

ABSTRACT

Title of Thesis: THE ARCHITECTURE OF WASTE: Creating New Avenues for Public Engagement with Trash

Jeannine A. Muller, Master of Architecture, 2016

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The relationship between industry, waste, and urbanism is one fraught with problems across the United States and in particular American cities. The interrelated nature of these systems of flows is in critical need of re-evaluation.

This thesis critiques the system of Municipal Solid Waste Management as it currently exists in American cities as a necessary yet undesirable ‘invisible infrastructure’. Industry and waste environments have been pushed to the periphery of urban environments, severing the relationship between the urban environment we inhabit and the one that is required to support the way we live. The flow of garbage from cities of high density to landscapes of waste has created a model of valuing waste as a linear system that separates input from output.

This thesis aims to investigate ways that industry, waste, and urban ecologies can work to reinforce one another. The goal of this thesis is to repair the physical and mental separation of waste and public activity through architecture. This thesis will propose ways to tie urban waste infrastructure and public amenities together through the merging of architecture and landscape to create new avenues for public engagement with waste processes.

THE ARCHITECTURE OF WASTE
Creating New Avenues for Public Engagement with Trash

By

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Preface

“Larger than life but part of it, infrastructure has an immediate presence; it shapes our environment and urban life in vital, authentic, and often messy ways...

We look at the physical elements of infrastructure and the often marginalized sites they produce as possible contributors to a meaningful public realm.

What if a new paradigm for infrastructure existed? What if the very hard lines between landscape, architecture, engineering, and urbanism could find a more synthetic convergence?”¹

-Weiss/Manfredi, Public Natures: Evolutionary Infrastructures

¹ Michael Manfredi and Marion Weiss. *Public Natures: Evolutionary Infrastructures* (New York: Princeton Architectural Press, 2015), 8-9.

Dedication

This is dedicated to my mom, for being my constant support system and for fostering in me a sense of compassion for the environment. And to my dad, for fostering in me a sense of pushing boundaries and following my passions: always telling me ‘where there’s a will, there’s a way.’

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List of Abbreviations

- DSNY: Department of Sanitation of New York
- MSW: Municipal Solid Waste
- MTS: Marine Transfer Station
- NYCEDC: New York City Economic Development Corporation
- TPD-:Tons Per Day
- WTE: Waste-to-Energy

Chapter 1_Background

Defining the Problem

Waste and the City

This thesis investigates the issue of waste: one that is not commonly associated with the field of architecture. While the management of waste is not typically connected to design, such as architecture and landscape architecture, it certainly shapes the places we inhabit. Infrastructure such as waste management is inextricably tied to the planning of cities, yet it is designed to be an infrastructure that does not make itself visible to the public eye. The operations of waste management are often tucked away in industrial areas of a city that are easily forgotten. A sanitation worker is someone whose job is one of the most important jobs of the functioning of a city, yet his worth is only acknowledged when he does not do his job. “Sanitation is the most important uniformed force on the street...No city can thrive without a workable solid waste management plan.”² How can this notion of invisibility be challenged through the role of design? How can a critical function of society be manifested in a way that visibly engages and benefits the public?

This thesis strives to address not only a social issue of an urban dweller’s relationship with trash, but address the issue of how a city can support itself, in terms of the waste it generates, in a way that is sustainable into the future. A successful ecology is one that is able to support itself, using waste as food in a cyclical nature. Unfortunately most American cities do not do this, most of them function solely in a

² Robin Nagel, *Picking Up: On the Streets and Behind the Trucks with the Sanitation Workers of New York City* (New York, Farrar, Straus and Giroux, 2013), 24.

one-way mode, only exporting waste. Pierre Belanger examines the city Kalundborg, Denmark (Figure 1) as an example of a successful industrial economy that that uses waste from one industry as fuel for another industry³. How can American cities begin to think of themselves as self-sustaining ecosystems?



Figure 1: Kalundborg, Denmark Waste Flows
Credit: Pierre Belanger

Lack of Architecture in Waste Management

By investigating the topic of waste management within the city, this thesis seeks to engage in a dialog between architecture, waste management, and public activity. There is currently a missing link between architecture and waste that is neglecting the ability for design to positively impact the relationship people have with waste. Harvard University's Graduate School of Design has launched a three year design research lab, titled Waste-to-Energy Research Lab, to question this missing link:

“Currently, architecture and design play a minor role in the design and construction of industrial building types. Except for a small number of exemplary projects, architecture and design have largely been

³ Pierre Belanger, “Landscapes of Disassembly,” *The International Review of Landscape Architecture and Urban Design*, no. 60 (2007): 88.

excluded from the development of these pervasive structures and the integration of these buildings within the larger constructed and natural environments.”

The mission of this lab is as follows:

“Using WTE facilities as a vehicle, this research lab proposes to re-engage interdisciplinary design and architecture with industrial buildings and facilities. WTE Research Lab conducts design research on novel and effective ways to rethink the relationship of architecture and waste – a (re)planned obsolescence.”⁴

The built environment that contains the activities of waste management are often removed from public eye. Because of this, as well as lack of environmental and economic motivations, it is hard for the public to understand and embrace the advances in technology for waste-to-energy functions. By including architects in the conversations about waste management and waste-to-energy potentials, they can create value in industrial environments and promote healthier communities. “Within this space of opportunity, new design concepts can offer hybrid solutions to generate clean energy, contribute to cities’ social and cultural activities, and protect wider urban atmospheres and microclimates.”⁵

Today, we are at a critical junction in establishing best practices for waste management strategies as population density and consumption patterns in cities increase. With technological advances, it is time for sustainable infrastructure to be put in place to support current trends of consumption. Is it possible to reintroduce society’s pride in new efficient facilities, as was the case with industrial buildings at

⁴ “About,” Harvard Graduate School of Design Waste to Energy. Accessed December 7, 2015, <http://research.gsd.harvard.edu/wte/>.

⁵ Andreas Georgoulas, Hanif Kara, and Leire Asensio Villoria, “The Missing Link: Architecture and Waste Management,” *Harvard Design Magazine* no.40 (July 2015) accessed October 15, 2015, <http://www.harvarddesignmagazine.org/issues/40/the-missing-link-architecture-and-waste-management>.

the beginning of the 20th century? How can architects engage and bridge the industrial periphery of urban environments back to the interconnected realm of public activity?

Defining Types of Waste

Municipal Solid Wastes are defined by the EPA as waste consisting of “everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries” which come from “homes, schools, hospitals, and businesses.”⁶ This excludes other types of waste including biosolids, hazardous waste, construction and demolition wastes, and agricultural waste, all of which have separate collecting facilities.

Municipal Solid Waste Treatment

As outlined in *Generation and Disposition of Municipal Solid Waste (MSW) in the United States – A National Survey*, completed by Columbia University’s Earth Engineering Center, in 2011 the U.S. generated 389 million tons of MSW⁷. The avenues employed to dispose of MSW and the percentage of each are: recycling (23%), composting (6%), combusting (7%), and landfilling (64%). Landfilling is the significantly dominant disposal method in the United States.

⁶ “Municipal Solid Waste,” US Environmental Protection Agency, last modified June 25, 2015, accessed December 7, 2015, <http://www3.epa.gov/epawaste/nonhaz/municipal/>.

⁷ Dolly Shin, “Generation and Disposition of Municipal Solid Waste (MSW) in the United States” (MS thesis, Columbia University, 2014), 20.

Landfilling

Landfilling is the predominant form of waste processing in the United States. It is the most well established and prevalent infrastructure for waste management, even though it takes up valuable land space and excretes pungent bio-gases. Some specifics on the process are as follows:

- Incoming trucks weighed at entrances
- States require liners and leachate collection
- Liners typically made of re-compacted clay and high-density polyethylene
- Prevent leachate leakage and biogas migration

Combustion

Combustion, also known as Waste-to-Energy (WTE), has faced a series of modern technological advances that redefine WTE as an economically and environmentally viable alternative to landfilling. “More public awareness of the cleanliness of WTE plants is needed to expand national waste disposal by combustion.”⁸ Some of these technological advances are as follows:

- Waste enters storage pit - negative pressure to prevent smells from escaping
- Waste moves to combustion chamber- temperature carefully monitored
- Heat produces steam which runs turbines, which produce electricity
- Gas scrubbers and hazardous particulate filters in place so harmful gasses are not released into atmosphere

Recycling

The two major types of Material Resource Facilities (MRFs) are clean and dirty. There differences are:

- Clean MRF
 - Single stream

⁸ Shin, “Generation and Disposition of Municipal Solid Waste (MSW) in the United States,” 12.

