste-to-energy projects in the region.[50] However, after much public opposition, Mayor Tom

[49] AB 939 excluded agricultural wastes, inert wastes, and other wastes not normally disposed of at landfills (California's Department of Resources Recycling and Recovery, 2015b).

[50] The study resulted in a proposal for three waste-to-energy projects known as Los Angles City Energy Recovery Projects (LANCER) (City of Los Angeles Public Works Bureau of Sanitation, 2006).

Bradley asked the City Council to terminate the projects and instead study an aggressive municipal recycling program (City of Los Angeles Public Works Bureau of Sanitation, 1993). Tasked with establishing a program that would achieve the Mayor's 50 percent recycling goal,[51] a consultant team helped the LASAN publish a Recycling Implementation Plan in April 1989[52] (City of Los Angeles Public Works Bureau of Sanitation, 1989). Acknowledging that recycling was just one component of managing solid waste, the City Council also authorized additional studies, one involving the development of a 30-year City of Los Angeles Solid Waste Management Policy Plan (CiSWMPP). After a four-year effort to produce the document, the CiSWMPP was published in 1993. Among other objectives, the Plan established a citywide diversion goal that met the deadlines, but exceeded the requirements of AB 939, diverting 70 percent of MSW by the year 2020 (City of Los Angeles Public Works Bureau of Sanitation, 2006).

Rate-with-Date Progress

In contrast to New York City, Los Angeles was very successful in its first year under AB 939, reporting an estimated 21 percent diversion rate from landfills and incinerators in 1990. By the end of 1995 and 2000, the City achieved a 45 percent and 60 percent diversion rate, respectively (California's Department of Resources Recycling and Recovery, 2016). According to LASAN, the City's success was attributed to its "well-established recycling infrastructure; public interest; savings from avoided disposal costs; and the City's proximity

[51] The Mayor established a goal of 50 percent residential waste reduction for the 720,000 dwelling units that the City serviced (City of Los Angeles Public Works Bureau of Sanitation, 1989).

[52] The Recycling Implementation Plan was published five months prior to California's enactment of AB 939 (City of Los Angeles Public Works Bureau of Sanitation, 1989).

to international markets through the Port of Los Angeles" (City of Los Angeles Public Works Bureau of Sanitation, 1993). However, the progress made in Los Angeles was not unique to that City; all of California's jurisdictions made significant progress in achieving the requirements of AB 939. The overall statewide diversion rate was 42 percent in 2000 and eventually exceeded the 50 percent diversion rate by 2005 (California's Department of Resources Recycling and Recovery, 2007, 2009).

Establishing Zero Waste Goals

In 2001, the California IWMB published a Strategic Plan to shift the state's focus from diversion mandates to principles of sustainability, product stewardship, energy recovery, environmental justice, and safe disposal of wastes. One of the Plan's goals[54] was to promote zero-waste in California. In the executive summary, the IWM Board wrote:

> As we look ahead, we must focus on changing not only our actions, but also our understanding about resources. Waste is a resource that Californians are using inefficiently. As natural resources stewards, our aim is toward a zero-waste philosophy, which focuses on the most efficient use of our natural resources in order to reduce waste and protect the environment.

The Board's definition of Zero Waste did not include rate-with-date diversion statistics. Instead it was broadly defined to include upstream design principles to encourage source reduction during manufacturing as well as end-of-pipe solutions such as reuse, repair, and recycling (California Integrated Waste Management Board, 2001b).

[54] The seven strategic goals of the Plan are listed in Figure 5.12 (CA Integrated Waste Management Board, 2001).

Zero Waste California

Increase participation in resource conservation, integrated waste management, waste prevention, and product stewardship to reduce waste and create a sustainable infrastructure.

Assist in the creation and expansion of sustainable markets to support diversion efforts and ensure that diverted materials return to the economic mainstream.

Educate the public to better understand and participate in resource conservation and integrated waste management strategies.

Manage and mitigate the impacts of solid waste on public health and safety and the environment, and promote integrat- ed and consistent permitting, inspection, and enforcement efforts.

Improve the efficiency and effectiveness of the Integrated Waste Management Board in pursuit of its mission.

Continuously integrate environmental justice concerns into all of the Board's programs and activities, including administrative and budgetary decisions.

Promote a "zero-waste California" where the public, industry, and government strive to reduce, reuse, or recycle all municipal solid waste materials back into nature or the marketplace in a manner that protects human health and the environment and honors the principles of California's Integrated Waste Management Act.

- Promote source reduction to minimize the amount of waste generated.
- Promote best business practices in product manufacturing and handling.
- Encourage recycling activities and new technologies in all businesses and residences.
- Promote new or existing technologies and processes to address existing or emerging waste streams.

Figure 5.12
Goals of California IWMB's Strategic Plan (IWMB, 2001)

The Los Angeles City Council adopted the RENEW LA Plan[55] in 2006, establishing the City's interest in the Zero Waste vision as an opportunity to transition from the current paradigm of "waste disposal" to one of "resource recovery." RENEW LA sets a goal of achieving at least 90 percent overall diversion through waste reduction, recycling, or non-combustion conversion by 2025, leaving only inert residue for landfill disposal. Building upon the leadership direction provided by RENEW LA, the Department of Sanitation established a stakeholder-driven planning process to develop its 20-year Solid Waste Integrated Resources Plan (SWIRP) with the vision that the City of Los Angeles would become a Zero Waste City (Pereira, 2009).

At the beginning of the six-year planning process, LASAN recruited stakeholders from the community[56] to establish regional working groups that would work in collaboration with LASAN to develop the SWIRP. In the first phase, the stakeholders developed a set of guiding principles to serve as the foundation for the SWIRP's planning process. In the following years, those principles were folded in the SWIRP's development.[57] According to the SWIRP Project Manager, Reina Pereira, the City's Zero Waste Plan includes upstream and downstream policies. Rather than just focusing on new programs or

[55] The Plan's complete title is Recovering Energy, Natural Resources and Economic Benefit from Waste for Los Angeles (Pereira, 2009).

[56] There were six regional working groups that corresponded to the six collection regions within the City of Los Angeles. Each region recruited stakeholders from the local neighborhoods, neighborhood councils, community groups, churches, and local businesses. Each group, comprised of as many as 100 actively involved members, met approximately six times during the first year to develop the guiding principles (The City of Los Angeles Public Works Bureau of Sanitation, 2007).

[57] The SWIRP planning process produced a Facilities Plan, Environmental Impact Report, Financial Plan and Implementation Strategy Plan (City of Los Angeles Public Works Bureau of Sanitation, 2013).

educational campaigns for recycling, the Plan also includes initiatives that address product stewardship, also known as extended producer responsibility (EPR). Product stewardship extends the responsibility for end-of-life management to the manufacturers of a product or package. The SWIRP proposes legislative advocacy campaigns to ensure that effective EPR programs are enacted into law (Pereira, 2016). (Refer to Figure 5.13 for the upstream policies outlined in the SWIRP.)

Enforcing a Diversion Rate

There are many contextual variables that likely affected the progress of both New York City and Los Angeles in achieving their respective diversion rate goals. However, the variability of enforcement should not be understated. Both Los Angeles and New York City had to comply with diversion mandates in the 1990s, but the key difference between the two cases was who was holding the municipalities accountable. In the case of Los Angeles, the state had issued the rate-with-date mandate with strong enforcement provisions. In the case of New York City, the City Council enacted the Recycling Law, only to be held accountable by its citizens.

In California, AB 939 carried a $10,000 per day penalty if a jurisdiction was not in compliance with the planning and/or implementation schedules. Ralph Chandler, the first executive director of the IWMB, noted the importance of the AB 939 legislature using a carrot-and-stick approach to induce cooperation. He explained, “Unless you have strong mandates with clear benchmarks and significant regulatory hammers, you are not going to see the anticipated results that help you achieve your policy objective.” He also explained that while the penalty sent a strong message to local jurisdictions, the Act also established technical support, planning tools, and state-sponsored programs to

LA's Upstream Proposals

Advocate for Extended Producer Responsibility for toxics - Advocacy for legislation making businesses responsible for their products that contain toxics such as pharmaceuticals, fluorescent lights, household batteries, treated wood, and other materials banned from disposal statewide

Advocate for Extended Producer Responsibility for difficult to recycle materials - Advocacy for legislation making businesses responsible for their products that are difficult-to-recycle materials, such as disposable diapers, composite materials, tires, white goods, durable goods, plastic, and food packaging

Advocate for State packaging legislation - Advocacy for packaging legislation making businesses responsible for their packaging, including alternatives to expanded polystyrene (expanded polystyrene containers, "peanuts" and "blocks") and plastic bags (statewide); and support for reusable shipping containers

Single use bag ban - Adoption of a citywide reusable bag policy at designated supermarkets and retail establishments (local policy approved by the City Council May 23, 2012)

Advocate for businesses to develop life-cycle analyses for products and packaging - Advocacy for businesses to develop life-cycle analyses for products and packaging, taking into account all environmental impacts of the product from manufacturing to the end of its useful life

Advocate for manufacturer take back programs - Advocacy for legislation to incentivize manufacturers to use local reuse and recycling markets for the products they manufacture

Figure 5.13
Priorities of EPR and Packaging Reduction Program of City of Los Angeles, as defined in SWIRP (LASAN, 2013)

help jurisdictions comply with the diversion mandates. The IWMB also worked with stakeholders to adjust the measurement methodology, establish more rigorous strategies for collecting data, and provide exemption protocols for cases where extenuating circumstances affected compliance (Chandler, 2016).

While NYC's Recycling Law did not include an enforcement plan or fine, the language chosen by the legislative sponsors was intentional to assure that the tonnage requirements were more than just aspirational goals. In stating, "The commissioner shall…establish and implement programs," NYC's Recycling Law was enforceable through litigation. However, as evidenced by the City's lengthy appeal process, noncompliance of the tonnage mandates, and eventual amendments to Local Law 19, the legal process brought forth by the NRDC had a marginal impact on increasing the diversion rate in the City. It is probable that if the State instead brought the action, the City might have been held more accountable to comply with the mandated provisions.

In 2011, California moved from a mandated diversion requirement to a voluntary recycling goal – an approach that appears to be a pivot from the carrot-and-stick tactic of AB 939. This is partially true, but California still mandates local jurisdictions to divert 50 percent of materials from disposal activities. Jurisdictions are still strictly monitored and face the same penalties if not in compliance with AB 939. The major change is that rather than perpetually increasing the requirements for jurisdictions, the legislature has decided to spread the responsibility of diversion/recycling to other stakeholders. AB 341 established a policy goal of achieving a 75 percent statewide

"recycling rate" by 2020.[58] However, it also directs CalRecycle,[59] to develop and adopt regulations for mandatory commercial recycling. The second bill, AB 1826, requires commercial businesses[60] to arrange for recycling services for organic waste and for local jurisdictions to adopt an organic waste recycling program for businesses and multifamily residential dwellings.[61] Signed in 2014, AB 1826 phases in the requirements over time from 2016 through full implementation in 2019.[62] These legislative directives are in addition to the ongoing requirements that have long-supported diversion activities, including mandated directives for extended producer responsibility programs, mandated reporting for facilities, and requirements for state agencies to purchase postconsumer recycled content products.

By shifting the responsibility away from the solid waste planning agencies, the theory is that policies and programs can address some of the upstream barriers to resource conservation or materials recovery. For example, Howard Levenson, CalRecycle's Deputy Director of Materials Management and Local Assistance Division, explained how the state is trying to address the historical challenges of establishing a robust organic materials market in the state of California:

> There are many social and environmental benefits to diverting organic materials from landfills, but part of the problem in

[58] AB 341 does not contain the word diversion and instead uses the term recycling for a range of activities related to source reduction, recycling, and composting.

[59] As part of a comprehensive government reorganization plan in California, many of the CIWMB's functions were combined with the Division of Recycling to form the California Department of Resources, Recycling, and Recovery (CalRecycle) in 2010 (AllGov California, 2015).

[60] AB 1826 applies to businesses that meet certain thresholds.

[61] AB 1826 defines multifamily residential as dwellings that consist of five or more units.

[62] See Figure 5.14 for the implementation dates and thresholds of AB 1826.

Figure 5.14
AB 1826 phases in the requirements for businesses (including multifamily residential dwellings that consist of five or more units) over time based on the amount and type of waste the business produces on a weekly basis. (CA State Assembly 2014)

AB 1826 Implementation Dates and Thresholds

January 1, 2016: Local jurisdictions shall have an organic waste recycling program in place. Jurisdictions shall conduct outreach and education to inform businesses how to recycle organic waste in the jurisdiction, as well as monitoring to identify those not recycling and to notify them of the law and how to comply.

April 1, 2016: Businesses that generate 8 cubic yards of organic waste per week shall arrange for organic waste recycling services.

January 1, 2017: Businesses that generate 4 cubic yards of organic waste per week shall arrange for organic waste recycling services.

August 1, 2017 and Ongoing: Jurisdictions shall provide information about their organic waste recycling program implementation in the annual report submitted to CalRecycle.

Fall 2018: After receipt of the 2016 annual reports submitted on August 1, 2017, CalRecycle shall conduct its formal review of those jurisdictions that are on a two-year review cycle.

January 1, 2019: Businesses that generate 4 cubic yards or more of commercial solid waste per week shall arrange for organic waste recycling services.

Fall 2020: After receipt of the 2019 annual reports submitted on August 1, 2020, CalRecycle shall conduct its formal review of all jurisdictions.

Summer/Fall 2021: If CalRecycle determines that the statewide disposal of organic waste in 2020 has not been reduced by 50 percent of the level of disposal during 2014, the organic recycling requirements on businesses will expand to cover businesses that generate 2 cubic yards or more of commercial solid waste per week. Additionally, certain exemptions may no longer be available if this target is not met.

Figure 5.15
Outreach materials from County of Los Angeles Department of Public Works on mandatory commercial organics recycling requirements. (CalRecycle, 2015)

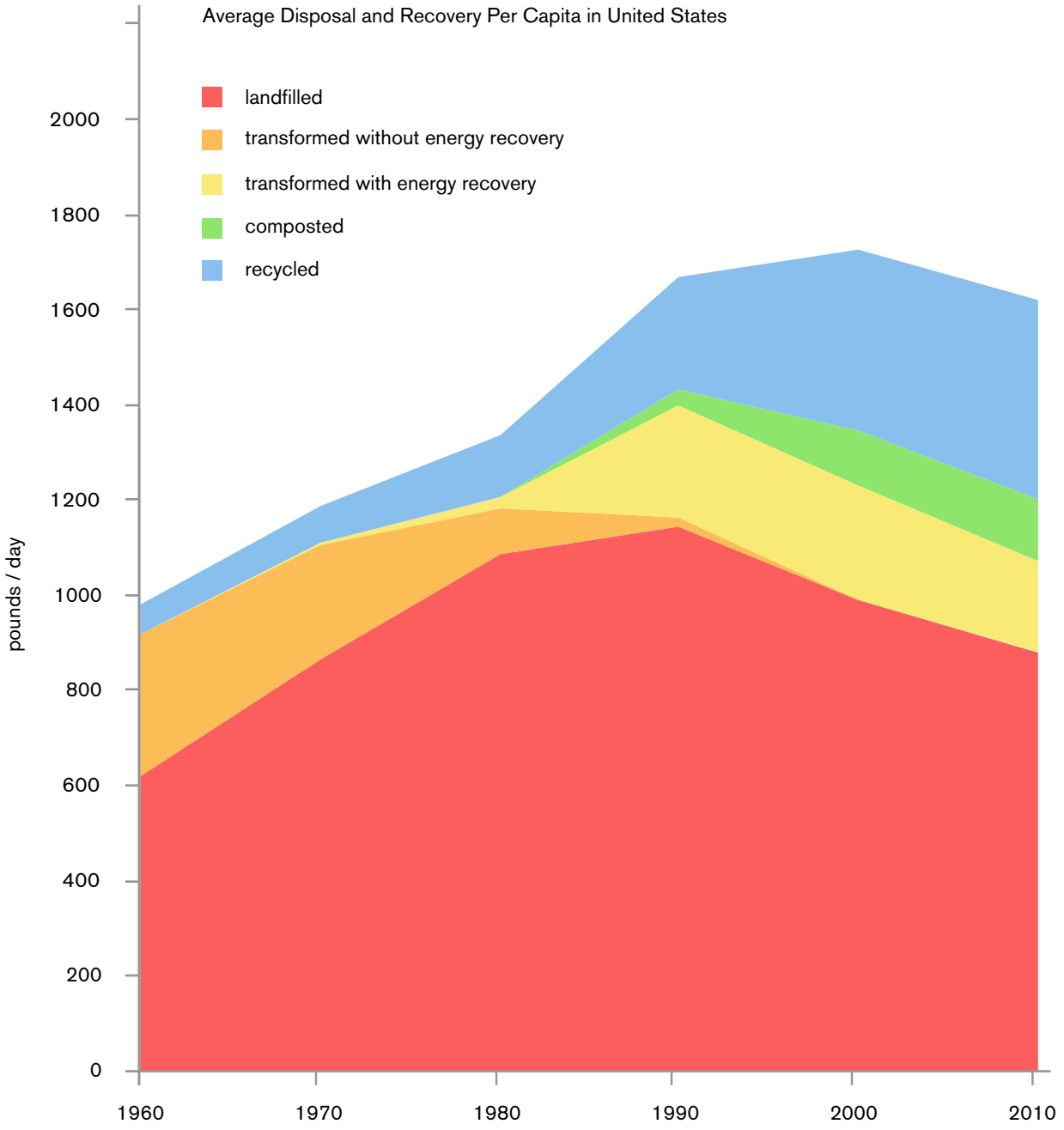
California is that landfilling is really cheap. Composting alone is marginal and with air and water quality restrictions, even more marginal. When you add anaerobic digestion technology to that equation, it becomes an expensive capital investment (with poorly established markets for its commodities). Therefore, we have to consider what is going to induce the public or private sector to make those investments. There are various policies that reward the move in that direction like funding incentives. There are also potential drivers like the commercial organics mandate and other climate change polices that will help change the market dynamics. We will no longer have a cheap outlet for disposing organics and there will be a consistent feedstock source (Levenson, 2016).