- Collects all recyclables as commingled
 - Dual stream
 - Separates Paper/cardstock from plastic/metal/glass
- Dirty MRF
 - Receives Municipal Solid Waste and separates waste sent to landfills and wastes that can be recycled

Composting

Composting is the biological decomposing of organic wastes such as yard wastes (grass clippings, leaves), food scraps, and manure. It exists on multiple scales from small scale that can be implemented by a single household to large scale, used by municipalities as a key strategy in waste management. The scales and techniques are defined:

- Small scale- household use
 - Backyard/on-site composting
 - Piling grass clippings/leaves
 - Vermicomposting
 - Relying on red worms to decompose organic waste
- Large scale- agricultural use
 - Windrow composting
 - Piling organic matter in long rows outdoors
 - Static-pile composting
 - Piles of organic matter placed on top of perforated piping, providing air circulation for controlled aeration
- Large scale- municipal use
 - In-vessel composting
 - Any method of composting that confines organic matter in a container, in which air flow and temperature can be measured
 - Anaerobic digestion
 - Process in which microorganisms break down organic matter in the absence of oxygen
 - End product is biogas- which can be combusted to generate electricity and heat

Waste Theory

Garbage as Unmarked Element

The physical spaces and built environment that are occupied and used to perform the act of managing a city's waste are often unnoticed, and unpleasant, and uninviting can be seen in this excerpt describing the space a sanitation worker inhabits in anthropologist Robin Nagel's *Picking Up*:

“[He] exists along both physical and cognitive edges...He occupies in-between physical spaces—the street, yes, but specifically the curb, the alley, the end of the driveway. He moves garbage, the ultimate unloved Stuff, to areas zoned mostly for industrial uses. He starts and finishes his workday in a garage that is usually on the outskirts of a neighborhood. He is the intercessor between the uncomfortable here and now of an individual's own refuse and a safely mythical ‘away’”⁹

Chapter 2_Precedent Analysis

Introduction

In order to understand the ways in which waste is manifested in built form, this precedent analysis compiles garbage based design projects. They include buildings and designed landscapes; a mix of conceptual, in progress, and completed works that are multi-functional in the way they engage with the process of waste. This analysis allows for a foundation of knowledge of projects attempting to do a similar task as this thesis. By first compiling a vast database and then more deeply investigating projects that align with the agenda of this thesis, themes will be extracted upon which to build on during the design phase.

Chronologically, these projects are concentrated in the twenty-first century, including a few projects with completion dates in the future. Geographically, the

⁹ Nagel, *Picking Up*, 23.

majority of the projects are located in Europe, where tight regulations and restricted land area have dictated a need for better waste management strategies.

Three Lenses: Building, Landscape, and the In-Between

This precedent analysis is organized and curated as a spectrum or range of projects, organized by time and by project typology: from building to landscape. Time runs from left to right and building to landscape runs from top to bottom. Therefore the projects that lie in-between building and landscape fall somewhere in the middle of the page. This range affords these projects flexibility by escaping a binary view of building vs. landscape and instead proposes a spectrum that uncovers the hybrid nature of the world that lies at the intersection of architecture and landscape architecture.

Many of the buildings in this analysis are waste-to-energy plants and recycling facilities and the majority of the landscape projects are multi-functional parks that are created over capped landfills. Within this spectrum of “building to landscape” lies a variety of program typologies and ideologies of waste management, ranging from ways to treat trash as it enters the waste management system to ways of reclaiming a landscape that has been formed by a different type of waste management.

Again, the timeline is read with time running from left to right and building to landscape running from top to bottom. Therefore the projects that lie in-between building and landscape fall somewhere in the middle of the page.

Timeline

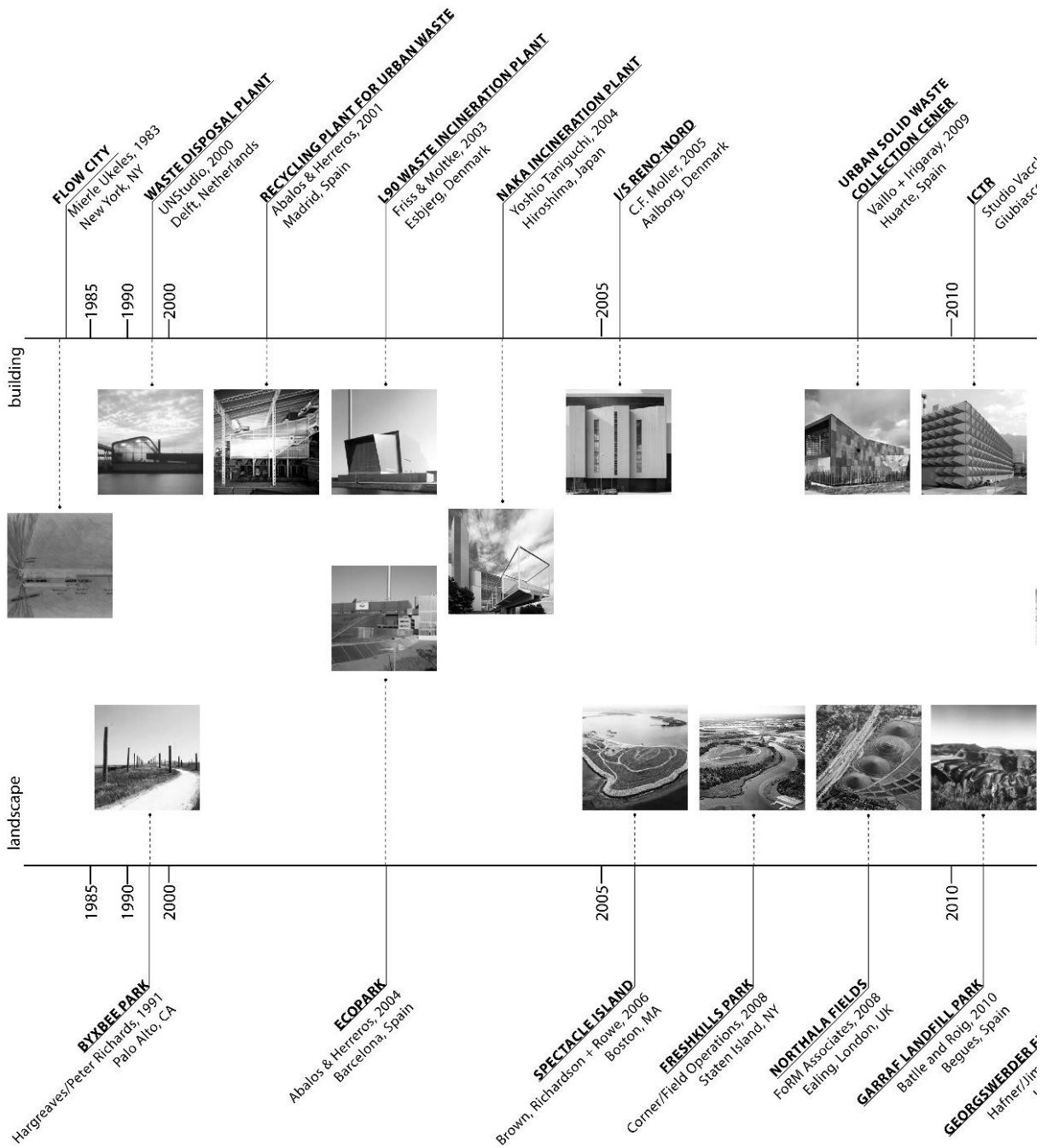


Figure 2: Precedent Timeline (pt.1)
Image by Author

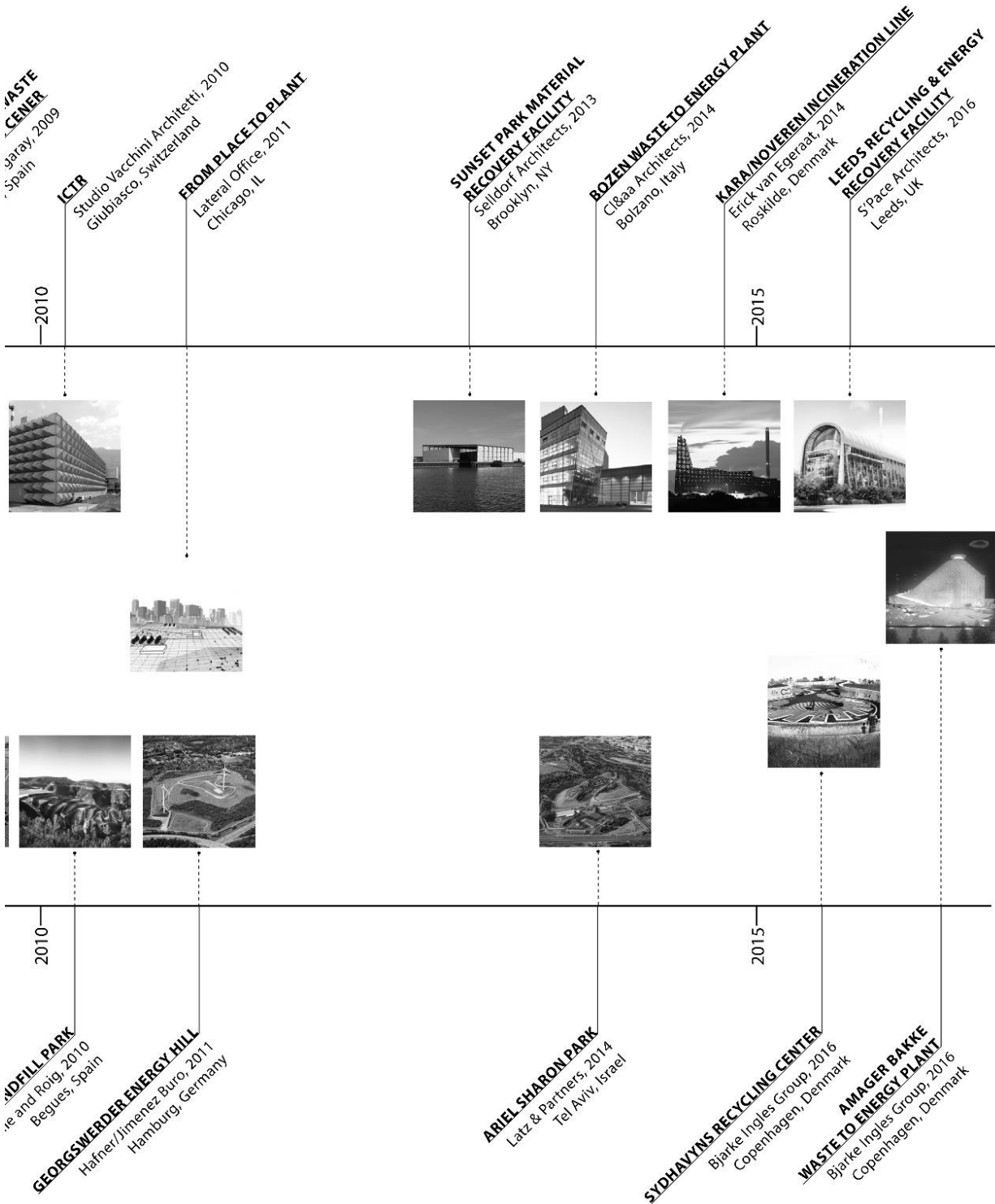


Figure 3: Precedent Timeline (pt.2)
Image by Author

Building

The majority of these projects are located in Northwestern European countries such as Denmark, the Netherlands, and Spain. As mentioned before, because of a variety of constraints such as political, geographic, and energy needs, many of these countries have been required to invest in waste management strategies other than landfilling. The most common and even more primitive alternative to landfilling is burning waste. With technological advances in more recent times, Waste-to-Energy plants have become both a significant waste management strategy and a source of energy. These plants have been used across Europe for a significant amount of time, but not all Waste-to-Energy plants are created equal. The projects of interest in this precedent study are those that go beyond the pure functional requirements of the prescribed industrial needs and add architectural value to the built environment.

The programs of the buildings examined include waste-to-energy plants, recycling, sorting, and composting centers. Many of them link an aspect of public outreach to them, whether it be a visitor's center, museum area, display area, public promenade, or other public amenity.

Delft Waste Disposal Plant

The Waste Disposal Plant in Delft, Netherlands was designed by UNStudio



and completed in 2000. It serves as an example of a building that uses design to communicate the waste management

Figure 4: Delft Waste Disposal Plant
Image by Christian Richters, source: UNStudio

policy of the City of Delft¹⁰. The programmatic requirements of the space include a recycling facility, compression facility, and transfer station. The fluid form is determined by the movement of vehicles and waste, while its gently sloping concrete surface wraps over itself to form a plateau, which separates the delivery from the removal and the sorting facilities from the public view to the river¹¹.

Recycling Plant for Urban Waste

The Recycling Plant for Urban Waste in Madrid, Spain by Abalos & Herreros in 2001 is another example of a building that's industrial function is expanded



through the architect's design. The recycling plant is "part of a wider political initiative to reevaluate and regenerate an area southwest of Madrid, which has been used as a large dumping ground and suffered social and environmental

Figure 5: Recycling Plant for Urban Waste
Source: estudio Herreros

deprivation as a result"¹². The objective of

this facility is to reconstruct the hillside through the generation of compost from organic waste¹³. The building's function, then, is greater than gathering waste from

¹⁰ "Waste Transferral Station," Phaidon Atlas. Accessed October 18, 2015.
<http://phaidonatlas.com/building/waste-transferral-station/3324>

¹¹ "Waste Disposal Installation," UNStudio. Accessed October 18, 2015.
<http://www.unstudio.com/projects/waste-disposal-installation>

¹² "Recycling Center for Urban Waste," Phaidon Atlas. Accessed October 18, 2015.
<http://phaidonatlas.com/building/recycling-plant-urban-waste/3299>

¹³ Phaidon Atlas. "Recycling Center for Urban Waste."

the surrounding region, but to mend the scars of industrialization that the city has imposed on the landscape.

The complex is comprised of two buildings and a weigh station pavilion. The two buildings are constructed from a bolted steel structure that can easily be dismantled, and enclosed in a recycled polycarbonate. The roof structure is a single pitched green roof that merges with the sloping landscape around it. Not only is the building constructed with recycled materials, but the entire complex is contrived as a built form that is designed for a lifetime of twenty-five years. After this time, it can be easily dismantled and elements recycled elsewhere¹⁴. By thinking about the lifespan of the building as part of a larger system, it is merely a piece that is plugged into a larger whole. This elevates the building from a purely functional building to one that brings value to its everyday functions.

Landscape

The landscape projects compiled in this precedent study are examples of former landfills that have been given new life. These landscapes of waste are able to be reclaimed back as environments inhabited and used by people and wildlife. While the majority of the building examples were in Europe, a number of these landscape projects are in the United States, where landfills are the prominent means of garbage disposal. These designed landscapes are able to foster multiple activities such as recreation, wildlife habitat, and energy production.

¹⁴ Phaidon Atlas. "Recycling Center for Urban Waste."

Freshkills Park

One of the most prominent examples of a landfill-to-park transformation is the Freshkills Park in Staten Island, New York. Closed in 2001, this landfill was the major recipient of trash from all boroughs of New York and was the largest landfill in the world. Designed by Corner/ Field Operations, the first phase of the park opened in



2008. Its uses include a variety of public spaces and facilities for recreation, wildlife habitat, energy production, art and culture, and education.

Figure 6: Freshkills Park
Source: Field Operations

Hybrid

Referring back to the timeline that organizes this precedent study, while the majority of the projects fall into the category of building or landscape, there are a number of projects that fall somewhere in between, highlighted in orange below.