ISIDORE

FINDINGS 06

Measuring Sustainability

Figure 6.1
Per capita disposal and recovery
methods in United States
from 1960 - 2010 (EPA, 2014)



Measuring Sustainability

Although the diversion rate is on of the primary indicators used by municipalities to measure the performance of MSW management, it fails to address all of the environmental, economic, and social objectives that plans, policies, and stakeholders have acknowledged as important. For example, it does not accurately measure progress toward materials conservation. As shown in Figures 6.1 and 6.2, the per capita diversion rate in the United States has increased since 1960, but so has the total generation rate. The idea of sufficient production, central to Zero Waste, is not measured

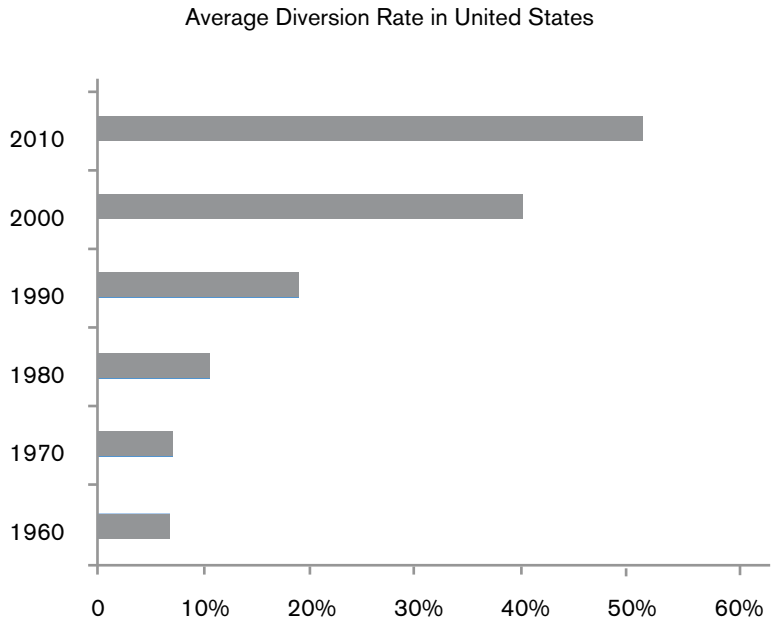
This chapter explores the shortcomings of the diversion rate indicator in promoting the principles of sustainability that stakeholders identified during interviews. Rather than just identifying the flaws of the indicator, the chapter presents strategies that have been successful in both cases, but relied on other metrics to measure progress.

ENVIRONMENTAL:

How to Promote the Highest and Best Use

There are standardized and comprehensive methods of evaluating environmental impact associated with materials management. As described in Chapter 3, life-cycle assessments provide a valuable decision-support tool for industry and policymakers in examining the energy and materials directly attributable to a product, process, or activity from cradle-to-grave (or cradle-to-cradle). However, because of their expense, they are rarely used in MSW management in the United States. Instead, planning agencies have relied on hierarchies of waste as evaluative tools to approximate environmental impact,[64] even

[64] In theory, a waste hierarchy could be location-specific and incorporate life cycle assessment into its development, but this has not been the case in practice..



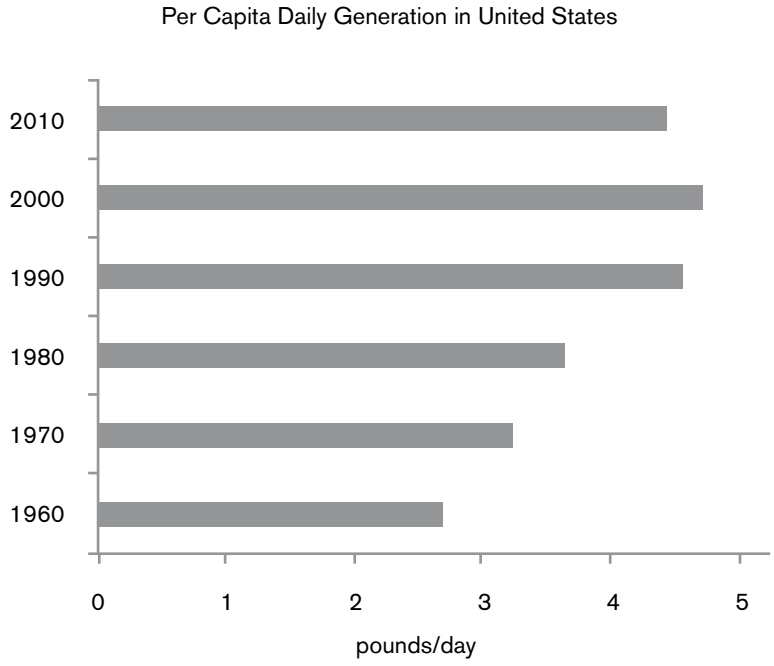


Figure 6.2
Per capita diversion and generation rates in United States from 1960 - 2010 (EPA, 2014)

though they lack scientific basis. To further exacerbate the estimation of environmental impact, the diversion rate indicator actually collapses multi-leveled waste hierarchies into two tiers – prevention, reuse, recycling, and composting versus energy recovery and landfilling. The indicator essentially equates some energy-intensive recycling operations with source prevention practices and toxic material substitution efforts.

Waste Hierarchies

Waste hierarchies are created to establish environmental priorities for stakeholders to apply to their policies, processes, or operations. Because the hierarchy effectively represents an inverse relationship between value and cost of solid waste management methods, mechanisms are required to loosen the stickiness of operating at the lowest levels. As evidenced by the waste management programs of the last few decades, without carefully considered incentives to move up the hierarchy, little progress is made. Therefore, to support actions according to a waste hierarchy, a proportional distribution of investment (money, time, political support, etc.) is required, but this is rarely adopted in practice.

[65] New York State's 1987 SWMP stated, "Over the next ten years, to 1997, the State's goal is to have the waste stream reduced up to 50 percent through waste reduction, recycling and reuse of waste materials (with 8 to 10 percent waste reduction)." The State Plan also established a waste management hierarchy, prioritizing: waste reduction; recycling and reuse; energy recovery; and landfilling (New York State Department of Environmental Conservation, 1986).

Waste Prevention

In 1989 when the Mayor approved NYC's Recycling Law, the City Council declared that the measures taken by the City "should be consistent with or surpass the reduction, recycling, and reuse goals established by the State" (New York Legal Publishing Corporation, 1990). Although the State explicitly created two indicators: one for source reduction and one for recycling and reuse,[65] NYC's Recycling Law only established an indicator to measure recycling progress. Because the Law mandated the City collect specific daily tons of recyclable materials, all of the allotted resources at the time were spent on recycling and nothing higher on the waste hierarchy.

Recognizing the shortcomings of the Law to achieve the State's goals, DSNY proposed a few reuse programs in its 1992 SWMP under the umbrella term of ***waste prevention***. However, most of its proposals for waste prevention consisted of DSNY's endorsement of current legislative and executive initiatives at the federal, state, and municipal levels. The SWMP stated that waste prevention was not really within DSNY's jurisdiction since it occurs upstream, prior to the waste management system (New York City Department of Sanitation, 1992).

For more than two decades, DSNY has provided funding and technical assistance to support materials exchange services for art supplies, books, building materials, industrial by-products, textiles, housewares,

[65] New York State's 1987 SWMP stated, "Over the next ten years, to 1997, the State's goal is to have the waste stream reduced up to 50 percent through waste reduction, recycling and reuse of waste materials (with 8 to 10 percent waste reduction)." The State Plan also established a waste management hierarchy, prioritizing: waste reduction; recycling and reuse; energy recovery; and landfilling (New York State Department of Environmental Conservation, 1986).

furniture, electronics, and other durable products (New York City Department of Sanitation, 2006, 2015b). Although there is significant potential to reduce the environmental impact through these reuse programs,[66] the overall estimated diversion rate for these programs is almost negligible. Less than three percent[67] of DSNY-managed waste was channeled through reuse partner organizations in 2014 (New York City Department of Sanitation, 2015a). It is certainly possible that these reuse networks might capture larger tonnages if there was more funding, education, accessibility, and convenience. However, the evaluation strategy of measuring environmental impact by diversion tonnage rather than employing life cycle thinking is important to consider. As seen in Figure 6.3, DSNY's annual recycling report tracks disposal and diversion tonnages in order to determine whether the diversion rate was met or not. Although DSNY is monitoring reuse tonnages, these programs simply cannot compete with the tonnages achieved in the scalable[68] commodity markets of paper, metal, glass, or plastic.

[66] DSNY's 1992 SWMP refers to these programs as 'waste prevention' initiatives although they technically fall within the 'reuse' category.

[67] In 2015, textile and other used materials donations equaled 55 tons, about 2.5 percent of DSNY's total managed diversion tonnage (New York City Department of Sanitation, 2015a).

[68] Because of the factors involved in bringing materials to market (or exchange), recycling operations are easier to scale than reuse activities.

Figure 6.3
DSNY's 2015 annual recycling statistics report (DSNY, 2015)

Type of Collection	Included in Diversion Rate (see note at bottom)	Managed By	Tons Per Day		Description
			Disposed	Diverted	
DSNY Curbside and Containerized Collections					
Refuse	C, CT	DS	9,663		Curbside Collections are roughly 90% residential; 10% institutional. Curbside Refuse is collected 2 or 3 times a week, and Paper/Cardboard Recycling & Metal/Glass/Plastic/Carton Recycling once a week, in bags or from cans set out at the curb.
Paper/Cardboard Recycling	C, CT	DS		1,018	Roughly 90% of Containerized Collections are from institutions, with 10% from large residential buildings. Containerized Collections take place at varying frequencies, from containers ranging from a 2 to a 30 cubic yard dumpster, to a compactor, to a Roll-Off container. If a waste generator uses containers for Refuse, they may, or may not, use containers for Paper Recycling. The use of containers for Metal/Glass/Plastic Recycling is rare. Often, waste generators set out their Refuse in containers, but opt for Curbside Collection of Paper/Cardboard Recycling and more often Metal/Glass/Plastic Recycling.
Metal/Glass/Plastic Recycling	C, CT	DS		784	Refuse also includes Street Basket Refuse collected by dedicated trucks and on the curbside routes.
Organics Recycling	C, CT	DS		43	In FY13, DSNY began Curbside Collection of organic material including food scraps, food-soiled paper, and yard waste from selected schools, institutions, multi-unit apartment buildings, and pilot neighborhoods. In addition, DSNY collects Christmas Trees citywide every January for composting. DSNY also collects food scraps from selected Green Markets. Budget permitting, DSNY collects Leaves and Yard Waste seasonally in all boroughs but Manhattan for composting.
Other DSNY Collections - Tons Disposed					
Street Dirt		DS	149		DSNY Street Sweepers brush and pick up dust and dirt from city streets daily.
Lot Cleaning		DS	12		DSNY cleans debris from abandoned lots. Bulk Metal collected from Lot Cleaning activity is diverted from disposal, and therefore is counted separately. See "Lot Cleaning: Metal Bulk" below.
Other City Agency Disposal		DS	307		Other Public Agencies + Non Profit Private Carters collect their own trash and dump it at transfer stations using DSNY's disposal contract.
Miscellaneous		DS	1		Pest Control, Abandoned Cars and Trucks, Emergency Response Division Cleaning, Emergency Response Division Hauling, Emergency Collections, Storm Sandy
Other DSNY Collections - Tons Diverted					
Lot Cleaning: Metal Bulk	DS	DS		-	Bulk Metal from DSNY operations, Lot Cleaning, and other operations is recycled, as are Derelict Vehicles which DSNY has the responsibility of removing from the streets. Derelict Vehicles are counted separately and not included in Diversion Rates. See "Abandoned Automobiles" below.
Other Metal Bulk	DS	DS		42	
Rikers Food Waste * *	DS	DS		5	Organic Waste from the kitchens and cafeterias at Rikers Island Correctional Facility are composted on-site by DSNY.
Harmful Products	DS	DS		2	DSNY diverts hazardous substances from disposal through residential drop-off facilities, recycling of various materials at DSNY garages, and collection of CFC's from appliances left for collection. Reporting of HHW, Automotive and Refrigerant diversion is part of the annual reporting to the Department of Environmental Conservation. In addition, other agencies report their management of harmful products through Agency Safe Handling Contracts.
Other Materials - Tons Diverted					
Redeemed bottles and cans	DS			174	The reverse vending machine industry reports on a voluntary basis the number and weights of containers redeemed in NYC. This information is an aggregate of all companies that reported.
Private Landscaper Leaf and Yard Waste	DS			56	DSNY accepts private landscaper waste for composting at its Fresh Kills compost site. In addition, DSNY accepts Christmas Trees and Wood Chips at its compost sites.
Other Organics Collections	DS			5	This includes food scraps collected from Green Markets and other locations that are funded, but not collected, by DSNY.
Re-fashioNYC Textile Donations	DS			4	Textile Waste collected from apartment buildings, non-profits and businesses, and recycled through "Re-fashioNYC", a DSNY-partnership program with the non-profit organization, Housing Works.
Textile Donations * *	DS			20	Textiles are collected for reuse or recycling through multiple strategies. This number includes DSNY-sponsored events, and information we have received about independent collections by non-profit community organizations, and other groups.
Other Used Materials Donations *	DS			31	Additional durable goods are collected for reuse or recycling in the City. This number includes DSNY-sponsored programs, and information we have received about independent collections by non-profit community organizations.
E-CycleNYC Electronics Collections * *	DS			1	Electronic Waste collected from apartment buildings and recycled through "E-CycleNYC", a DSNY-partnership program funded and implemented by the company Electronics Recyclers International, Inc.
Electronics Recycling *	DS			13	Electronic Waste is collected for recycling through mutiple strategies. This number includes DSNY-managed programs, including SAFE Disposal Events and Agency Safe Handling contracts. It also includes data we have received about independent collection events facilitated by non-profit community organizations, retailers, and other outlets.
Rechargeable Battery Recycling *	DS			0	The Rechargeable Battery Recycling Corporation (RBRC) can report to DSNY the weight of rechargeable batteries collected in NYC covered by the NY State Rechargeable Battery Recycling Law.
Plastic Bag Recycling * * *	DS			N/A	The NY State Dept of Environmental Conservation does not track or report weight of plastic bags recycled by retail stores located in NYC that are covered by the NY State Plastic Bag Recycling Act.

Diversion and Tonnage Summary

	Disposal (Tons)	Diversion (Tons)	2015 Diversion Rate	2015 Diversion Goal	2015 Goal Met?	+/-
Not counted in Totals		1,793	N/A			
Curbside and Containerized (C, CT)	**9,663**	**1,844**	**16.0%**	16.0%	Yes	0.0%
DSNY-Managed Total (DS)	**10,131**	**2,197**	**17.8%**	16.0%	Yes	1.8%

Despite the conflicting priorities of diversion rate indicators and waste hierarchies (in practice), this approach continues into the Zero Waste movement. The Zero Waste International Alliance established a 42-level hierarchy (refer to Figure 6.4). Beginning with Rethink, the hierarchy is guided by value distinctions according to a complete life-cycle analysis of material flows:

> Minimize ecological footprint required for product, product use, and service provision; Encourage the preservation of resources and discourage their destructive disposal or dispersal.

It also describes incentives to promote a closed-loop model:

> Shift funds and financial incentives to support a Circular Economy over the harvesting and use of virgin natural resources; Enact new incentives for cyclical use of materials, and disincentives for wasting.

However, the Alliance often entangles different levels of the hierarchy together in a way that doesn't suggest a commitment to any prioritization of impact:

> Design and purchase products from reused, recycled or sustainably-harvested renewable, non-toxic materials to be durable, repairable, reusable, fully recyclable or compostable, and easily disassembled (Zero Waste International Alliance, 2015c).

Their lack of explicit boundaries is also reflected in their 90 percent diversion from disposal goal. By including all activities that reduce, reuse, recycle, and compost materials, as acceptable ways of achieving Zero Waste, there is no assurance that anything but the easiest and cheapest option will be selected. Again, as evidenced by the diversion goals in New York City, only modest changes have occurred in the number of prevention and reuse activities while recycling dominates the equation.

Zero Waste Hierarchy of Highest and Best Uses

Rethink

- *Design and purchase products from reused, recycled or sustainably-harvested renewable, non-toxic materials to be durable, repairable, reusable, fully recyclable or compostable, and easily disassembled;*
- *Shift funds and financial incentives to support a Circular Economy over the harvesting and use of virgin natural resources;*
- *Enact new incentives for cyclical use of materials, and disincentives for wasting;*
- *Facilitate change in how end users' needs are met from "ownership" of goods to "shared" goods and provision of services;*
- *Support and expand systems where product manufacturing considers the full life-cycle of their product in a way that follows the Zero Waste Hierarchy and moves towards more sustainable products and processes. Producers take back their products and packaging in a system that follows the Zero Waste Hierarchy;*
- *Identify and phase out materials that cause problems for Closed Loop Systems;*
- *Facilitate and implement policies and systems to encourage and support local economies;*
- *Re-consider purchasing needs and look for alternatives to product ownership;*
- *Provide information to allow for informed decision-making;*
- *Be aware of and discourage systems that drive needless consumption.*

Reduce

- *Plan consumption and purchase of perishables to minimize discards due to spoilage and non-consumption;*
- *Implement sustainable purchasing that supports social and environmental objectives as well as local markets where possible;*
- *Minimize quantity and toxicity of materials used;*
- *Minimize ecological footprint required for product, product use, and service provision;*
- *Choose products that maximize the usable lifespan and opportunities for continuous reuse;*
- *Choose products that are made from materials that can be easily and continuously recycled;*
- *Prioritize the use of edible food for people;*
- *Prioritize the use of edible food for animals.*

Reuse

- *Maximize reuse of materials and products;*
- *Maintain, repair or refurbish to retain value, usefulness and function;*
- *Remanufacture with disassembled parts; dismantle and conserve "spare" parts for repairing and maintaining products still in use;*
- *Repurpose products for alternative uses.*

Figure 6.4
ZWIA adopted the first Zero Waste Hierarchy of Highest and Best Uses in 2013 as part of Zero Waste Week. (ZWIA, 2015)

Recycle/Compost

- *Support and expand systems to keep materials in their original product loop and to protect the full usefulness of the materials;*
- *Maintain diversion systems that allow for the highest and best use of materials, including organics;*
- *Recycle and use materials for as high a purpose as possible;*
- *Develop resilient local markets and uses for collected materials wherever possible;*
- *Provide incentives to create clean flows of compost and recycling feedstock;*
- *Support and expand composting as close to the generator as possible (prioritizing home or on site or local composting wherever possible);*
- *Whenever home/decentralized composting is not possible, consider industrial composting, or if local conditions require/allow, anaerobic digestion.*

Recover

- *Maximize materials recovery from mixed discards and research purposes after extensive source separation;*
- *If conditions allow, recover energy using only systems that operate at biological temperature and pressure.*

Residuals Management

- *Examine materials that remain and use this information to refine the systems to rethink, reduce, reuse, and recycle in order to prevent further discards;*
- *Ensure minimization of impacts by means of biological stabilization of fermentable materials;*
- *Encourage the preservation of resources and discourage their destructive disposal or dispersal;*
- *Plan systems and infrastructure to be adjusted as discards are reduced and its composition changes;*
- *Minimize gas production and release and maximize gas collection;*
- *Use existing landfill capacity and maximize its lifespan. Ensure it is responsibly managed;*
- *Contain and control toxic residuals for responsible management.*

Unacceptable

- *Don't support policies and systems that encourage the destructive disposal of organics and/or the destruction of recyclables;*
- *Don't support energy and destructive disposal systems that are dependent upon the continued production of discards;*
- *Don't allow the incineration of discards;*
- *Don't allow toxic residuals into consumer products or building materials.*

ECONOMIC:

Financial Viability of Resource Conservation and Recovery

The financial viability of a solid waste management's system is complicated to assess because it is a structured set of components that are sensitive to market fluctuations, generation rates, contamination rates, and program incentives. While the rate-with-date indicator has occasionally served as a signal for investors interested in the development of diversion activities and related infrastructure, it has not helped lower the costs of diversion as predicted in the 1980s. While the social and environmental benefits of resource conservation and materials recovery are now widely acknowledged, there is not always the requisite financial support to ensure a municipality can maximize its diversion rate. This is particularly true for waste management agencies that have no direct authority over the revenue stream and thereby cannot raise rates, structure financial incentives, or fund research pilots without legislative or budget changes.

Municipal Budget Priorities

New York City allocates funds each year for DSNY's services through the City's Executive Budget (New York City Council, 2016). The City of New York remains one of the few large cities to provide services[69] with funding exclusively from the general tax revenue. Because the Mayor and City Council use the annual Executive Budget to establish priorities and allocate resources accordingly, DSNY's operating budget remains exclusively in the hands of elected officials. As fiscal crises have impacted the City over time, DSNY has also felt the effect.

[69] DSNY collects waste from all residential units, all non-profit organizations and City agencies housed in tax-exempt buildings.

Robert Lange, director of DSNY's Bureau of Waste Prevention, Reuse, and Recycling, explains:

> Having worked for the City for almost thirty years, I can tell you that the City's financial situation impacts what we do. For example, when you institute a (program), you have to have enough patience as a municipal government to see it through. Historically, every two to four years, there has been a recession or fiscal crisis where we're told to cut ten percent of the budget, so we have to pick what we're going to cut.

Although New York City established a recycling mandate in 1989, signaling its commitment to the recovery and reuse of recyclable materials, the municipal budget did not always reflect that promise.

In the 1980s, when local landfill capacity was diminishing, many cities began researching and proposing extensive incineration infrastructure. The public opposition to these proposals helped establish extensive public support for alternate strategies like recycling. Eric Goldstein, Environmental Director for the Natural Resources Defense Council, reflects upon the initial lack of political support for resource conservation and recovery in New York City:

> Surveys showed that the vast majority of people in every borough, regardless of political party, race, or class, all supported recycling. However, if they were forced to make a choice between decent housing, low crime, and good schools, recycling would be lower on the list for them. Consequently, for a number of (Mayoral) Administrations, they paid very little attention to the issues of solid waste. Solid waste policy in New York City was crisis-oriented because intensity counts a lot in politics. When the proposals for incinerator projects had the ironic effect of making recycling now a real big public

> policy issue, this empowered environmentalists and solid waste activists to go to the City Council and get the (recycling) statue passed.

While the NYC Recycling Law established comprehensive requirements to "jumpstart the recycling program" with legally enforceable mandates, the mixed political support by the City's government officials became evident over time as annual budgetary funds were distributed (Goldstein, 2016).

Right after NYC's Recycling Law was passed, progress toward the diversion rate mandate was stalled by a citywide budget shortfall. With the limited budget allocations, DSNY deployed scattered curbside collection services[70] throughout the five boroughs, but the City struggled to recycle sufficient tonnages to achieve the Law's mandates. Gradually, DSNY unified the program, expanded the number of collected materials, and provided a consistent weekly collection schedule (Sze, 2007). By 2002, the City's diversion rate had grown to 19 percent of the DSNY-managed waste stream. Although the City was finally making progress toward its recycling goals, it was also facing the worst financial deficit in decades in the wake of the September 11th attacks. Many city services endured budget cuts that year, including DSNY's recycling program (Clarke & Maantay, 2005).

The newly elected Mayor Bloomberg wanted to suspend recycling of metal, glass, and plastic to save the City roughly $50 million. In a

[70] Recycling services were initially stratified citywide Different boroughs and districts received different levels of service until 2000 (Sze, 2007).

compromise with the City Council, who was facing mounting public pressure to preserve the program, the City decided to scale back the operation. DSNY would continue to recycle metal, mixed paper, and cardboard but suspend plastic recycling for one year and glass for two years (Clarke & Maantay, 2005). According to Marjorie Clarke, former co-chair of the Manhattan Citizen's Solid Waste Advisory Board, the changes to the program confused the public and recycling participation rates declined as a result.[71] DSNY had spent millions of dollars teaching the public to separate more of its materials from the solid waste stream; now residents would have to recycle less. The temporary suspension of plastic and glass also required three discrete educational messages[72] to inform residents of what DSNY would accept for recycling. As a result, even after the recycling program was fully restored, the citywide diversion rate had dropped to 15.8 percent and has not substantially increased since 2004[73] (Clarke, 2016).

Negative Pricing and Market Failure

One of the principal economic challenges with diversion mandates in the United States is that municipalities are required to recycle even when the market value of certain commodities falls to zero. Planning and collection of MSW is often the responsibility of the municipality while

[71] In the three months immediately after the cessation of plastic and glass collections, data showed that paper/cardboard recycling rates also declined by over 12 percent even though DSNY was still collecting paper/cardboard (Clarke, Read, & Phillips, 1999).

[72] The decision necessitated five discrete educational messages to instruct residents: (1) to alternate weekly set-outs; (2) not to set out glass or plastic; (3) a year later, to reinstate plastics; (4) 10 months later, to reinstate glass, and (5) to restore weekly set-outs .

[73] DSNY's diversion rate for curbside and containerized materials was 16 percent in 2015. The diversion rate for all of DSNY-managed materials (including street dirt, lot cleaning, redeemed bottles and cans, textile donations, etc.) was 17 percent in 2015 (New York City Department of Sanitation, 2015a).

private sector firms largely run processing and disposal operations. Once the materials leave the public sector, they are subject to the global commodity market to determine their value. In the early days of MSW recycling, it was assumed that the cost to collect and process materials would be mitigated by their sale to manufacturers. While this is sometimes true, there is significant variation in the establishment of markets for different materials as well as substantial volatility of commodity pricing. Therefore, there are times when processors are unwilling to buy certain materials and municipalities with diversion mandates must actually sell materials for a negative price[74] rather than dispose them (New York City Department of Sanitation, 2004).

From a cost perspective, diversion activities are in direct competition with landfills and incinerators, but methods of disposal in the United States are often cheaper options than methods of diversion. CalRecycle recently published a statewide analysis of tipping fees[75] at landfills that concluded "landfills are likely the cheapest path for materials to flow down" (California's Department of Resources Recycling and Recovery, 2015c). This is noteworthy in a state that has made significant progress expanding its recycling infrastructure and now operates at a scale that should be cost-competitive with alternate methods of disposal. The reality is that the market-based policy instruments for environmental protection have not successfully internalized the environmental externalities associated with the cradle-to-grave means of production.

[74] "Selling at a negative price" means that municipalities must pay processors to accept materials that have no value (New York City Department of Sanitation, 2004).

[75] A tipping fee is the charge levied upon a given quantity of waste received at a waste processing facility.

Almost all solid waste management options require significant capital investment, but reuse, recycling, and composting programs are much more labor intensive than disposal options. (Refer to Figure 6.5 for the number of employees required for each type of operation.) Landfills and transformation facilities are also well suited for the heterogeneous product that municipalities deliver and can offer bulk discount rates to large producers. Conversely, the costs associated with diversion often disproportionately increases as the rate increases. For example, there may be scalar advantages to increasing the diversion tonnage of aluminum, but the capture and diversion of food waste requires unique educational campaigns, collection and processing equipment, and market analysis. Since the easiest materials to recover were already selected[76] and the most willing generators already are participating, recovering the materials still in the waste stream or reaching non-participating generators will be a costly affair. To promote the highest and best use of materials must be viewed as a social and environmental good that requires the financial and regulatory assistance of government to guarantee.

Research and Development Assistance

One method that government agencies have employed to support the highest and best use of materials is through financial assistance for businesses to develop or expand their capacity to prevent, reduce, reuse, or recycle. This upstream approach helps spread the responsibility of resource conservation and recovery from MSW planning agencies and sanitation departments to other parties. The State of New York developed an innovative program in the early 1990s that not only

[76] The "easiest materials to recover" refers to materials selected because collection, sorting, and processing costs were minimal and/or there were already existing secondary markets.