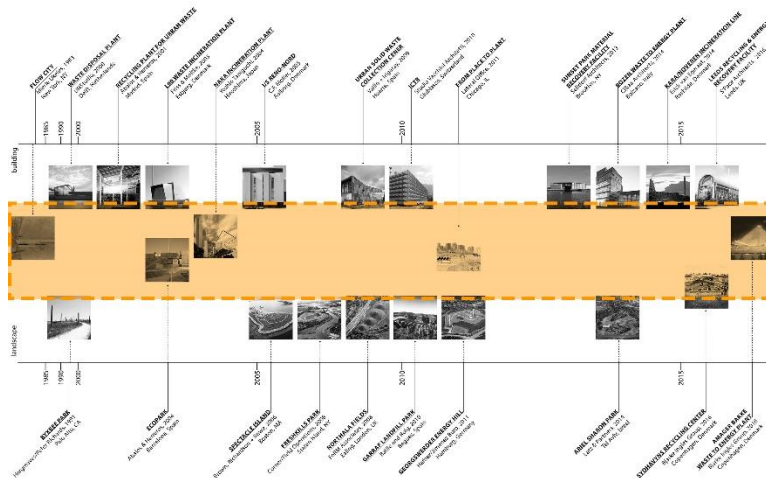
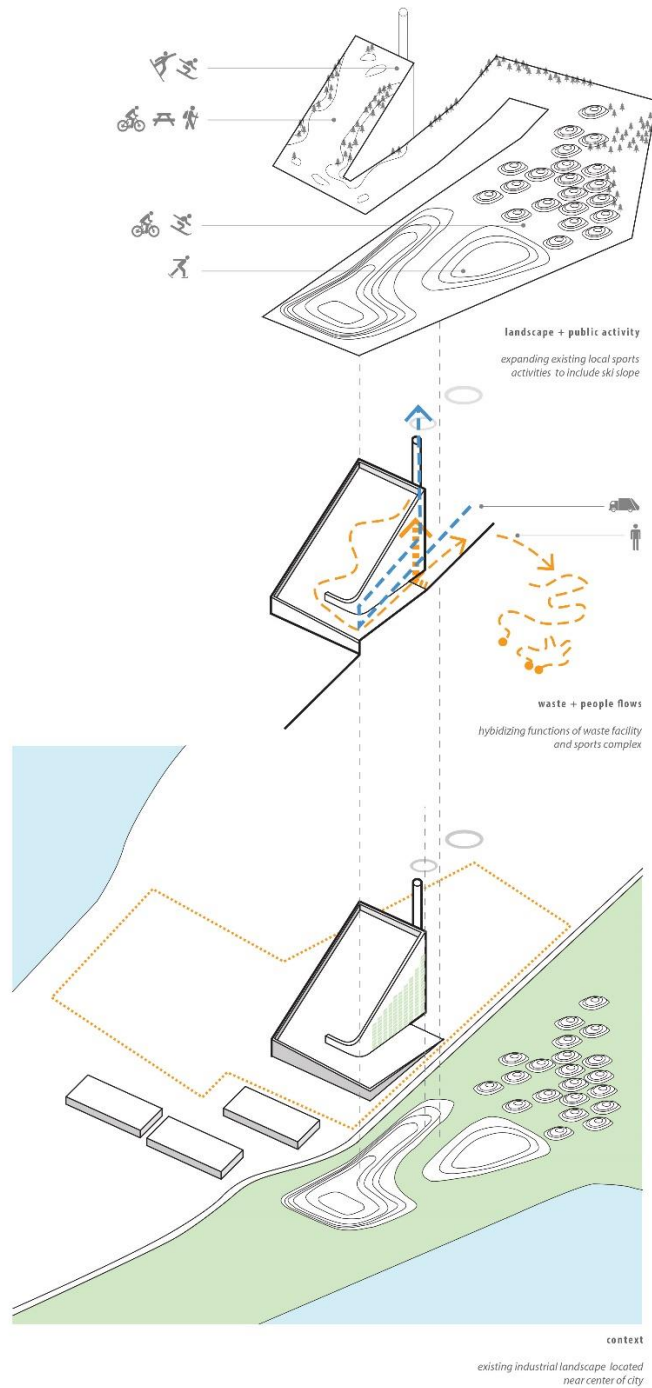


Figure 7: Precedent Timeline- Hybrid Zone
Image by Author

These projects are of particular interest as they blend architecture with landscape, waste processing and public amenity. Five particularly captivating projects will be

analyzed further in depth to extract design strategies that can become a knowledge base upon which to be drawn from during the design process.

Amager Bakke Waste to Energy Plant



AMAGER BAKKE WASTE-TO-ENERGY PLANT
BJARKE INGLES GROUP
COPENHAGEN, DK

Figure 8: Amager Bakke-Context, Waste + People Flows, Landscape + Public Activity
Image by Author

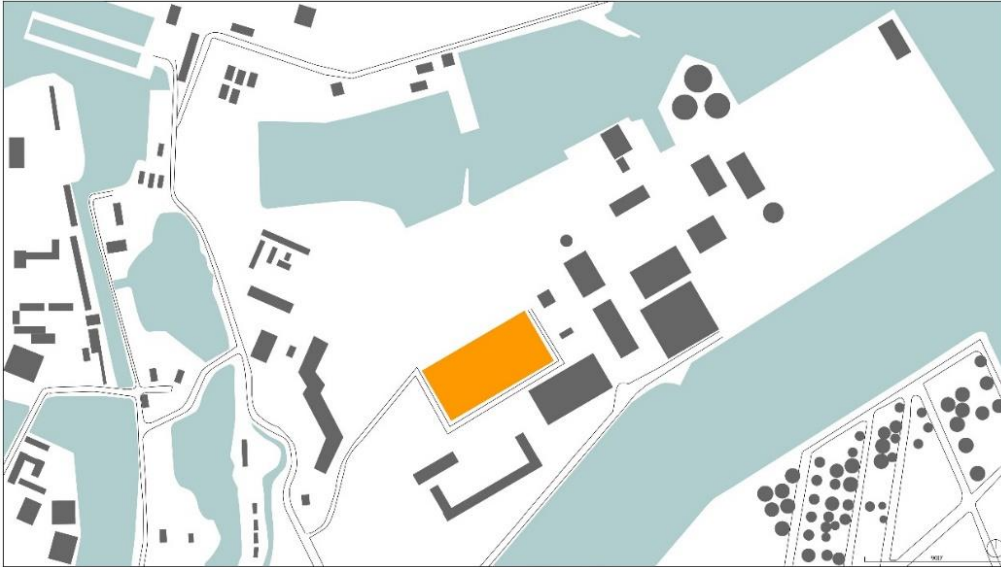


Figure 9: Amager Bakke Site Plan
Image by Author

The Amager Bakke Waste to Energy Plant, designed by Bjarke Ingles Group, combines waste treatment with public amenity to create a hybridized building typology. By incorporating a public ski slope into a waste to energy plant, the building is elevated from a typical industrial building to a new typology that attracts and encourages public interaction with what is typically regarded as negative and ‘off-limits’. Located in an industrial area not far from the central historic district of Copenhagen, the building serves as a destination for visitors and locals alike.