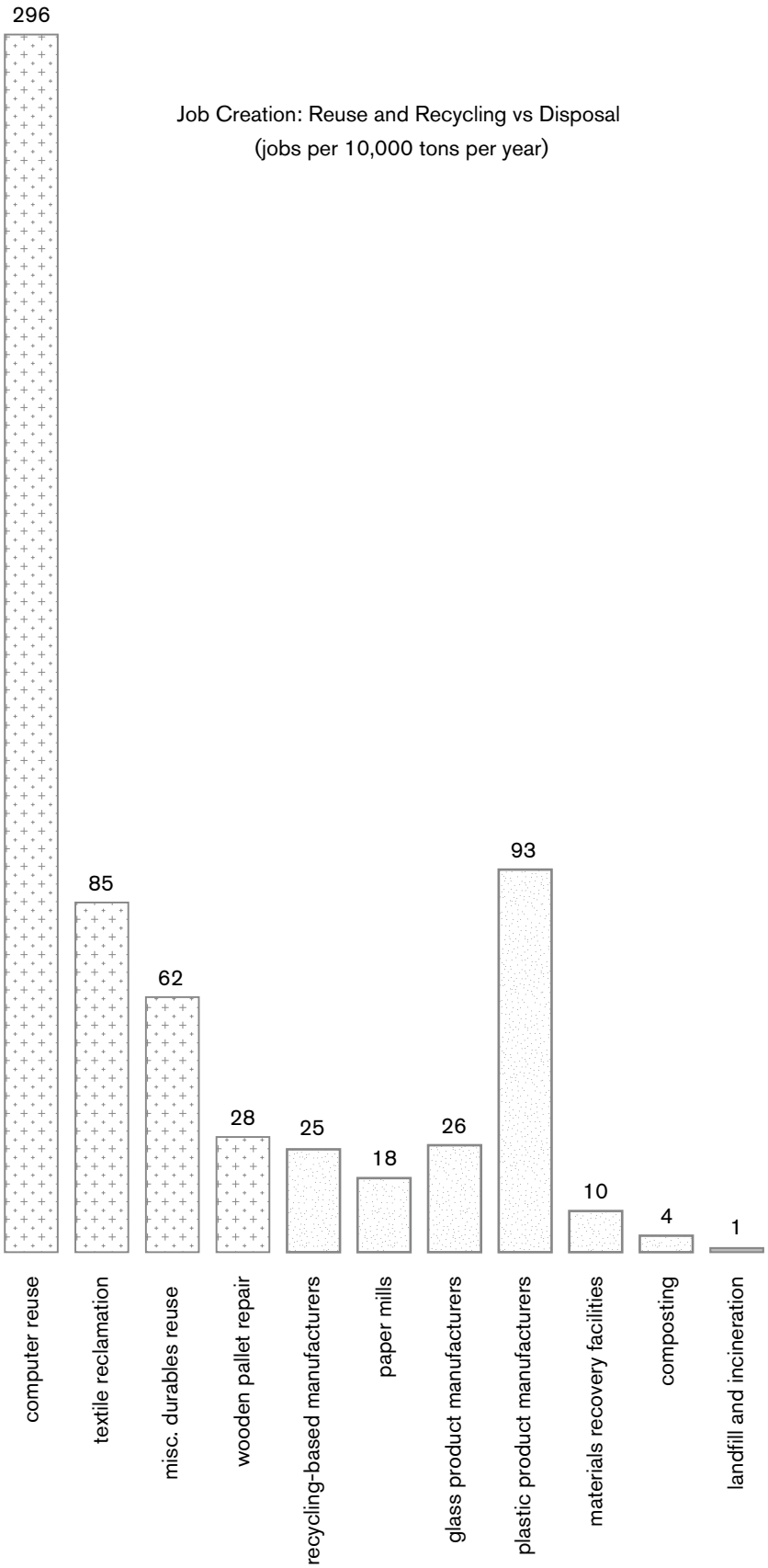


Figure 6.5
Number of employees required for each MSW management option (ILSR, 1997)

produced environmental benefits, but also yielded numerous jobs and extensive returns on investment. Developed within an economic development agency rather than the DEC, the program staff brought their understanding of markets to solid waste management in a way that produced far-reaching results.

The State of New York established the Office of Recycling Market Development (ORMD)[77] within the Empire State Development Corporation shortly after the New York Solid Waste Management Law was passed. The ORMD helped the State identify and establish markets for the recyclable materials municipalities were collecting. Brenda Grober served as one of their information specialists, facilitating the development of a market-based industry within New York State. Reflecting upon the conception of the ORMD, Grober noted:

> We were mandating communities across the state to divert recyclable materials for recovery without any understanding of the dynamics of recycling or what exactly was going to happen to those materials. All of a sudden we had stockpiles of materials as tall as the building with no idea of how to utilize them as resources.

According to Grober, the ORMD quickly realized they needed to help both municipalities and manufacturers understand the financial viability of recycling in order to put those stockpiles to use. The ORMD provided technical assistance for local planning agencies to analyze their diversion volumes, sorting capacity, associated operation costs,

[77] The ORMD was initially called the Environmental Conservation Services Unit when it was founded.
[78] The expression, secondary materials, traditionally refers to industrial byproducts of a manufacturing process that are used as an ingredient of another manufacturing process to create another product.

and secondary materials[78] commodity pricing. They even tested recycling cooperative pilots with to individual coordinate material recovery operations volumes models. They also provided research and development funding for businesses interested in utilizing the diverted materials. The funding helped businesses understand the characteristics of the recyclable materials; the economics of utilizing those materials instead of virgin supplies; and the available technology that could be efficiently applied to those processes. Despite its broad market development mandate; however, funding was initially limited [79] (New York State Department of Environmental Conservation, 2010).

In 1993, the State Legislature established the Environmental Protection Fund to support a broad range of environmental initiatives, including solid waste programs at the DEC and ESD. With annual allocations from the EPF, the ORMD[80] created a formal financial assistance program to support a broader definition of the ***recycling market***.The Environmental Investment Program (EIP)[81] provided matching grants to projects that lead to the reuse, remanufacturing, or recycling of secondary materials, but also supported projects that would reduce the volume or toxicity of waste before it is generated. Funds were available for capital investment; technical assistance; and research, development, and demonstration.

[79] From 1987 to 1993, the ORMD awarded nearly $2 million in feasibility study grants, committed $1.4 million in loans and interest subsidies, and directed an additional $36 million in loans, interest subsidies and loan guarantees from the Urban Development Corporation and the New York State Job Development Authority (New York State Department of Environmental Conservation, 2010).

[80] The Office of Recycling Market Development's name eventually changed to Environmental Services Unit.

[81] The Environmental Investment Program was initially called the Recycling Investment Program until the ESD changed the name in 1998.

Although the ESD is not directly affiliated with DEC, they worked collaboratively to establish investment priorities based on DEC's strategic objectives and areas of greatest inefficiency in the marketplace. Because the EIP was an outcome-based funding program, projects were required to achieve environmentally significant results and economic benefits to receive funds (See Figure 6.7 for aggregated economic and environmental benefits achieved by EIP projects.) Between 1994 and 2008, the EIP committed nearly $60 million and leveraged $221 million in private sector support. The State's financial commitment to market development for diversion activities had increased 14 times[82] during this period, providing assistance to about 400 projects throughout the State (See Figure 6.8 for two NYC-funded projects).

Despite the comprehensive focus and impact of the EIP, the program ended in 2013. Currently, there are no comparable state-sponsored programs in New York State that provide funding opportunities for businesses to invest in the prevention, reuse, and recycling industry. Financial investment is primarily limited to municipal infrastructure[83] or academic research. The DEC voiced concern about the lack of investment from the state in waste reduction and recycling programs before the closure of the EIP program, referencing per capita investment of other states for comparison (See Figure 6.6). Despite the pleas of DEC to further expand allocations of the EPF to solid waste planning, state legislators have prioritized other areas of focus instead.

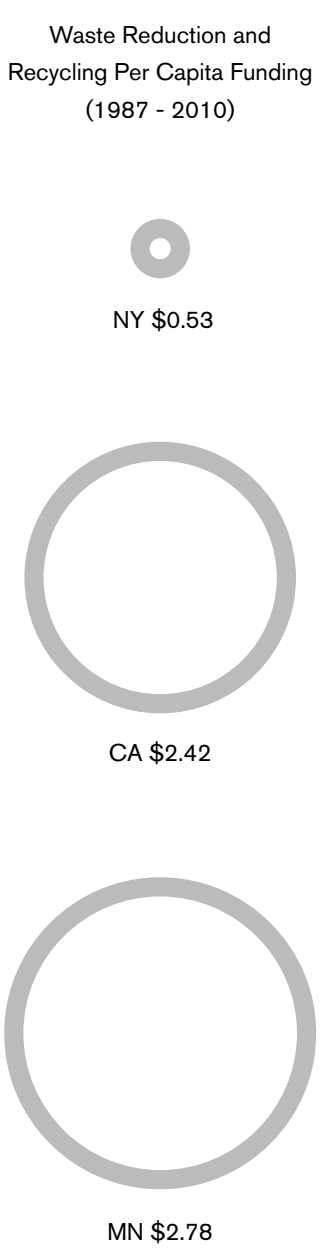


Figure 6.6
Per capita investment of states in waste reduction and recycling programs (DEC, 2010)

[82] The average annual budget for grant funds went form $285,000 to $4,000,000.

[83] The DEC currently funds a few programs: Municipal Waste Reduction and Recycling Program, Household Hazardous Waste Program, Municipal Landfill Closure Program, and Municipal Landfill Gas Management Program.

Business Waste Prevention

Investments:
- ESD: $671,612
- Private: $530,161

Benefits:
- $1,363,702 annuallly
- 24 jobs created
- 1,097 companies assisted
- 19, 212 tpy materials recycled or reused

C&D Recycling and Reuse

Investments:
- ESD: $2,679,032
- Private: $4,367,831

Benefits:
- $13,470,570 annually
- 54 jobs created
- 226,570 tpy recycling capacity installed
- 485,445 tpy materials recycled or reused

Glass

Investments:
- ESD: $3,738,288
- Private: $9,613,068

Benefits:
- $12,355,678 annually
- 250 jobs created or retained
- 395,498 tpy recycling capacity installed
- 227,249 tpy materials recycled or prevented
- 1.65 mgpy water reduced or recycled

Organics

Investments:
- ESD: $11,559,163
- Private: $33,241,351

Benefits:
- $36,402,338 annually
- 886 jobs created or retained
- 864,738 tpy composting capacity installed
- 556,667 tpy materials composted
- 3,415 tpy waste prevented

Reuse and Material Exchanges

Investments:
- ESD: $1,810,372
- Private: $3,228,334

Benefits:
- $6,393,691 annually
- 11 jobs created or retained
- 1,968 tpy new reuse capacity
- 22,443 tpy materials reused

Metals

Investments:
- ESD: $1,694,532
- Private: $6,858,686

Benefits:
- $85,609,151 annually
- 84 jobs created or retained
- 376,000 tpy recycling capacity installed
- 295,743 tpy materials recycled or prevented

Paper

Investments:
- ESD: $8,579,327
- Private: $39,682,244

Benefits:
- $20,146,650 annually
- 1,324 jobs created or retained
- 875,746 tpy recycling capacity installed
- 422,092 tpy materials recycled or prevented
- 367 mgpy water reduced or recycled

Plastics

Investments:
- ESD: $6,041,722
- Private: $9,399,670

Benefits:
- $15,441,392 annually
- 291 jobs created or retained
- 97,154 tpy recycling capacity installed or retained
- 45,588 tpy materials recycled or prevented
- 124 mgpy water reduced or recycled

Figure 6.7
Aggregated benefits achieved by all Empire State Development environmental investments from 1987 - 2008 (NY DEP 2010)

New York State
Environmental Investment Program
Capital Project Summary
IceStone, LLC

Project Background
IceStone, LLC manufactures IceStone®, a 100 percent recycled glass and concrete durable surface material for commercial and residential applications (countertops, showroom surfaces, bathroom vanities, bathroom dividers, etc.) in a 55,000 square foot daylight facility in the Brooklyn Navy Yard. IceStone is non-toxic, free of volatile organic compounds and manufactured using a low emission process. The company has 60 employees. In the manufacturing process, recycled glass is mixed with cement, water, pigments and proprietary ingredients, poured into molds, cured and polished. IceStone began operations in 2003 after purchasing the recycled glass/concrete manufacturing system from Great Harbor Design Center. The production yield of the manufacturing system was low due to a combination of many factors (curing conditions, mix design, vibration conditions, etc). Most of these were addressed and corrected via an Environmental Investment Program R&D project completed in September 2006. The remaining factor affecting product output was the polisher.

Polishing is a crucial, final step in the manufacturing process, ensuring the product's structural integrity and revealing the luminescence of the glass, and creating the look for which the product is named. The polishing machine had been purchased at the time the Great Harbor Design Center was formed and was now nearly ten years old. The equipment's age, as well as its outmoded technology, regularly caused structural problems in the slabs, such as bowing and breaking. The machine also required three passes to complete each slab. Only 37 percent of the polished slabs were saleable. The company was spending money on labor, overhead and raw materials to produce slabs that ultimately could not be sold and the poor production yields adversely affected the company's ability to keep up with the growing demand for its product.

Project Description
At the outset of the project, a European manufacturer was chosen to supply the polishing equipment. A purchase order was placed in June 2006. The manufacturer completed construction of the polisher in May 2007 and the machine was shipped to a warehouse in the U.S. for holding until IceStone was ready for installation. Preparation of the area for machine installation started in May 2007. A building and some structures on the factory floor were removed. Then, geotechnical and structural engineers determined that, in order to support the weight of the machinery, the foundation needed to be strengthened. This was an unforeseen and major obstacle for IceStone. It required an additional $600,000 construction contract that included a new foundation, the driving of 20, 60 foot steel piles into that foundation, and the construction of a four foot thick concrete pile cap. Because of the additional construction (and the need to identify and negotiate financing for it), final site preparation was not complete until May 2008. During the installation, it was discovered that the polishing belt had been damaged during shipment. A replacement part was ordered and in November 2008 the equipment was turned on for the first time and calibrated. The first production runs began in December 2008.

Project Results
Initial production runs indicate that the new polisher is yielding 86 percent saleable product and IceStone anticipates that this will increase over time. The improved yield has helped to boost IceStone annual sales by $ 3.7 million, reduce waste by 3,348 tons per year (compared to what the old polisher would have generated at present day sales levels), and saved the company $2.4 million per year in raw material and disposal costs (compared to what it would have cost using the old polisher at present day sales levels).

Contractor:	Brooklyn Economic Development Corporation	**NYS EIP Investment:**	$100,000
County:	Kings	**Contractor Match:**	$636,283
ESD Region:	New York City	**Total:**	$736,283
ESD Contact:	518.292.5340	**Completion Date:**	Dec., 2008

New York State
Environmental Investment Program
Technical Assistance Project Summary
Community Environmental Center, Inc.'s
"Build It Green!" Building Materials Reuse Center

Project Background
Founded in 1994, Community Environmental Center (CEC) is the largest not-for-profit energy contractor in New York State, serving large portions Brooklyn and Queens through weatherization contracts with the New York State Division of Housing and Community Renewal and the New York State Energy Research and Development Authority. In 2004, CEC commissioned a study on the potential of deconstruction contracting and retailing reused building materials in New York City. The study revealed large untapped demand for both. Using grant funds from the U.S. Environmental Protection Agency, CEC assembled and trained a crew of 10 deconstruction workers. Another grant from the Durst Foundation then enabled CEC to contract with Durst to deconstruct five buildings. By the time the work was completed, CEC had salvaged 70 tons of reusable materials. CEC sold a portion of the materials directly from the job sites and from a temporary storage space. Having shown that the model could work, CEC then applied for and secured EIP assistance to start up and operate a building materials reuse center (BMRC) called "Build It Green! NYC" (BIG!NYC). BIG!NYC was launched in leased warehouse space in Astoria, New York. At the time of its startup in March 2005, with the exception of structural timbers there were no other City outlets for reusable, salvaged construction and demolition materials and the vast majority of reusable items still flowed to disposal.

Project Description

BIG!NYC's focus during start-up was on warehouse and retail operations, so during this period CEC did not engage in deconstruction activity. However, as with most BMRCs, once word got out that BIG!NYC existed, the operation was quickly overwhelmed by the flow of reusable building materials. To ensure sufficient revenue and to control costs, BIG!NYC focused on obtaining and selling items with the highest resale value rather than on larger quantities of lower value materials. At the close of the project, BIG!NYC was open Tuesdays through Saturdays from 10 am to 6 pm, had two full-time and two part-time employees, and was generating approximately 250 sales per month.

Project Results
BIG!NYC set goals to divert 1,020 tons of building materials from disposal, generate $299,000 in revenue and save NYC businesses $194,650 in avoided purchase and disposal costs over the first two years of operation. By the end of the project, BIG! had generated higher revenues ($357,903) after diverting only 427 tons of building materials, and saved businesses $162,880. BIG! had raised more revenue with less tonnage than anticipated.

Lessons Learned
Access to at least one truck and a dedicated pick-up crew is crucial to a BMRC's ability to collect reusable materials at a moment's notice. Calls for donations tend to come in just before items are to be disposed, so being able to move quickly is essential. Also, BIG!NYC lowered its standard discount on materials from 50% to 75%-off to sell more items rather than focus on obtaining the best price per item. Finally, BIG! has only scratched the surface of capturing saleable items from the approximately 13,500 tons of construction debris disposed of daily in NYC. It is estimated that NYC could support at least five additional BMRCs similar to BIG! Now that the BMRC is established and growing, the CEC plans to target development of its deconstruction services.

Contractor:	Community Environmental Center, New York, NY	**Investment:**	$260,000
County:	Queens County	**Contractor Match:**	$421,768
ESD Region:	New York City	**Total:**	$681,768
ESD Contact:	518/292-5340	**Completion Date:**	October, 2007

Figure 6.8
Reports from two EIP-funded projects in NYC (ESD, 2013)

Figure 6.9
The City of Los Angeles operates a Pay-As-You-Throw system based on the size and number of black bins. (City of LA, 2013)

Pricing Incentives

Another issue with the financial viability of 'diversion' arises with policies that employ pricing incentives to encourage participation. Unlike New York City, many other municipalities pay for their MSW services with a combination of tax funding and monthly charges paid by generators. While some cities charge a fixed rate per unit, others offer a Pay-As-You-Throw (PAYT) system[84] to create a financial incentive for generators to lessen the volume of disposed material (National League of Cities: Sustainable Cities Institute, 2013). While the EPA reports that PAYT communities can reduce between 25 and 45 percent of their disposal tonnages (United States Environmental Protection Agency, n.d.), there are some issues with revenue generation for municipalities with high diversion rates.

The Bureau of Sanitation in Los Angeles currently uses a proportional PAYT pricing structure for its residential customers.[85] The price is based upon the number and size of black bins residents used for their solid waste disposal (See Figure 6.9). Recycling and composting services (collected in blue and green bins, respectively) are provided at no additional cost to the customer as a financial incentive to divert more materials from landfills and incinerators (City of Los Angeles Public Works Bureau of Sanitation, 2013). One issue with the City moving toward Zero Waste is that the black bin fee is currently subsidizing the recycling and composting services. Right now, all households pay for a 60-gallon black bin, whether they fill it or not. However, when generators stop producing waste for the black bins entirely, will the

[84] PAYT programs may include proportional pricing, variable rate pricing, or multi-tiered pricing.

[85] Residents of the City of Los Angeles pay a set price per unit of trash that they generate, but there is variability in the rate if the resident opts for a larger bin.

municipality still charge them a solid resource fee? Will this send a mixed message about their participatory progress?

In theory, as more items are diverted to the green and blue bins, the black bin fee could increase for those still disposing of waste. However, this is a challenging concept to sell to the public. According to Reina Pereira, a senior environmental engineer with LASAN, the public may be hostile to another fee increase since it was as low as $6 per month in 2003 and now costs $36.32 per month.[86] Since the City Council must approve any changes to the solid waste fees, LASAN can advocate for their restructuring, but does not have the authority to make those decisions alone (Cavanaugh, 2008; Pereira, 2016).

SOCIAL:

Public Participation

Changing the waste system implicitly requires changing practices and behaviors. For those interested in the systematic redesign of the production and disposal system, the goal is bigger than individual behavioral change. It ultimately requires significant buy-in from all stakeholders. Although the diversion rate may provide a proxy estimation of public support, it does not account for why stakeholders are not participating or help resolve any structural limitations to participation. While surveys are often administered to understand participation rates, well-organized convening opportunities in New York City and Los Angeles have provided more than just qualitative feedback for policymakers. In both cities, citizen-led groups have often filled in the gaps for local and state agencies, providing research, conducting

[86] The solid resource fee for one 60-gallon black bin is $36.32 per month for single family dwellings and duplexes and $24.33 per month for multi-family dwellings (three or more units) (The City of Los Angeles Public Works Bureau of Sanitation, 2016).

educational campaigns, and advocating for legislative changes.

New York City's Advisory Groups

With the enactment of the Recycling Law, New York City was required to establish a citywide recycling advisory board (CRAB) and five citizens' solid waste advisory boards (SWABs). These boards were expected to provide recommendations to elected officials about New York City's recycling program, with particular respect to methods of educating the public and encouraging participation in the recycling program (New York Legal Publishing Corporation, 1990). Comprised of members from various professional backgrounds,[87] the CRAB and SWABs have historically done more than just review and provide recommendations about the City's SWMP and its periodic updates.

According to Marjorie Clarke, former Chair of the co-chair of the, the Manhattan SWAB's list of accomplishments (see Figure 6.10) demonstrates, "The SWAB has a long history of making creative recommendations, advocating for more money for recycling and waste prevention, providing new research, and seeing some of those efforts come to fruition in the form of new legislation and higher budgets." Clarke also pointed to the CRAB's policy document, Recycle First, as a tool that had significant impact on the City's movement away from its incineration plans (Clarke 2016). Concurrent with the longstanding environmental campaigns that highlighted the human end environmental impacts of MSW incineration, the CRAB's report

[87] According to Local Law 19, "Membership of each citizens' board shall represent community boards, recycling industries, carting industries, environmental organizations, government agencies, labor organizations, business organizations, property owners, tenant organizations, and member of the general public, Members shall serve for a term of two years without compensation and shall designate one member to serve as chairperson and one as vice-chairperson."

- Recommended DSNY establish an intensive recycling zone in Park Slope. This pilot project has served as a focal point for research into additional recyclables such as food waste, mixed plastics and papers, and household hazardous waste, as well as more intensive waste prevention education.

- Conducted a successful budget fight to restore recycling funds to the Fiscal Year 1992 budget when it appeared recycling might be terminated entirely. This included obtaining 15,000 signed petitions and production of a radio spot to encourage public input into this decision.

- Influenced DSNY to require recycled content in blue bags in the residential recycling regulations.

- Established contacts with the Rent Stabilization Association, Local 32BJ (the building superintendants' union), the Council of New York Cooperatives, the Real Estate Board, and many other major residential housing organizations in the City to improve recycling participation rates.

- Advocated for the passage of Intro. 131, which gave the City Council the power to approve or disapprove the SWMP before it could be submitted to NYS Department of Environmental Conservation.

- Commissioned the Appendix to Recycle First, the citizens' advisory boards' alternative to the SWMP. This collection of several dozen case studies on recycling education, collection, processing, marketing, and on waste prevention and composting, not only buttressed Recycle First's arguments, but also served to move DSNY to conduct much more of their own research in these areas.

- Recommended a prevention-oriented waste composition study, which was included in the SWMP. DSNY has issued a massive RFP to undertake this and other important research they recommended.

- Inspired the creation of the DSNY position of Director of Waste Prevention and supporting staff for the position.

- Provided critical input into the City's procurement debate, introducing novel concepts on buying products and packaging which are more reusable, durable, and recyclable, less toxic and more energy-conservative, and having extended warranties and more recycled content.

- Conducted educational seminars for the public on recycling issues, market development for recyclables and procurement of recycled products.

- Educated NYC Community Boards about solid waste management and conducted a series of forums to encourage public acceptance of fairly distributed solid waste management facility sites.

Figure 6.10
Manhattan SWAB's list of accomplishments
(Maggie Clarke Environmental, 2005)

helped advocate for alternative methods of managing MSW. The City Council subsequently approved a long-term SWMP that emphasized recycling, waste prevention, and composting (Casey & Mehrotra, 2011).

In response to the long-standing efforts by environmental justice organizations in New York City, DSNY included principles of borough equity in its 2006 SWMP. To help distribute the burden of waste infrastructure more proportionately across the City, the SWMP established four community advisory groups (CAGs) in districts[88] that would host solid waste facilities in its 2006 SWMP (New York City Department of Sanitation, 2006). In the last decade, the CAGs have advised city administrators on community-related concerns regarding the development of converted marine transfer stations (MTS). One MTS is currently operational and the remaining facilities are under construction. The most contested facility is the East 91st Street MTS where residents have fought through lawsuits, protests, and electoral efforts for years to stop the project. However, as the project moves forward, their CAG[89] continues to meet regularly with representatives from DSNY and other city agencies to address community concerns. One compromise that came from these meetings was the relocation of an access ramp leading to the MTS in order to mitigate the facility's impact on the neighborhood (Rosengren, 2015).

[88] The four solid waste facilities include: Hamilton Ave in Brooklyn District 7, Southwest Brooklyn in Brooklyn District 11, East 91st Street in Manhattan District 8, and North Shore in Queens District 7 (SWMP 2006).

[89] The East 91st Street CAG includes elected officials, community members at large, and representatives from community-based organizations like We Act, Pledge 2 Protect, Civitas, and Upper Green Side. Some of the opposition efforts to the MTS have come from the leadership of this CAG (Pledge 2 Protect, 2016).

Education to decrease consumption – Partner with L.A. Unified School District to develop a Zero Waste curriculum and increase recycling in the schools.

City leadership as a model for Zero Waste practices – Demonstrate leadership in recycling at all City facilities and parks. Model Zero Waste behaviors such as phasing out expanded polystyrene foam takeout containers.

Education to increase recycling – Educate residents and businesses about existing City programs and encourage them to make recycling and Zero Waste "second nature."

City leadership to increase recycling – Lobby for State legislation on initiatives, such as producer responsibility and packaging legislation.

Manufacturer responsibility – Support initiatives to encourage or require producers to take responsibility for the "end of life" management of products and packaging.

Consumer responsibility – Require stakeholders to participate in recycling and composting programs.

Convenience – Provide recycling receptacles wherever there are waste receptacles.

Incentives – Provide more incentives for recycling and composting, such as "pay-as-you-throw" rate structures.

New, safe technology – Support the development of new, safe technology for managing the City's waste. Technology should not impact already burdened communities.

Protect public health and the environment – When embarking on any new idea or plan, the City should carefully consider the long-term consequences and impacts.

Equity – All areas of the City should share in the burden and benefits of new facilities. New developments should pay their fair share of the system-wide costs. All generators should have access to recycling and composting, and sensitive environmental areas and communities should not be burdened with waste impacts. Green jobs created by new programs and facilities should support the local communities.

Economic efficiency – Find solutions that are both economically efficient and environmentally preferable. Promote economic sustainability through investment in green jobs and economic development.

Figure 6.11
Guiding principles identified by stakeholders during the SWIRP planning process in Los Angeles in 2008 (City of LA, 2013)

Community Participation in Los Angeles

In 2007, the City of Los Angeles initiated an innovative community-driven planning process to develop its Solid Waste Integrated Resources Plan (SWIRP). The purpose of the stakeholder outreach was to "hear first-hand the leading issues and concerns related to solid waste and to solicit recommendations for both motivating greater public participation and ultimately changing waste disposal behavior." The first phase of the planning process involved the establishment of 12 guiding principles (see Figure 6.11) and the second phase was dedicated to the identification and analysis of policies, programs, and facilities to implement that vision. After years of constituent interviews, business outreach, regional workshops, citywide conferences, and scenarios evaluations,[90] the SWIRP was published in 2013.[91]

Parallel to the participatory-process of the SWIRP, a collaborative stakeholder-engagement process also transpired to address concerns with the City's non-exclusive permit system for the management of commercial waste. In response to mounting concerns by community-led advocacy groups, the City Council directed the Bureau of Sanitation to study franchise system options. Working with consultants[92] and local stakeholders, the Bureau of Sanitation responded with a proposal for an exclusive franchise system because it would offer the greatest

[90] The public outreach process brought together more than 3000 stakeholders throughout the City during more than 250 meetings, workshops, and citywide conferences.

[91] The City of Los Angeles published a Program Environmental Impact Report, Financial Plan, and Implementation Strategy in 2014.

[92] In 2010, the Bureau of Sanitation contracted with HF&H Consultants to prepare an analysis comparing exclusive and non-exclusive franchise systems in terms of environmental, social, financial, and customer service options.

possibility of achieving a high diversion rate while also minimizing health and environmental impacts. By the spring of 2014, the City Council almost unanimously approved the exclusive franchise system for the commercial waste sector (Murphy & Pincetl, 2013).

Many of the stakeholders involved in the SWIRP planning process with the Bureau of Sanitation formed the coalition, Don't Waste LA (DWLA), to promote changes in the commercial sector. Led by the Los Angeles Alliance for a New Economy (LAANE), DWLA hoped to supplement the work of the SWIRP with a combined commercial-sector franchise. Not only did they underscore challenges of meeting the City's Zero Waste goals without reforming the commercial waste sector, the coalition also provided elected officials with exhaustive policy recommendations. Working with the Los Angeles City Attorney's Office and the Bureau of Contract Administration to ensure their recommendations were legally sound, the coalition "delivered policy language that was legally defensible, enforceable, and actionable" (Cornejo, 2016).

Comprised of environmental and community leaders, worker health and safety advocates, and small businesses, DWLA persistently advocated for changes to the commercial waste sector that would go beyond diversion goals. With an exclusive franchise system, DWLA identified opportunities to establish high-road standards in the Request for Proposal (RFP) document. Harnessing the diverse expertise of their coalition, DWLA submitted recommendations for the RFP to address issues of environmental justice; provide adequate safeguards and salaries for laborers; and reduce the sector's greenhouse gas

emissions. According to Jackie Cornejo, the former director of DWLA, the Project's success is attributed to their collaborative partnership and comprehensive vision:

> The industry was saying that we only wanted the exclusive franchise system because of labor issues, but when the Environmental Impact Review validated what we had been saying for five years, we felt vindicated. The exhaustive process of preparing our recommendations paid off because for the first time, we were not fighting against the California Environmental Quality Act process. It was supporting our proposal.

Initially conceived as an "impossible system to change," the commercial waste sector in the City of Los Angeles will transition to its exclusive franchise system by 2017 (Cornejo, 2016).

FINDINGS 07

Limitations of Data

Limitations of Data

A common problem for sustainability indices is that their utility at measuring progress is limited to the data collection and reporting practices in place. To reliably gauge a jurisdiction's progress in achieving its diversion rate goal requires accurate data on material flows. This information; however, is often estimated or inconsistently reported. In contrast to the hazardous waste stream, there are no mandated federal requirements or standards for reporting the flows of nonhazardous waste. More often than not, state agencies and local jurisdictions also have very limited reporting requirements for haulers and waste facilities. Even in cases where requirements are established, without uniform standards to ensure consistency and audit systems to assist with compliance, the accuracy and thereby utility of the indicator will still be in question. This chapter explains both the historical and current challenges of using the diversion indicator in New York City and Los Angeles.

Standards

One of the principal challenges with using a ***diversion rate*** as an indicator to measure progress is that there is no consistent approach to determine such a rate. The EPA tried to establish a voluntary, standard methodology for collecting, measuring, and reporting data in order to "achieve uniformity and address wide variations in what is counted as MSW and recycling from one area to another." Working with state and local officials to develop a national guide, the EPA reviewed a wide range of scopes before publishing *Measuring Recycling* in 1997 (United States Environmental Protection Agency, 1997). However, despite the acceptance of the guiding methodology at the time, widespread variability still exists across the country, within

states, and even within jurisdictions over time.[93] The EPA's website suggests that, in practice, few "define recycling in the same way, use the same approach for measuring recycling rates, or include the same materials in their rates" (United States Environmental Protection Agency, 2016b).

In their published guide, the EPA established standard elements for measuring recycling, including the designation of what is considered disposal versus recycling activities. The report also established measurement protocols for calculating the diversion rate, including standard units and ways to account for imports and exports of materials. (Refer to Table 7.1 for more detailed explanations of the six standard elements.) The guide also included steps for designing and implementing an effective recycling measurement system. For example, the guide offered suggestions of the type of data to compile, when to collect it, where to acquire it, and how to verify its accuracy (United States Environmental Protection Agency, 1997).

Although *Measuring Recycling* included suggestions for agencies with measurement programs already in place to switch to the standardized approach, there are likely many reasons for why so few have adopted the guidelines almost two decades later. One explanation is that state officials may be bound to existing data collection systems due to legislated requirements. The EPA's website also suggests that the difficulty of jurisdictions to obtain complete information may be a limiting factor in calculating a reliable rate (United States Environmental Protection Agency, 2016b). While all of these reasons may help explain the variability, the EPA has not published an update to their

[93] The lack of consistency over time makes longitudinal comparisons difficult to assess.

EPA's Standards for Measuring

Include only the standard scope of MSW

MSW is generated from residential, commercial, institutional, and industrial sources. Although it is common practice to landfill materials such as municipal sludge, nonhazardous industrial process wastes, and construction and demolition (C&D) debris along with MSW, these materials are not included in the standard scope of MSW or in calculating a standard recycling rate. Such wastes are referred to as Other Solid Waste in this guide.