Flow City

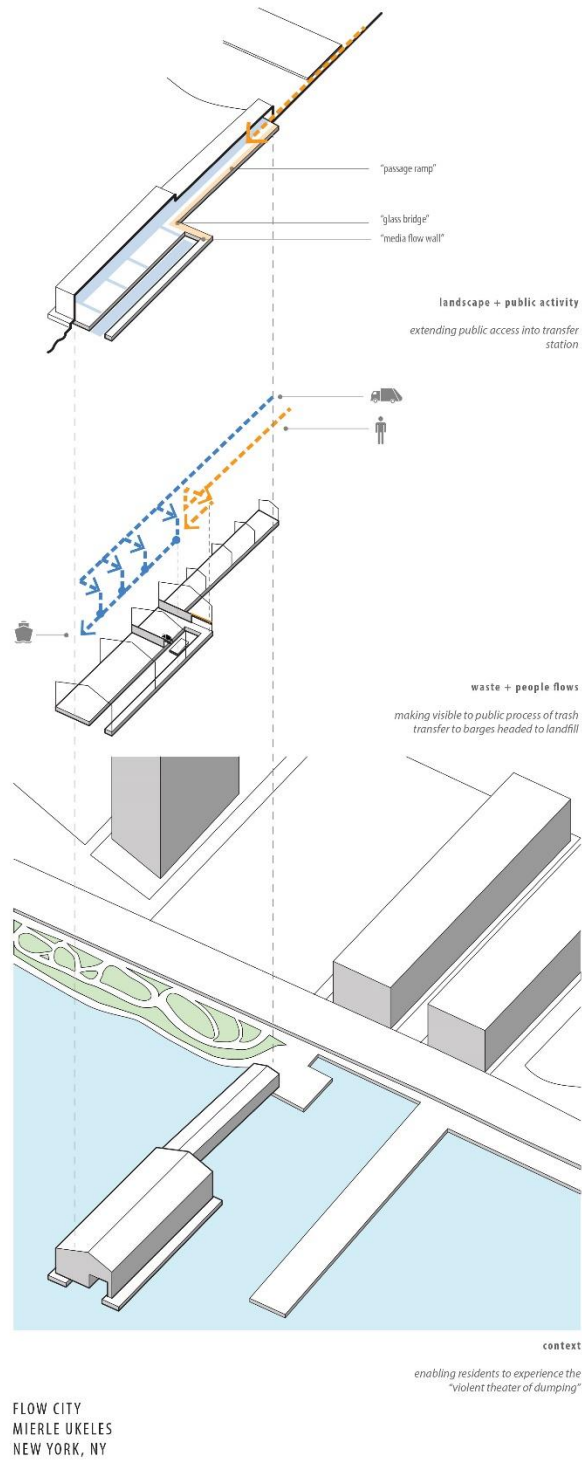


Figure 10: Flow City- Context, Waste + People Flows, Landscape + Public Activity
Image by Author



Figure 11: Flow City site plan
Image by Author

Flow City is a unique project that captures the desire to link the public with the operation of trash movement in New York. This project was constructed as an exhibition along the 59th Street Marine Transfer Station along the Hudson River in 1983. It is by artist Mierle Ukeles, who in her manifesto describes her work as “maintenance art” and has been the unsalaried artist-in-residence at the New York City Department of Sanitation since 1977. In the artist’s own words:

“ ‘I call it FLOW CITY because it embodies a multiplicity of flows: from the endless flow of waste material through the common and heroic work of transferring it from land to water and back to land, to the flow of the Hudson River, to the physical flow of the visitors themselves.’”¹⁵

This exhibit enables residence to experience the “violent theater of dumping” in an attempt to bring consciousness to people that their garbage has a life after they throw it away. “The fantasy that many people have about garbage is that it exists outside the realm of time. There’s such denial involved.”¹⁶

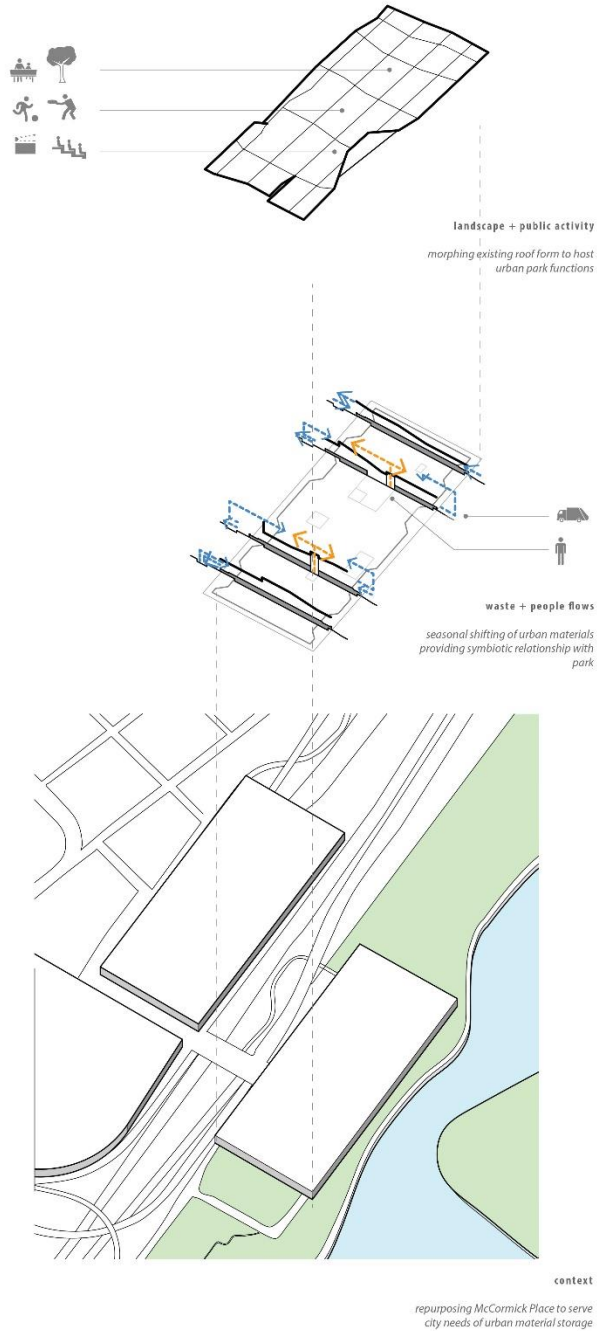
¹⁵ Ukeles, Mierle Laderman. 1996. “Flow City”. *Grand Street*, no. 57. Jean Stein: 199–213. doi:10.2307/25008073. 209.

¹⁶ “Flow City” 210

In Flow City, people are led through a sequence of moments that run parallel to the flow of trash as it enters the station and moves into barges that bring the trash to Freshkills landfill. They first walk through the ‘passage ramp’ which is a narrow metal grate passage that runs above a floor strewn with trash. Next, they observe the act of trucks unloading trash into barges along the ‘glass bridge’. Finally, they end at the ‘media flow wall’, which is a wall of screens which show where the trash they just witnessed goes next on its journey. There are a series of live feed cameras, as well as images and models of Freshkills Landfill, the garbage’s final resting place.

While this project is not a design project by an architect, it is extremely pertinent to the conversation of exposing the invisible process of waste management to the general public. This affords the public to make the connection between the trash they put to the curb for the garbage man to collect, and the aggregate mass of trash produced by everyone in the city and the labor required to deal with it.

From Place to Plant



FROM PLACE TO PLANT
LATERAL OFFICE
CHICAGO, IL

Figure 12: From Place to Plant- Context, Waste + People Flows, Landscape + Public Activity
Image by Author