Include only standard recycling activities

Some examples of recycling activities included are recycling old newspaper into new paper, recycling discarded aluminum cans into new ones, offsite composting of leaves, and mulching old pallets into wood chips. Preconsumer recycling, such as recycling trimmings from paper converting operations, is not included in calculating a standard recycling rate. Also omitted is the recycling of all non-MSW materials, such as C&D debris and used oil. Source reduction activities, including reuse practices and backyard composting, also are excluded from the standard recycling rate. Combustion for energy recovery, like other types of MSW disposal, is excluded.

Use the standard equation for calculating a recycling rate

The MSW recycling rate is calculated by dividing the total amount of MSW recycled (including offsite composting) in the measurement year (the previous calendar year) by the total amount of MSW generated. MSW generation is equal to the total amount of MSW recycled plus the total amount of MSW disposed of, in tons.

Account for imports and exports of MSW and recyclables

The standard methodology requires that your recycling rate include only materials generated in your state or locality.

Obtain data on a calendar year basis

To be consistent, the standard methodology requires collection of data for the previous calendar year (January to December).

Report data in tons

Data sources are asked to report quantities in tons and to use conversion factors if the tonnage is not available.

Figure 7.1
EPA's standard elements for measuring recycling (EPA, 1997)

recycling methodology since 1997 nor conducted a survey to identify what jurisdictions comply with their approach. Neither the City of Los Angeles nor New York has ever used the EPA's standard methodology to measure recycling. Both cities have followed explicit protocols as established by legislated requirements, updating their methods of measuring as the requirements changed over time.

New York State first introduced its constituents to the terms ***reduction rate*** and ***recycling rate*** in its 1987 SWMP where it outlined a statewide goal of 50 percent diversion in ten years. Although the DEC provided specific numerical goals and even offered a targeted schedule of reduction rates throughout the planning period, the SWMP provided limited guidance of how either rate might be calculated. Explicit definitions of ***reduction*** or ***recycling*** were not provided. There was no clear identification of what materials, activities, or sectors might be included in these calculations. The SWMP also did not provide any standardized units or equation to provide consistency among local jurisdictions.

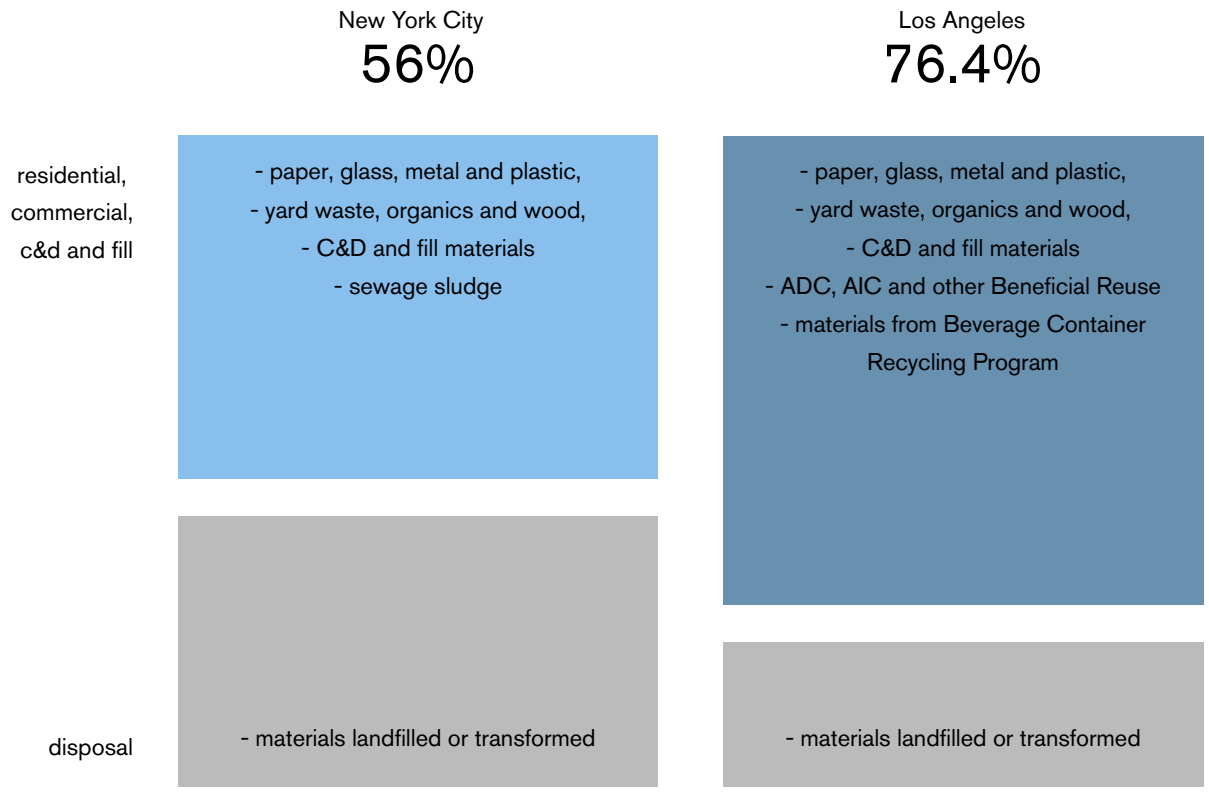
In the 1999/2000 SWMP Update, DEC presented a summary of progress for solid waste management in New York State from 1987 - 1997. The Plan included some data (via tables and charts) to demonstrate how its recycling goal was achieved. It also noted the State's methodology for measuring recyclables was different than the EPA because it included more types of recycled materials, such as used oil or beneficially used materials. In order to compare with the national average, DEC calculated the State diversion rate according to the EPA's standards – a six point difference (New York State Department of Environmental Conservation, 1999).

California first presented the ***diversion rate*** in 1989 as an indicator to measure progress in reducing the quantity of disposed waste in the state. The term, diversion rate, described the percentage of total waste diverted from disposal through ***diversion activities***. Under AB 939, ***disposal*** included landfilling, transformation, and exported waste. Diversion activities included source reduction, recycling, composting, alternative daily cover (ADC), alternative immediate cover (AIC), beneficial reuse at solid waste landfills, and transformation diversion credit.

Over time, California established different ways of measuring diversion progress and also updated its standards of what officially qualifies as diversion versus disposal. For example, the state switched to a per capita disposal rate indicator in 2008 to measure jurisdiction progress in a more simplified and timely way. A few years later, after the passage of AB 341, the legislature established yet another indicator. The term diversion is no longer used, replaced by the non-technical definition of ***recycling*** which covers a range of activities related to source reduction, recycling, composting, and anaerobic digestion. Under AB 341, ADC, AIC, other beneficial reuse at landfills, transformation credit, and waste tire-derived fuel are defined as ***disposal-related activities*** and no longer count toward the state's goal (California's Department of Resources Recycling and Recovery, 2015c).

Although the state stopped measuring progress with a diversion rate in 2008, the City of Los Angeles has continued to use this term in reporting to its continents. In 2006, the City adopted a Zero Waste goal with a 90 percent diversion rate before the state's per capita disposal measurement system was in place. The City's Bureau of

Figure 7.2
Diversion rates for New York City (2012) and Los Angeles (2011) (DEC, 2012; LASAN, 2011)



Sources: 2012 data from DEC's annual Planning Unit Recycling Report prepared by NYC's Department of Sanitation
Note: Materials from Returnable Container Act ("Bottle Bill") or are part of a Beneficial Use Determination are not reported (designation for materials that can be directed to alternative use considered to be beneficial compared to disposal). DSNY does not have information on disposal or recycling facilities receiving NYC commercial waste, either inside or outside NY State.

Source: 2011 data from City of Los Angeles' Zero Waste Progress Report
Note: Rate estimated according to CalRecycle's diversion methodology. Reporting method calculates rate using data from a base-year generator study to estimate annual diversion tonnage and data reported by haulers to determine diversion tonnage.

Sanitation (LASAN) then began a 6-year stakeholder-driven planning process to develop a Solid Waste Integrated Resources Plan (SWIRP) around that 90 percent diversion goal. The SWIRP has since defined 'diversion' as activities that "reduce, reuse, recycle, or convert the resources now going to disposal."

Incomplete Data

Another challenge with using a diversion rate indicator in practice is that it requires a systematic porting from many different stakeholders. In New York State, for example, DEC relies on planning units to report recycling and disposal data for all generating sectors within their planning unit. There is concern about double counting materials that pass through transfer facilities and the overall consistency among jurisdictions with units, material type, frequency of measurement, etc. However, the primary challenge in the State with respect to waste flow data is that the system is voluntary. Therefore, many planning units do not provide any data or only provide information on a portion of the waste stream. Annual disposal tonnages for municipally collected residential waste may be reported, while the commercial and institutional waste streams are omitted. DEC has noted that jurisdictions or sectors where waste is predominately privately-collected, the data reporting is particularly sparse. In their 2010 Beyond Waste Plan, DEC affirmed:

> Additional attention to the issue of the collection and use of data is critical to the state's ability to measure progress in moving Beyond Waste. It is important to evaluate one community against the next and to evaluate the state's progress in comparison to other states. DEC will continue to work with the EPA and regional organizations to develop consistent measures of success (New York State Department of Environmental Conservation, 2010).

In New York City, one of the challenges with collecting data is that the regulatory responsibility for nonhazardous waste management is shared by two agencies that have distinct priorities. In the 1950's, the responsibility for waste collection was divided between DSNY and private hauling companies. DSNY collects and processes waste generated by residences, institutions, not-for-profit organizations, and other municipal agencies (hereinafter referred to as DSNY-managed waste). Generators of commercial and C&D waste contract services with private hauling companies (New York City Department of Sanitation, 2003). While DSNY regulates some of the operations of permitted facilities and develops SWMPs for all sectors of the waste stream, the Business Integrity Commission (BIC) regulates the licensing of private haulers. This bifurcated system was established to control the expansion of organized crime in the commercial hauling industry (Arrona, 2016) Therefore, the mission of BIC[94] is to minimize collusion and ensure fair competition within the industries it regulates; it does not have an explicit interest in maximizing efficiency or promoting the other goals of the SWMPs.

Although the current commissioner of BIC is interested in evolving the mission of the agency, there are still numerous challenges to having a bifurcated system. According to Robert Lange, the director of DSNY's Bureau of Waste Prevention, Reuse, and Recycling, "It would make much more sense to integrate BIC with DSNY." In

[94] The BIC was formed in 2001 via a charter revision where the Trade Waste Commission was combined with the Markets Division at Small Business Service and the Gambling Commission. The Trade Waste Commission was initially established in 1996 as the regulatory agency to oversee commercial waste hauling in New York City.

Figure 7.3
Jurisdictional 'boundaries' for governing commercial waste stream in New York City (Lange, 2016)

addition to the regulatory challenges associated with overlapping management, Lange also points out the difficulties in planning for or supporting programs for commercial waste. Because the commercial waste leaves the governing bounds of DSNY while in possession of the hauler (see Figure 7.3), the Department has historically struggled to know the quantification and characterization of the commercial stream with any level of precision. Without the authority to mandate compliance from haulers for reporting data,[95] DSNY has relied on waste characterization studies of the commercial sector to provide information for their planning purposes. However, the expense of an accurate characterization study has constrained the number of funded studies[96] and without frequent updates, the data is also limited in its utility (Lange, 2016).

Integrity of Data

Another challenge with the use of indicators in solid waste management is how to determine and collect relevant data with an appropriate level of quality and integrity. There are always financial limitations to consider because of the cost-accuracy tradeoff paradigm with data collection (LCP Consulting, 2010). Whether a census, sample or

[95] DSNY has the authority to promulgate regulations at waste transfer stations and recycling processing facilities within the City's jurisdictional bounds. As part of their data-driven planning efforts, DSNY requires these facilities to provide station reports. Because haulers often deliver commercial waste to these facilities, there is an opportunity for DSNY to collect commercial waste data. The problem is that an unknown quantity of waste moves directly outside of the City limits to other transfer stations, processing facilities, or disposal sites. Because the quantity and destination of exported waste fluctuates according to economic and logistical decisions, DSNY cannot accurately account for this portion of the waste stream without other methods of verification.

[96] DSNY produced a "Commercial Waste Generation and Projection" study in 2004 and a "Commercial Solid Waste Study and Analysis" in 2012. According to Robert Lange, the 2012 study was not well funded and therefore the results are not very accurate and/or useful.

other estimation method is employed, there are biases and errors that will impact the accuracy of the data. If there are mandates or incentives without strict verification procedures in place, intentional misreporting of information may also occur (Powell, 2011). The key challenge will always be determining how much money and effort should be spent to limit those inaccuracies.

After the EPA published the *Agenda for Action* in 1988, 29 states passed laws that established recycling goals (National Solid Wastes Management Association, 1991). Although the EPA used data derived from statistical models to determine the feasibility of its national diversion rate,[97] they also cautioned that their estimates were only indicative of national averages. They warned that since there is regional variability, their figures should not be used for local planning purposes[98] (United States Environmental Protection Agency, 1977). However, a survey conducted by Recycling Times in 1991 reported that only a quarter of the states with recycling goals had analyzed data from their municipalities to calculate their diversion rates (National Solid Wastes Management Association, 1991).

The 1989 Recycling Law in New York City is a noteworthy case of how the use of inaccurate data can be a costly affair. As previously mentioned, the City faced litigation for more than a decade for not complying with the provisions of the Law. According to Robert Lange:

> The baseline data used to derive the figures in Local Law 19 was not carefully measured. Right away, we were able

[97] The EPA estimated 25 percent of total gross discards, by weight, could be recycled in 1975. This rate was used to support the Agenda for Action's goal in 1989.

[98] See excerpt from the Fourth Report to Congress.

> to demonstrate the tonnages were based upon inflated assumptions and that the target numbers made no sense. However, the members of City Council that passed the Recycling Law were not about to concede that the numbers were not rational. We weren't able to amend Local Law 19 until there was enough turnover in the City Council and there was no longer the same vested interest in those numbers (Lange, 2016).

California's Evolving Indicator

California is an example of a state that has mandated very specific disposal reporting requirements for stakeholders handling or managing nonhazardous waste, from hauler to district. The state's methodology for reporting has taken decades to develop and refine. Although it has one of the most comprehensive reporting systems in the country, CalRecycle still believes that more data – and more accurate and standardized methods of reporting – are required to achieve the state's objectives.

In California under AB 939, jurisdictions were required to produce studies where they quantified the amount and identified the types of solid waste disposed and diverted within their boundaries. They would use this information to measure progress toward the diversion mandates, expressing their diversion rate as diversion tonnage divided by disposal tonnage (California Integrated Waste Management Board, 2001a).

Fourth Report to Congress: Post-Consumer Solid Waste Generation and Resource Recovery Estimates

The material flows approach utilizes detailed U.S. government and industry trade association statistics on material consumption and product shipments to household and commercial sectors in deriving solid waste generation estimates. While this approach yields reasonably accurate estimates for most of the manufactured goods components of the waste stream, the food and yard estimates can be considered only rough approximations. In addition, the estimates presented are indicative only of U.S. nationwide totals or averages. Since there is considerable regional variability in waste generation, collection, and recycling rates, these nationwide figures should not be used for local planning purposes.

In 1990, after jurisdictions produced baseline studies, many cities and counties expressed concern about the difficulty and expense of obtaining diversion data[99] in comparison to disposal tonnages. In response to the concerns, the system was redesigned in 1993[100] to a disposal-based measurement system. Rather than require diversion data, the IWMB created a mechanism to estimate annual waste generation tonnages from a base-year estimate. These amounts were adjusted for changes in population, employment and taxable sales. The IWMB could then compare the actual disposal tonnage in any given year with a projected tonnage (if materials were not diverted) to determine an estimated diversion rate (California Integrated Waste Management Board, 2001a).