Figure 13: From Place to Plant site plan
Image by Author

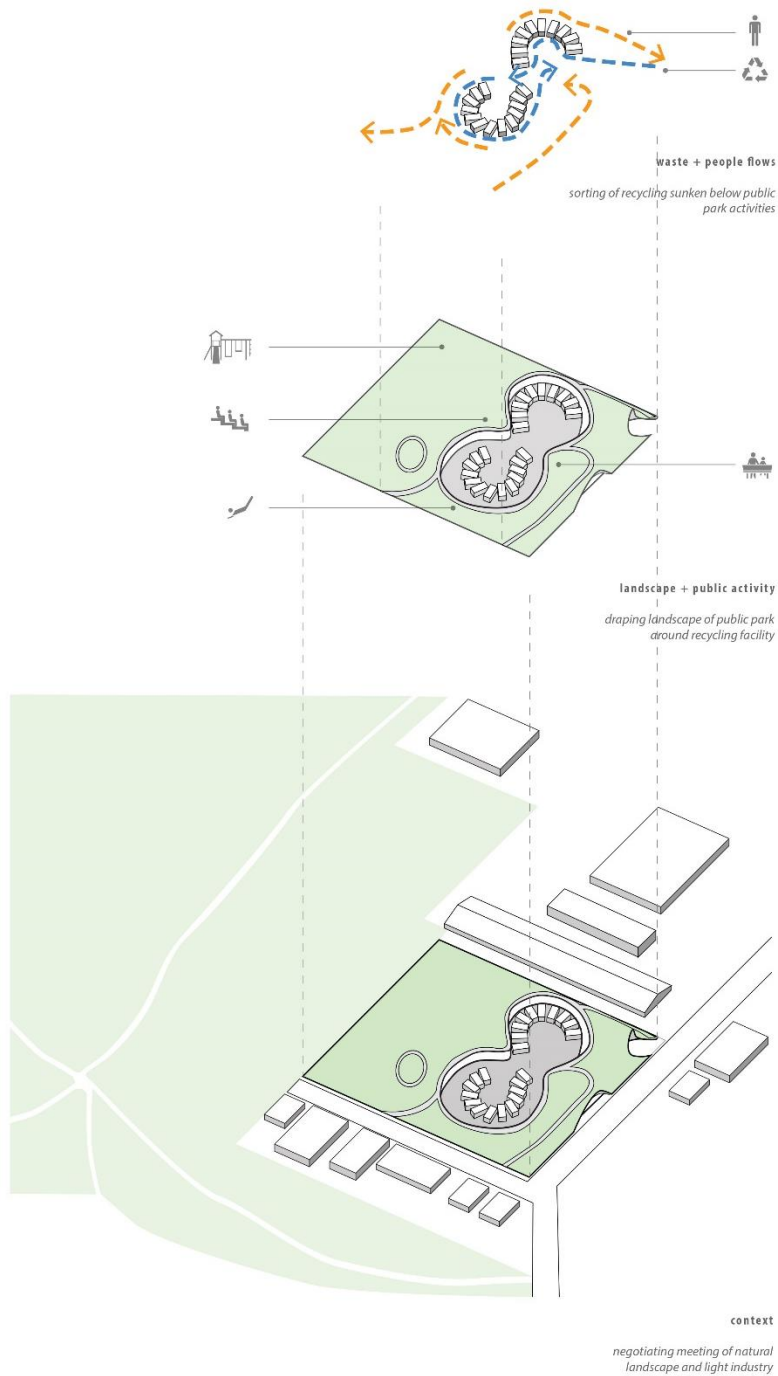
From Place to Plant by Lateral Office reimagines McCormick Place in Chicago as an opportunity to simultaneously “address and celebrate Chicago’s impressive urban logistics while extending the city’s project of open space by creating a new urban park experience.”¹⁷ This speculative project repurposes the building as a plant for the management of urban materials such as soil, trees, salt, sand, and snow. Conceptually, the programmatic needs of material storage shift through the seasons and the urban park located on the roof of the building acts as a receptacle for these materials and repurposes them to suit the needs of the varying public amenities being offered, again shifting throughout the seasons. Waste flows in and out depending on the season and current need of the city and then up to the roof to serve the public in the roof parkscape. The proposal includes transforming the roof through a series of strategic moves: folding, punching, pulling, pushing, and bending. This allows a range of urban experiences that respond to the season, such as a beach

¹⁷ “From Place to Plant,” Lateral Office, last modified 2011, accessed October 18, 2015. <http://lateraloffice.com/filter/Work/FROM-PLACE-TO-PLANT-2011>

during the summer with surplus sand from the winter or sledding parkland during the winter by blowing filtered snow from urban collection. On their way up to the roof, through transparent cores, visitors can catch views of the storage space.

This project has a two-fold set of functions. It serves the need of storing and managing urban materials and providing a public park. Rather than achieving these two functions completely divorced from each other, which is common practice, Lateral Office has intertwined these functions in a symbiotic relationship in which both functions inform and strengthen each other.

Sydhavyns Recycling Center



SYDHAVYNS RECYCLING CENTER
BJARKE INGLES GROUP
COPENHAGEN, DK

Figure 14: Sydhavyns- Context, Waste + People Flows, Landscape + Public Activity
Image by Author

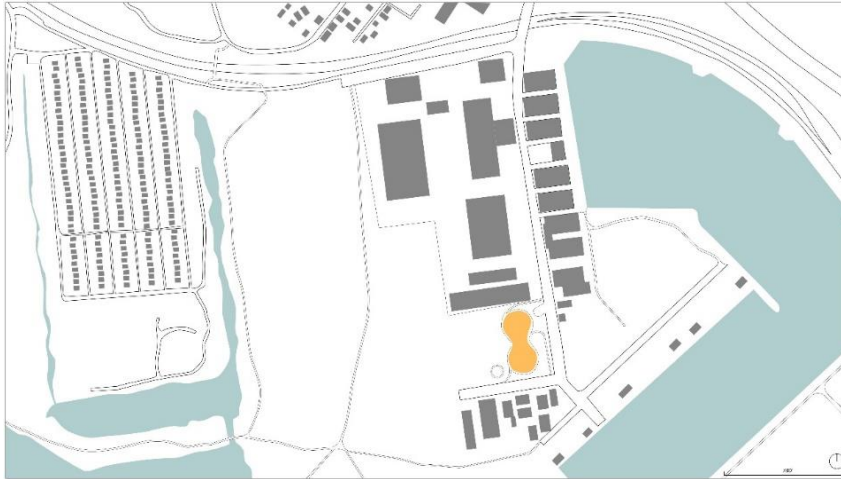


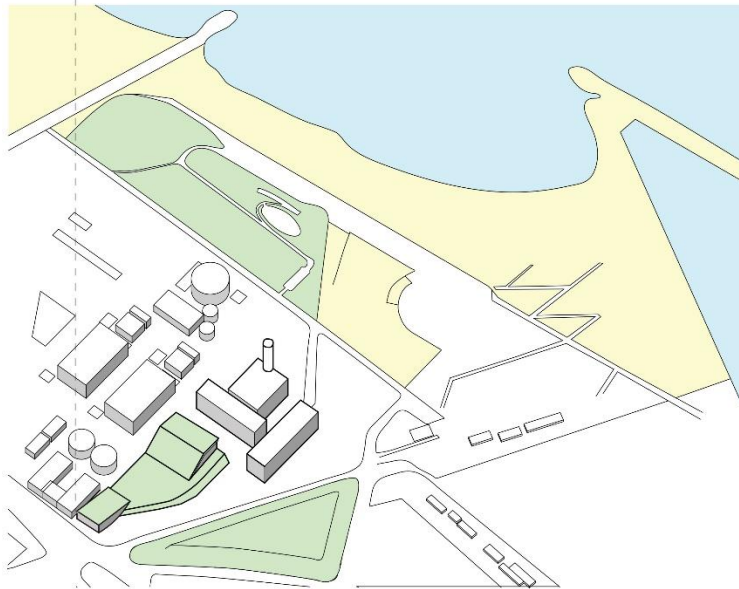
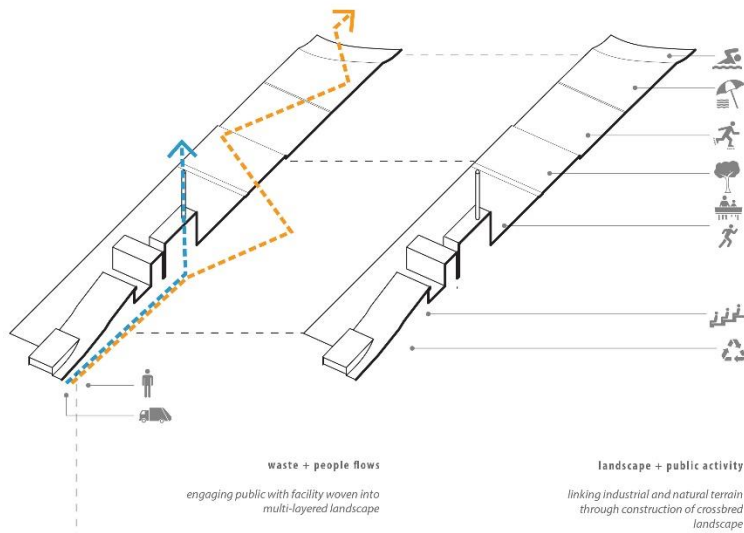
Figure 15: Sydhavns Site Plan
Image by Author

Sydhavns Recycling Center, designed by Bjarke Ingles Group is set to be completed by 2016. It is located in the Sydhavns district of Copenhagen, southwest of the historic city center. Located near the water within a light industry area, this recycling center imbeds itself into the landscape, connecting with a large park. Rather than acting as a building separated from its natural context, the building instead tucks itself underneath and within the altered landscape. As stated by BIG, the recycling center is “... a way to start thinking of our cities as integrated manmade ecosystems, where we don’t distinguish between the front and back of house. But rather orchestrate all aspects of daily life, from consumption to recycling, from infrastructure to education, from the practical to the playful into a single integrated urban landscape of work and play.”¹⁸ This integration between buildings and landscape in the urban environment is an important shift in design thinking. By realizing that all spaces, both buildings and landscapes are constructed entities within

¹⁸ “Sydhavns Recycling Center,” Bjarke Ingles Group. Accessed October 20, 2015. <http://www.big.dk/#projects-gbs>

the city often combining complex networks of infrastructure, it can be argued that any design needs to address the overlap of architecture and landscape.

Ecopark



context

constructing multiple intricate experiences of natural components within existing industrial landscape

ECOPARK
ABALOS & HERREROS
BARCELONA, SPAIN

Figure 16: Ecopark- Context, Waste + People Flows, Landscape + Public Activity
Image by Author

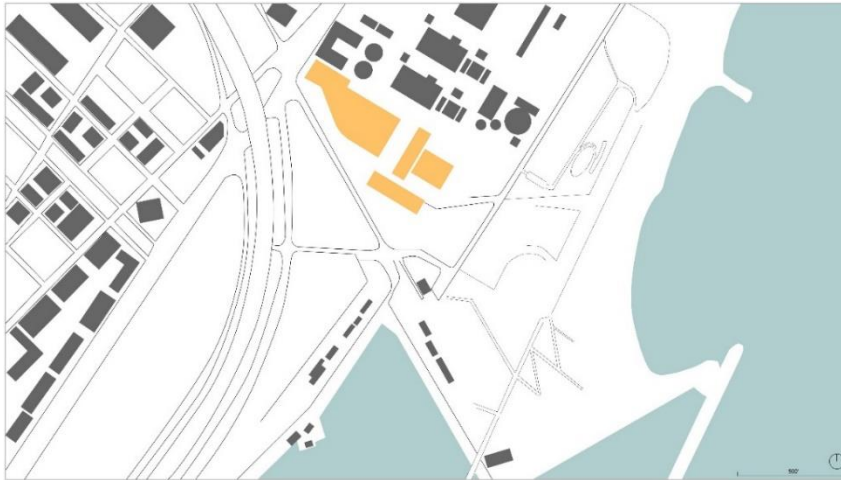


Figure 17: Ecopark Site Plan
Image by Author

An example of a hybrid between building and landscape design is Ecopark, an expansion of a waste treatment facility that stitches across layers of urban fabric to tie the recycling facility to a public promenade and beach amenity. It is designed by Abalos & Herreros in 2004 and located in the North Eastern area of Barcelona. The design blends programmatic services into the landscape, creating a hillside that acts as a buffer to ease the tension between the extending promenade and the nearby highway. The public plaza weaves between this hillside, a facility building, outdoor facility elements and shifted topographic changes to navigate the public from the edge of the highway along the facility, to the beach. By linking various pieces of the public plaza along both building and landscape elements of the facility, it becomes an integral backdrop to the beach amenity.

Chapter 3_Geography of Waste-to-Energy

WTE_ United States

To begin researching where to site this proposed investigation of the link between architecture and Waste-to-Energy (WTE), it is logical to base the decision on the geography of waste within the US. Siting this project within a context of existing WTE will bring precedent, and support the case to heighten the relationship between design and WTE.



Figure 18: MSW Disposal Breakdown by EPA Regions
Credit: Columbia University Earth Engineering Center

Of the four types of MSW disposal discussed earlier: landfilling, combustion, recycling, and composting, Figure 18 shows the percentage for each region of the U.S. The east coast, comprising of Regions 1-4 make up the majority of WTE generation. Looking within the northeast corridor, New England (Region 1) has a WTE rate of 41% and New York (Region 2) has a WTE rate of 21%. It is therefore prudent to further investigate these regions.

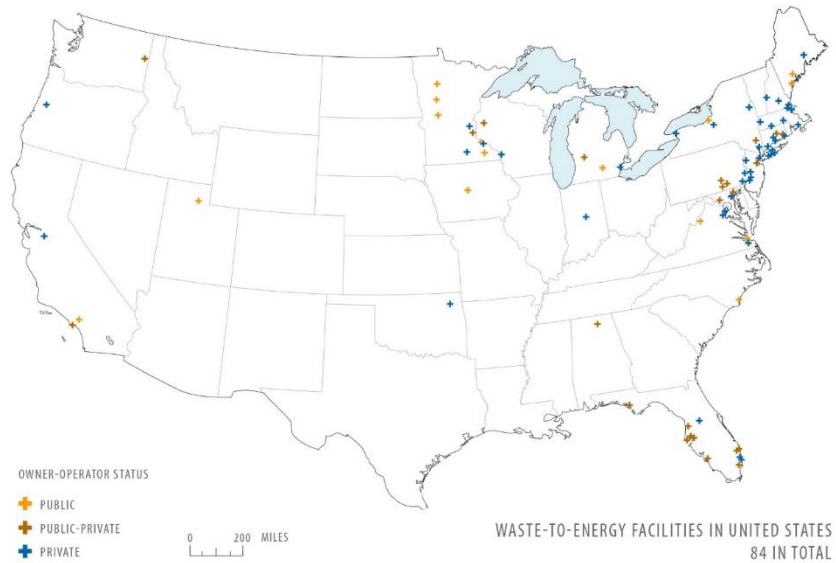


Figure 19: Waste-to-Energy Facilities in the United States
Image by Author

When isolating the WTE facilities in the U.S., the concentration of WTE facilities in the Northeast Corridor is apparent (Figure 19). The other areas in the country that have a high number of WTE facilities are in Florida and Michigan. It is clear that there is a strong connection between population density, urbanized areas, and Waste-to-Energy infrastructure. Maps from the U.S. Census Bureau, Figure 20 and Figure 21 show Population Density by County and Urbanized Areas, respectively. In both maps, it can be easily discerned that the northeast region has extremely high population density, located around urban centers. The connection between density and WTE is very strong economically, as with areas of increased density, space is more valuable. With high land values in areas of high density, landfills are not viable options for waste disposal, and WTE becomes an economically viable alternative.



Figure 20: Population Density by County
Credit: US Census Bureau



Figure 21: Urbanized Areas and Urban Clusters: 2010
Credit: US Census Bureau

An important driver aside from existing WTE infrastructure and population density is the desire to locate this proposal in a large city. With future population increase and density growth, cities are a crucial built environment to consider looking forward. With population increase, current infrastructure will be strained and new creative solutions will have to be examined in order to support large numbers of people in growing urban conditions. Waste infrastructure is one of the most important systems that a functioning city is dependent on. The northeast corridor proves a fertile testing ground with all of these considerations.