After almost a decade of using the disposal reporting system (DRS), the IWMB convened a few working groups of industry professionals to assess the accuracy of the system. They published a set of recommendations in 2001. Some of the issues raised by the working groups included:

- concerns about the large errors found during base-year estimations[101]
- the lack of adjustment for demographic changes in generator types (e.g. manufacturing community becomes bedroom

[99] Waste diversion activities are typically more decentralized, dispersed, and reluctant to provide information than disposal facilities.

[100] With the passage of AB 2494 in 1992, the IWMB was required to develop a disposal-based measurement system.

[101] About half of California's landfills did not have scales in 1990 when base-level studies were conducted and there were no standardized volume-to-weight conversion factors in lieu of scales. Measuring waste generation also proved costly and many studies contained inaccurate data.

- community)
  the lack of adjustment for changes in the nature of solid waste
- produced
- issues with identifying jurisdictions of waste origin
  variability in standards of measuring disposal (e.g. whether special wastes, construction and demolition debris, and/or inert waste should be included)

The Board reviewed the working group recommendations, spanning categories from data accuracy to alternatives to numerical compliance (California Integrated Waste Management Board, 2001a). As a result of the report, additional regulations went into effect in 2006 to improve the accuracy of the DRS with more frequent and rigid reporting requirements for haulers, facilities,[102] and jurisdictions (California Integrated Waste Management Board, 2005).

In 2008, California updated its measurement system again to move to a simpler, more timely, and more accurate indicator – a per capita disposal rate (California's Department of Resources Recycling and Recovery, 2012). Jurisdictions had to establish new base-year generator estimates from data collected during 2003-2006. From that data, per capita generator rates were established for comparison to per capita disposal rates for any given year. To meet the target of AB 939, a 50 percent equivalent per capita disposal target was calculated

[102] *Facilities* include landfills, transformation facilities, transfer stations, and material recovery facilities.

from the generator rate. For example, the base waste generation level in the Los Angeles jurisdiction[103] was 13.8 pounds per person per day. Therefore, their per capita disposal rate target is now 6.9 pounds per person per day. This is a unique target for the Los Angeles jurisdiction and therefore cannot be used to compare progress across jurisdictions (California's Department of Resources Recycling and Recovery, 2011).

[103] Although the City of Los Angeles establishes its own plans and policies for MSW through LASAN, the City of Los Angeles Area Integrated Waste Management Authority (LAIWMA) formed in the early 2000s as a local enforcement agency in order to report to CalRecycle. LAIWMA is a regional agency comprised of the following cities: Artesia, Beverly Hills, Duarte, Hidden Hills, Lynwood, Manhattan Beach, Pomona, Rancho Palos Verdes, Redondo Beach, Rosemead, Sierra Madre, South Gate, and Torrance.

DISCUSSION 08

Other Methods of Measuring


Tyve
Grab n Go

Other Methods of Measuring

Data in waste management is as old as the practice because the costs of collection and disposal have always had a close relationship with the quantity of waste produced. Because there were also opportunities to recover value,[104] data on the composition of the waste stream and its variability by generator type, season, and setting was also reported (Chapin, 1990). Over time, compilations of statistics on MSW were produced in the United States by federal agencies like the Office of Technology Assessment and the EPA. With the assistance of consulting firms, the EPA, also published manuals and conducted trainings on what type of data should be collected and how it should be measured and analyzed (U.S. Congress, 1989; United States Environmental Protection Agency, 1972, 1997). Although there is ample understanding of the value of data in solid waste planning and policymaking, the cost is often the limiting factor. Therefore, it is essential for governing agencies to select indicators that actually reflect the established priorities, pursue cost-effective or self-funded reporting systems to collect data, and develop estimation methodologies that accurately measure progress.

Waste Characterization Studies

Studies to determine the types of materials being discarded in a waste stream have evolved significantly from the 20th century. There are now consulting companies who specialize in characterizing material streams through site-specific studies. This approach relies on sampling, sorting, and weighing the individual components of the waste stream

[104] Initially, the only way a city could offset the costs of collection and disposal was through the sale of its solid waste to livestock farmers, particularly those raising swine. As reduction processes became popular, ammonia, glue, grease, and dry residuum for fertilizer were extracted from the waste and sold. Other salvageable materials were also sorted and resold, but this was not commonly viable at the municipal scale (Zimring & Rathje, 2012).

to estimate its composition. In contrast to a 'material flow' estimation approach, the site-specific studies can define a local waste stream with great specificity. Well-executed MSW studies[105] can provide data about the quantity and composition of materials generated by each sector, subsector, and region;[106] the quantity and composition of materials diverted; levels of contamination; and seasonal or market variations in the waste stream. From policymakers to private investors, the results from MSW waste characterization studies are useful for a variety of stakeholders, as the data may be applied to the following:

- planning and implementation of collection systems;
- design of transfer, processing, and disposal facilities;
- estimation of facility capacity;
- estimation of environmental impacts;
- development and assessment of diversion programs;
- justification of financial incentives;
- targeted development of secondary materials markets;
- development of policies;
- negotiation of franchising or facility contracts; and
- accounting of hauling costs (for PAYT customers)

  (CalRecycle, 2015a; Canadian Council of Ministers for the Environment, 1999; Carr, 2016; Lange, 2016; Levenson, 2016; Morrison, 2016; Pereira, 2016; Scott, 2016).

[105] Well-executed waste characterization studies include a systematic selection methodology; a representative sample size; and uniform field sorting protocols. The number of material categories may vary, but generally 10-15 primary categories and 40-60 secondary categories are defined. Generator data is less-often categorized, but becoming a prominent component (Canadian Council of Ministers for the Environment, 1999).

[106] Common sector categories include residential, institutional, commercial, and C&D. Subsector categories may include industry groups for commercial sector, number of units for residential sector, and project type for C&D sector. Regions may be classified by neighborhood, community district, zip code, county, etc.

DSNY in New York City has a longstanding history of using waste characterization studies to assist their MSW planning efforts. They conducted studies and applied the results to their initial SWMP. In New York City's Preliminary Recycling Plan of 1991, DSNY described the value of the composition study:

> By analyzing more precisely the materials that make up the City's waste streams, and in what proportions they appear, we will be better able to designate new materials for recycling, to design efficient collection systems, to build or procure the necessary processing capacity, and to locate markets for these recyclables (New York City Department of Sanitation, 1992).

Subsequent characterization studies for New York City have also focused on specific products and packaging for their waste reduction potential as well as targeted streams like street basket waste.

Waste characterization studies in New York City are also important tools used to periodically update the price terms in the City's agreements with recycling processors. For example, the results from New York City's 2004-2005 residential waste characterization study were used during contract negotiations with Sims Municipal Recycling of New York, LLC (hereinafter referred to as Sims). In 2008, the City signed a 20-to-40 year agreement with Sims, designating the company as the sole processor of DSNY's metal, glass, and plastic (MGP) stream and co-processor of DSNY's mixed paper stream. The characterization results formed the basis for the composition assumptions of each load of commingled metal, glass and plastics (MGP) or mixed paper. Because the contract is structured to even out the market fluctuations over time, it is important that both parties understand changes to the

diverted composition since each commodity's value can vary widely[107] (Lange, 2009).

The City of Los Angeles recently used data from their waste characterization study, combined with population and employment projections, to create a Generation Projection Model for their recent SWIRP (Donegan, 2016). LASAN explains that the projection helps to target materials for new diversion programs and calculate future processing requirements for each facility type (Pereria, 2016).

The City of Los Angeles also benefits from California's solid waste characterization studies, including data from the statewide reports in their planning processes. CIWMB and CalRecycle have completed nine site-specific studies since 1999, collecting data on materials disposed and diverted from the various sectors. The organization has committed to conduct these multi-million dollar studies with marked frequency because changes in the MSW composition vary according to demographics, economic activity, consumptive behaviors, and impact of diversion activities (Carr, 2016).

[107] According to Robert Lange, "MGP is processed by Sims Municipal Recycling of New York, LLC for a fixed fee, which is tied to inflation. The fee is modified monthly based upon the value of the commodities. If commodity values collectively increase above (but not below) a two-year base average, the tip fee is modified by the city's share of the increase being applied as an offset to the per-ton price in that month. Mixed paper is always a revenue generator. The price is calculated monthly in relationship to a floor price. Floor price varies based upon the tonnage delivered. In months where the "value" of a ton is higher than the floor price, the city is paid that amount per ton. In months where the "value" of a ton is less than the floor price, the city is paid the floor price and Sims receives a credit for the absolute difference between the monthly value per ton and the floor price – to be paid back when or if the monthly per-ton price exceeds the floor price (Lange, 2009).

California recently used the statewide waste characterization study of 2008 to pass new directives that help local jurisdictions further divert waste from disposal. The results of the study showed that the largest generator was the commercial sector and the largest material remaining in the disposed waste stream was organic waste.[108] Consequently, state legislators used the characterization results to implement laws focused on both the commercial sector and organic stream.

The State of New York, in contrast to California, has only published estimate statistics for its jurisdictions to use. In 2010, through a painstaking process, the DEC used data from dozens of composition analyses[109] to approximate the material composition in New York State. Using those figures, they created 'composition calculators' for planning units to estimate the MSW characterization for their specific geographic area.[110] While the calculators provide some information for local jurisdictions to use in their planning efforts the lack of specificity is marginally more helpful than the EPA's national material flow estimates.[111] The expense of producing a statewide characterization study has been the limiting factor in New York State. However, as previously mentioned, the value of site-specific data is really indispensable if localities want to make targeted investments in closing the materials loop.

[108] In California's 2008 Statewide Waste Characterization Study, other organic material was the largest class of material overall and within the residential and commercial streams. The other organic class consisted of food, leaves and grass, prunings and trimmings, branches and stumps, manures, textiles, and carpet.

[109] Data from the following sources were used to calculate New York State's 2008 MSW Materials Composition: New York City, Onondaga Co. Resource Recovery Agency, Seattle, San Francisco, Vermont, Wisconsin, Missouri, Georgia, Oregon, Ohio, Delaware, Pennsylvania, and California.

[110] Geographic areas were categorized as rural, suburban, and urban.

[111] DEC's characterization estimates are almost identical to EPA's projections.

Business Audits

As an addendum to New York City's first SWMP, a final strategic report on waste prevention was included. The report by CalRecovery[112] provided recommendations to address the structural barriers of waste prevention, including how to develop ways to determine the costs, analyze the effects on the local economy, and measure success of waste prevention efforts. The report stated, "Currently, there are no well established methods for measuring the effectiveness of reduction and reuse." Although this report was written 25 years ago, many of the identified barriers of waste prevention still exist, including how to measure progress.

In order to address the lack of measuring tools for waste prevention, CalRecovery's report recommended comprehensive programs to promote waste audits for businesses and institutions. Distinct from citywide or statewide waste characterization studies, these waste audits are conducted at the business- or institution-level. They provide specific data about the organization's materials acquisition, use, and disposal activities. Although the report suggested that the City could mandate waste audits, it also suggested voluntary programs to promote the financial savings[113] realized by organizations that undergo a detailed waste audit. In the last few decades, many businesses and institutions have voluntarily adopted waste auditing because the financial savings justifies the expense of the study. There are now organizations like the

[112] Marian Chertow led the research for CalRecovery's 1992 report. Chertow is now Director of the Programs on Solid Waste Policy and Industrial Environmental Management at Yale and considered a pioneer in the area of industrial symbiosis.

[113] There are front-end and back-end savings that can be realized from waste prevention. Waste audits can help with internal materials purchasing improvements and help lower costs associated with solid waste disposal.

U.S. Zero Waste Business Council that provide technical assistance, peer-to-peer mentorship opportunities, and certification programs for businesses interested in the benefits of waste prevention.

Per Capita Generation

New York State shifted from the diversion rate indicator to per capita metrics in its 2010 SWMP. Not only does this help normalize the data, but also per capita generation rates[114] can serve as indicators for materials conservation, reuse, and prevention. The problem is that neither California nor New York currently has accurate ways of measuring generation rates.[115] There are no reporting requirements for reuse, recycling and composting operations. In California, where some data is collected through a voluntary reporting system,[116] there are no mechanisms to ensure accuracy or consistency of reporting. To address this issue, CalRecycle is in the process of developing strategies to track the flow of materials throughout the state. With the passage of AB 901 last year, CalRecycle now has the authority to collect information directly from facilities and to expand reporting requirements beyond disposal operations. CalRecycle sees AB 901 as an important tool to help California measure its progress toward the 75

[114] Per capita generation rates equal the total amount of solid waste disposed plus the amount recovered, divided by the total population.

[115] Both states have accurate accounting systems for disposal data, but estimate total generation tonnages.

[116] CalRecyle's Facility Information Toolbox (FacIT) is a facility inventory of California's solid waste handling, recycling, and market infrastructure, and a capacity projection model. FacIT includes primary processors (transfer stations, materials recovery facilities, compost facilities, etc.) and secondary processors (recycled feedstock producers, recycled product manufacturers, etc.), emerging technology facilities, disposal facilities, and some primary collection facilities (California's Department of Resources Recycling and Recovery, 2014).

percent statewide recycling rate. Although the state is still developing the regulatory framework,[117] from the slides CalRecycle presented at the first informal meeting, it appears that the measurement system will not account for waste prevention activities. However, having tonnage data for disposal, composting, and recycling will contribute to a more accurate per capita generation rate that can be used in longitudinal studies to approximate waste prevention progress.

Outcome-Based Funding

One initiative in New York State that did establish ways of measuring the success (or failure) of waste prevention efforts was the ESD's Environmental Investment Program. As an outcome-based funding initiative, it required projects to produce measurable environmental benefits to receive matching funds. Although a variety of projects were funded during its 15-year tenure, there was a shift over time to prioritize projects that promoted waste and pollution prevention. Of course, the results were limited to projects financed by the EIP, but these likely represented the most innovative or impactful waste prevention initiatives at the time. The EIP not only required projects to account for its environmental outcomes (as shown in Figure 6.7), but also publish descriptive information about the project for the public to use. Figure 6.8 shows a sample of the published reports still available on the ESD's website.

Greenhouse Gas Emissions

[117] The regulatory development process and project timeline consists of informal workshops and a formal rulemaking process governed by the Office of Administrative Law. A series of informal workshops began in April 2016 and allows stakeholders to provide feedback on the creation of regulations related to AB 901. The formal rulemaking process is expected to be complete by mid 2017.

Through the issuance of climate change legislation around the country, there has been significant attention (and funding) dedicated to the reduction of greenhouse gas emissions, conversion to renewable energy sources, and promotion of energy efficiency practices. New York State's Energy Plan and California's Climate Adaptation Strategy both reflect these priorities. Legislative attention has recently begun to focus on reducing the emissions in hauling and disposing of waste in landfills.[118]

In the United States, landfills are one of the largest sources of anthropogenic methane. Greenhouse gases (GHGs) like methane are emitted into the atmosphere as a byproduct of the decomposition of organic material in landfills.[119] One of the ***short-lived climate pollutants*** (SLCPs), methane's comparative impact on climate change is more than 25 times greater than carbon dioxide.[120] Although some landfills are now equipped to capture and harness their landfill gases (LFGs) in order to reduce GHG emissions, they are not full-proof

[118] Although the associated greenhouse gas emissions from our current methods of production and consumption extend throughout the life cycle, the attention to emissions in solid waste is still a relatively new phenomenon.

[119] Landfill gas is comprised of approximately 50 percent methane and 50 percent carbon dioxide, with trace levels of other compounds (Environmental and Energy Study Institute, 2013). Because of the anaerobic conditions of most landfills, there is significantly more production of methane than when the bacteria are in the presence of oxygen. During aerobic decomposition, the decomposition emits predominantly carbon dioxide and very little methane (United States Environmental Protection Agency, 2016a).

[120] When measured in terms of their warming effects, short-lived climate pollutants (SLCP) are more powerful than the longer-lived greenhouse gases like carbon dioxide. However, as the name suggests, these pollutants have shorter atmospheric lifetimes (Environmental and Energy Study Institute, 2013). This statistic represents a pound for pound comparison over a 100-year period (United States Environmental Protection Agency, 2016a).

Figure 8.1
Per ton estimates of GHG emissions for waste management scenarios (EPA, 2015)

systems and will continue to emit LFGs while the landfill is actively receiving waste[121] (Environmental and Energy Study Institute, 2013; United States Composting Council, 2011).

During the scoping plan for California's Global Warming Solutions Act (hereinafter referred to as AB 32), the California Air Resources Board (ARB) began the process of identifying opportunities to reduce GHGs from the MSW sector. The ARB identified 'Recycling and Waste' as an early action measure,[122] recommending the reduction in landfill methane and a move toward Zero Waste as their optimal strategies. The 2008 Plan states that the ARB will work with CIWMB and others to develop and implement landfill methane controls, mandatory commercial recycling, organic diversion programs, waste reduction initiatives, and incentives for compost use (California Air Resources Board, 2008).

AB 32 requires California to reduce its GHG emissions to 1990 levels by 2020. Noting that the reductions would only be accomplished through "a combination of policies, planning, direct regulations, market approaches, incentives, and voluntary efforts," ARB established a Cap-and-Trade program as one of its key initiatives. Beginning in 2013, the ARB established the first cap of 162.8 million metric tons

[121] Methane collection at a landfill does not typically begin until the active portion of the landfill (the cell) is covered with an impermeable membrane. Some operator may begin collecting LFG prior to the cell's closure however, a significant amount of gas still escapes to the atmosphere. The EPA estimates that 25 percent of the methane generated in a landfill with gas collection will escape over the life of the landfill (United States Composting Council, 2011).

[122] "The 2008 Scoping Plan also identified the need for mandatory commercial recycling and other programs to develop and implement alternatives to landfilling" (California Air Resources Board, 2008).

– the maximum amount of GHG emissions that can be released that year. The cap will continue to decline about 2-3 percent each year to help reduce the amount of pollutants released in the atmosphere. Authorizations to emit in the form of emission allowances are allocated for trading during quarterly auction (California Air Resources Board, 2008, 2016). A portion of the proceeds from the auctions is deposited in the Greenhouse Gas Reduction Fund (GGRF). This provides an opportunity for the California to invest in climate action, with an emphasis on delivering benefits to disadvantaged communities. The first two years of funding from the GGRF, totaling $900M, concentrated on programs that achieved near-term GHG reductions, provided net carbon sequestration, or enabled long-term sector transformation (California Air Resources Board, 2015a).

Because the GGRF provides a substantial source of funding for California's developing "clean energy economy," there are unique opportunities for State agencies[123] to invest in emerging technologies. One of the recent proposals for GGRF allocations related to solid waste management came from the California Compost Coalition and Clean Fleets coalition. Their proposal is requesting funds to transition the state's waste collection fleet (still operating on diesel fuel) to a Clean Fleet that run on renewable natural gas (RNG), a carbon negative fuel. Their vision is that the RNG fuel for the collection trucks will be produced through the purification of biogas from community-

[123] The *administering agencies* of the GGRF largely consist of agencies on the State's Climate Action Team (CAT). Chaired by the Secretary of the California Environment Protection Agency, the CAT provides recommendations to the ARB for consideration as the Board develops its Climate Change Scoping Plans. The team reflects the input and expertise of a range of state and local government agencies (California Air Resources Board, 2008).

scale anaerobic digestion facilities. Sized to serve a population of 100,000, these facilities will predominately process food waste delivered by the Clean Fleet from commercial generators. In addition to the RNG, the digestion process will also produce digestate that can be further processed into a high-quality compost to be used on California's vineyards (California Compost Coalition and Clean Fleets, 2016; Edgar, 2016).

Titled the Biomethane Transportation Fuel Powering the Solid Waste Industry, this proposal weaves together Governor Brown's Climate Change Pillars[124] in a way that is suggestive of the potential for interagency cooperation. It hopes to mitigate methane generation from landfills, generate renewable energy, convert organics to a carbon negative fuel, sequester carbon into the soil (California Compost Coalition and Clean Fleets, 2016; Edgar, 2016). There are additional co-benefits of this proposal to improve soil conditions, including improvements to water-holding capacity and erosion control as well as the return of essential nutrients to the soil. Because there are several policy drivers[125] in California setting the stage for the diversion of organics from landfills, there is significant attention on infrastructure

[124] Governor Brown established the Climate Change Pillars: 2030 Greenhouse Gas Reduction Goals in 2015. The five pillars are (1) reducing today's petroleum use in cars and trucks by up to 50 percent; (2) increasing from one-third to 50 percent our electricity derived from renewable sources; (3) doubling the efficiency savings achieved at existing buildings and making heating fuels cleaner; (4) reducing the release of methane, black carbon, and other short lived climate pollutants; and (5) managing farm and rangelands, forests and wetlands so they can store carbon (California Air Resources Board, 2015b).

[125] AB 1826 mandates commercial organics collection. AB 876 requires local jurisdiction must identify 15 years of organic processing capacity. The draft of California's Short-Lived Climate Pollutant Strategy (SB 605) calls a 90 percent diversion rate of organics from landfills by 2025.

development at all levels to prepare for the anticipated tonnages of organic material that will return to the materials loop. There are still many issues of concern with bringing organic materials processing to scale in the most sustainable way. However, the outlined benefits are promising, particularly if agencies begin to function more collaboratively at the nexus of air, energy, soil, water, and waste (Levenson, 2016).

CONCLUSION 09

Conclusion

This thesis analyzed the strengths and limitations of the diversion rate as an indicator for measuring progress in Zero Waste Cities. The indicator helped Los Angeles and New York City establish extensive recycling infrastructure while highlighting some of the environmental issues associated with the linear system of consumption. As Eric Goldstein reflects, environmental values are much more widely shared as a result of recycling programs (see Figure 9.1). However, as critics of recycling have noted, these efforts have also promoted the equivalent of environmental absolution – because people can recycle, they don't feel pressure to change consumption habits (Luke, 1997; MacBride, 2012). Since the term diversion does not provide any indication of conservation or whether materials are being diverted indefinitely, it has not succeeded at accurately measuring either City's progress toward the tenets of Zero Waste. Other standardized methods of assessment should be utilized to measure and guide progress. Alternate forms of governance and product stewardship should also be tested to reflect the priorities central to Zero Waste.

"It is safe to say that the environmental movement has focused on municipal solid waste, specifically household waste, in part, as a way of changing public behavior and attitude. The hope is that as you participate in a recycling or composting program, you're actually thinking about your waste, where it goes, and how much you generate. It might even influence your purchasing decisions. Getting people to think more broadly about waste generation issues and consumption issues have fostered the development of environmental values that are now much more widely shared."

Figure 9.1
Quote from Eric Goldstein about the successes of NYC's 1989 Recycling Law (Goldstein, 2016)

Discussion

Zero Waste advocates promote their philosophy as an innovative vision for the 21st century – a transformative approach to the consumptive paradigm. In practice, however, Zero Waste looks like a rebranded version of the MSW frameworks of the 1980's. Despite the best intentions of advocates to promote upstream approaches to materials management, the responsibility of achieving Zero Waste still largely falls upon municipal solid waste planning agencies[126] rather than being

[126] In the case of both Los Angeles and New York City, the solid waste planning agencies only have enforcement powers over a portion of the waste stream.

shared among producers, consumers, and other political entities. As Robin Murray warns in his Zero Waste manifesto, "Waste cannot be treated in isolation. Waste is only the final stage of a much wider chain of production and consumption in which the problems associated with it are rooted."

Rather than creating new measures or signals of success, the Zero Waste plans of Los Angeles and New York City have continued to use the diversion rate as an indicator of progress even though the metric does not reflect the central tenets of Zero Waste. As analyzed in this report, the metric was initially established to address rising costs associated with limited disposal capacity. Although perceptions of solid waste evolved to consider a more comprehensive view of the social, economic, and environmental factors that are intertwined in MSW management, the indicator has not changed.[127] As explained in Chapter 5, because the diversion rate was not just a supportive tool, but also a mandated goal throughout California and New York City, it had the unintentional effect of promoting recycling rather than pollution prevention or resource conservation. Los Angeles and New York City had to meet the mandatory tonnages according to the legislature's prescribed deadlines so LASAN and DSNY predominantly focused on opportunities to maximize diversion rates. They supported the most cost-effective, scalable, and measurable[128] strategies that diverted materials from disposal even when that contradicted what was known to be best in terms of social, economic, or environmental sustainability.

[127] Both CalRecycle and DEC have made changes to the way they measure progress; however, neither Los Angeles nor New York City adopted those changes when establishing their Zero Waste goals.

[128] These strategies were the easiest to measure. As mentioned in Chapter 6, waste prevention and reuse activities are traditionally difficult to measure.

Interagency Responsibility

If one of the central tenets of Zero Waste is to address the upstream factors that lead to waste in the first place, it is essential to move beyond the limited jurisdiction of Sanitation Departments. To be effective, Zero Waste goals should be promoted by all governing agencies in an integrated approach, from the federal to the local level. There are opportunities to close the materials loop across all sectors. Public agencies should not only lead by example, supporting conservation initiatives within their departments, but also leverage their purchasing power across agencies.

Offices of procurement should adopt Environmentally Preferable Procurement (EPP) policies[129] to eliminate toxic products and services, avoid single use products and disposable packaging, purchase salvaged or remanufactured equipment, and patronize other Zero Waste companies. Economic development agencies should expand local secondary materials markets and establish programs that provide assistance to businesses interested in waste prevention. Through land use regulations and zoning ordinances, planning departments should address issues of environmental justice related to the siting of facilities. Agencies that approve, permit, and inspect construction projects[130] should establish reuse and recycling incentives and/or mandates to

[129] Environmentally Preferable Procurement is the practice of purchasing products or services that have reduced negative effects on human health and the environment when compared with competing products or services.

[130] The Department of Buildings (DOB) regulates construction projects in New York City and the Department of Building and Safety (LADBS) oversees them in Los Angeles.

promote waste prevention and deconstruction[131] on job sites. Parks departments can promote decentralized composting operations while education departments can teach students about composting and other waste prevention concepts. There are many opportunities, in addition to those listed here, for governing agencies to promote the goals of Zero Waste.

Product Stewardship

Beyond governing agencies establishing goals that consider the circular methods of production, there is a need for legislators at all levels to develop and implement clear directives and/or strong incentives that address product stewardship, also known as extended producer responsibility (EPR). Product stewardship extends the responsibility for end-of-life management to the manufacturers of a product or package. EPR policies encourage product design changes that minimize the negative impacts on human and environmental health at every stage of the product's life-cycle; this helps internalize externalities into the cost of a product. These policies also attract new entrants to the market and force existing establishments to transition to more environmentally responsible practices.

EPR policies require sufficient political will by legislators; comprehensive and accurate data for analysis; and inclusive stakeholder input – from manufacturers, stewardship organizations, retailers, and environmental groups – in order to develop sound policies. All of these requirements

[131] Deconstruction is the systematic disassembly of a building with the purpose of recovering valuable materials for reuse in construction, renovation, or manufacturing. The practice requires more labor and skill than standard demolition, but offsets the cost of additional labor through lower waste disposal costs.

have historically impeded many product stewardship initiatives. However, as legislators adopt climate adaptation plans and foundations fund resiliency projects, Zero Waste advocates have a real opportunity to build broad-based coalitions around waste prevention strategies that help mitigate anthropogenic climate change. For example, the stakeholders involved in the SWIRP planning process in Los Angeles identified nine policies they most strongly supported. Three of those policies would "make businesses responsible for products and packages" (City of Los Angeles Public Works Bureau of Sanitation, 2013). The County of Los Angeles is also currently developing a pharmaceutical waste EPR initiative to hold companies responsible for the safe collection and disposal of unused medications from the public.

Technological Tools

Fortunately, some of the past challenges with data management and accessible reporting can now be avoided with technological advancements. Electronic reporting systems (ERS) promise more timely, accurate, complete, and cost-effective reporting. They also can also make data anonymous through aggregation procedures so private companies feel more secure sharing proprietary information with the public. If the EPA updated their measuring protocols today, they could promote the adoption of their standards through a national electronic reporting system. This would allow jurisdictions to more accurately compare progress between jurisdictions and perhaps foster the development of regional planning authorities because standards would be in place.

Just as Zero Waste goals should not be isolated to municipal sanitation departments, we should also consider the relevance of

MSW data to other sectors. As described in Chapter 8, the data from waste characterization studies is applicable to a variety of stakeholders. In the last few years, as more stakeholders realize the utility of understanding material flows,[132] there has been substantial advancement in the development of technology to capture and analyze that data, particularly from the private sector. For example, many private collection companies have employed radio-frequency identification (RFID) technology on their bins and trucks to improve data collection, reporting, and tracking, thereby improving customer service and enabling accurate billing (and rejection for unpaid accounts). Using electromagnetic signals, RFID systems transmit identifying information from an integrated circuit on a tag (attached to a bin) to a reader (attached to a truck). This technology, coupled with cameras, on-board scales, GPS devices, and analytic software, has been applied to measure participation in recycling and composting programs, enable pay-as-you-throw systems, and optimize collection routes. While the RFID bins may not be ideal for all contexts,[133] the technology demonstrates the potential for innovation and efficiency in data collection. It also confirms the variety of applications for data in MSW management, depending upon the stakeholder's objectives.

Improvements in mobile technology may also provide solutions to overcoming historical obstacles in resource conservation. The smartphone and its mobile applications (hereinafter referred to as

[132] The growth in the number of technological tools in MSW has also coincided with the advancement of mobile application software, low-cost sensing technology, big data computing, etc.

[133] New York City is far too dense to deploy a PAYT containerized system. There are examples of municipalities that addressed this issue through the use of RFID stickers on bags to track materials. This could be a viable option, but would require further research.

mobile apps) have the unique ability to target some of the long-lasting barriers to waste prevention. For example, a host of mobile apps to prevent food waste emerged in the last couple of years. These apps facilitate the practice of food rescue, matching businesses that have surplus food with local emergency food programs. Smartphones have also added a level of convenience to material exchange services, providing expedient opportunities to post advertisements, browse listings, find matches, and schedule donation pickup services. Some of these online services are also collecting statistics to estimate their environmental benefits over time.

Zero Waste Indices

The MSW sector should continue to build upon existing methods of measurement, but consider opportunities to create a composite set of quantitative and qualitative indicators to account for the various dimensions of Zero Waste. Because there is lack of consistent data within and between localities, lack of standard methodologies for measurement, and lack of standard definitions, the EPA ideally would develop this composite index after consulting with stakeholders across the country. There are existing indices for waste management like Wasteaware[134] and the Zero Waste Index[135] that could be used as

[134] Wasteaware is a set of benchmark indicators, developed by testing various prototypes in more than 50 cities worldwide. It builds upon the work from UN-Habitat's Integrated Sustainable Waste Management framework. The analytical framework considers the protection of public health, environmental protection, resource value, inclusivity, financial sustainability, and institutional capacity (Wilson et al., 2015).

[135] The Zero Waste Index predicts the amount of virgin materials, energy, and greenhouse gas emissions substituted by the resources that are recovered from waste streams (Zaman & Lehmann, 2013).

a point of departure. However, the index should reflect the priorities of Zero Waste and yet be mindful of how the data will be reliably collected, reported, and analyzed.

Conclusion

As efforts to mitigate global climate change continue, it is imperative that Cities consider opportunities to transition from the current, extractive means of production to a more sustainable and just framework. The Zero Waste movement presents a divergent philosophy from our consumptive-oriented paradigm – that disposal is not a sign of progress, but rather a symptom of a failed economy. It aims to confront those failures by addressing the upstream factors that lead to waste in the first place. However, the framework of Zero Waste in practice has not reflected its theoretical tenets. By adopting the diversion rate as a primary performance indicator, Zero Waste Cities are limiting their scope to end-of-pipe strategies. This thesis has demonstrated the influence of the diversion indicator at promoting recycling of MSW even when Cities acknowledged that waste prevention should be the main priority. Therefore, it is critical that a more comprehensive set of metrics is developed that considers both upstream and downstream progress.

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