WTE_Northeast Corridor

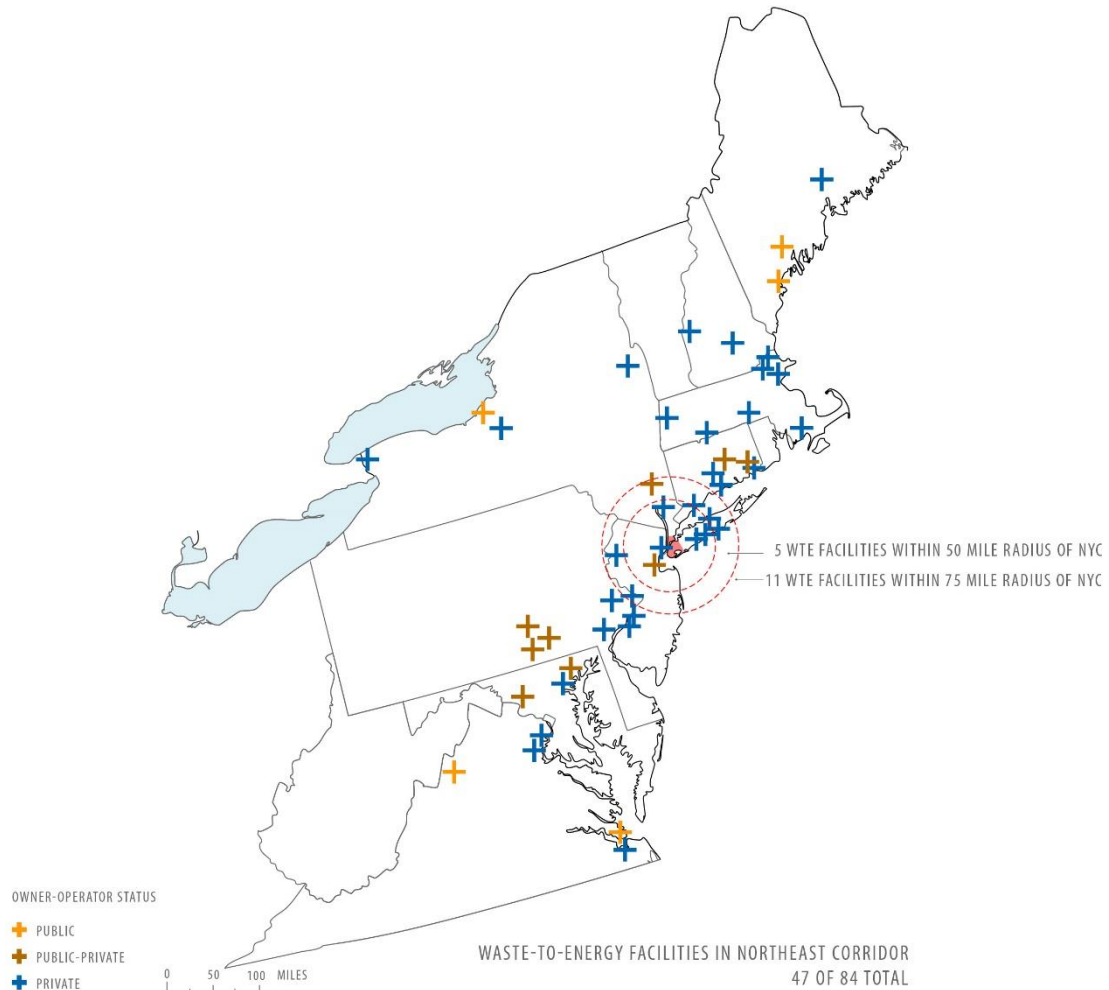


Figure 22: Waste-to-Energy Facilities in Northeast Corridor
Image by Author

Zooming into the Northeast Corridor, the hot-bed of WTE activity in the U.S., it is clear to see that the concentration of facilities are located in high density metropolitan areas- around the cities of Boston, New York, Philadelphia, and Washington, D.C. There is an especially high concentration of WTE facilities around New York City. As seen in Figure 22, there are eleven WTE plants within a seventy-five mile radius of New York and five WTE plants within a fifty mile radius. Since New York is the densest city, it makes sense that it would have a high number of nearby WTE facilities.

WTE_New York State

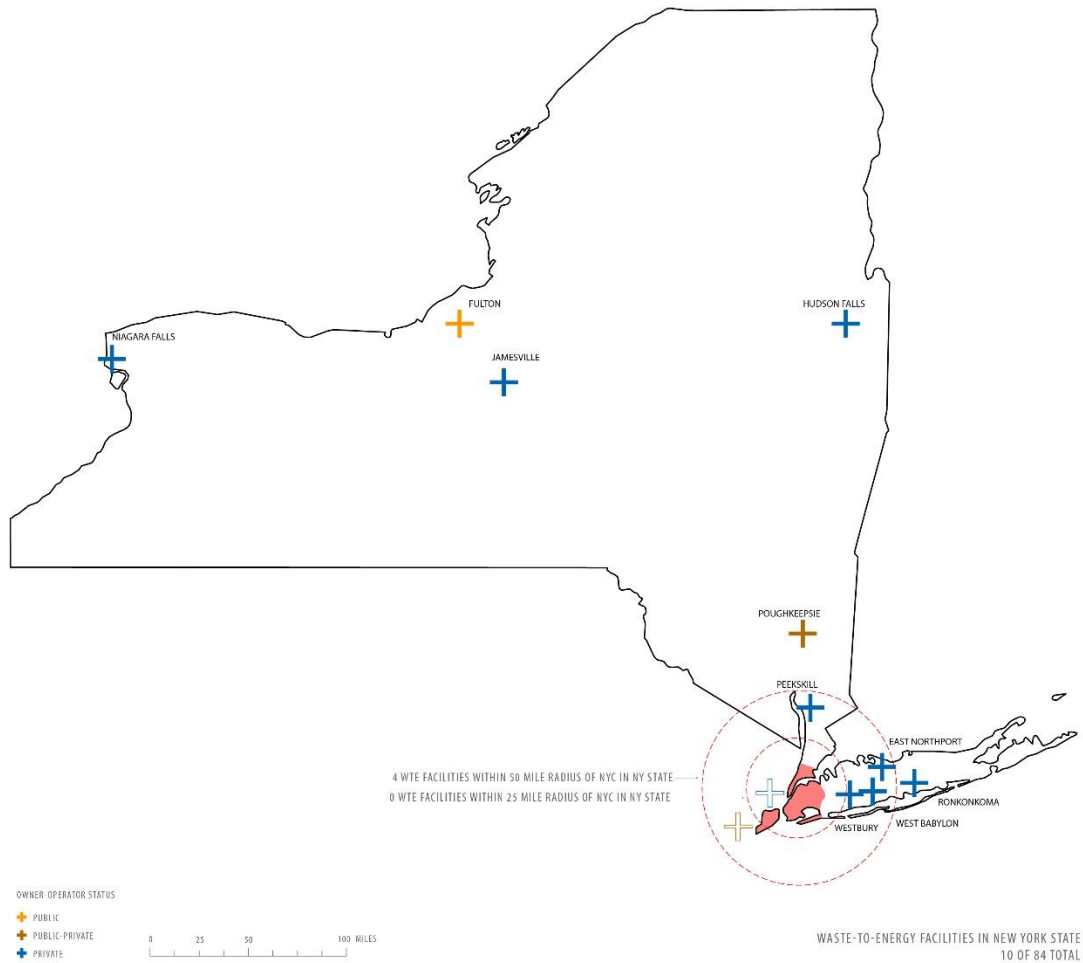


Figure 23: Waste-to-Energy Facilities in New York State
Image by Author

Zooming further into New York and isolating the state, it is apparent that there is an issue with the location of the WTE facilities and their relationship to New York City. While there are six plants within a fifty mile radius, there is only one WTE facility within a twenty-five mile radius. That plant is located in Newark, NJ and is a receptacle for a portion of New York’s Municipal Solid Waste. Within New York City itself, there are no Waste-to-Energy facilities. There is a huge demand and no supply for a Waste-to-Energy facility located within the five boroughs of New York. A facility within city limits would allow waste to be processed within the same city

that it is generated in, providing energy back to the city. This would begin the cycle of a closed loop system, such as in Kalundborg, Denmark (Figure 1). Locating a WTE facility within the city would not only produce energy, but more importantly reduce and/or eliminate the need for the city's trash to be exported.

Since the closing of Freshkills Landfill in 2001, once the largest landfill in the country, the city of New York is exclusively exporting their garbage to other states, by truck, rail, and barge. This costs taxpayers a lot of money and harms the environment. The city is in need of a more effective way of managing their trash.

WTE_ New York City

This thesis proposes a Waste-to-Energy facility in New York City as a way to begin to think about Waste-to-Energy as a creative solution to the city's trash problem. This thesis will draw from the body of knowledge gathered from the hybrid projects analyzed earlier in Chapter 2, and will propose a WTE facility that ties in landscape and public amenities to further the discussion of the place of architecture and landscape architecture within industrial zones of a city. It will attempt to answer questions raised earlier about the issues of public awareness of trash and the appropriation of architecture within the field of waste management. This project will hopefully be a prototype of a way to rethink waste infrastructure in a way that is larger than the scale of building.

In order to begin siting this design proposal within the city, the process used above of beginning at the macro scale and working down to the micro scale to justify site decisions will be employed by beginning at the city scale and working down to

the neighborhood scale. But first, some guidelines regarding New York Municipal Solid Waste will be laid to further support the proposal.

Chapter 4_NYC Garbage

Current Practices

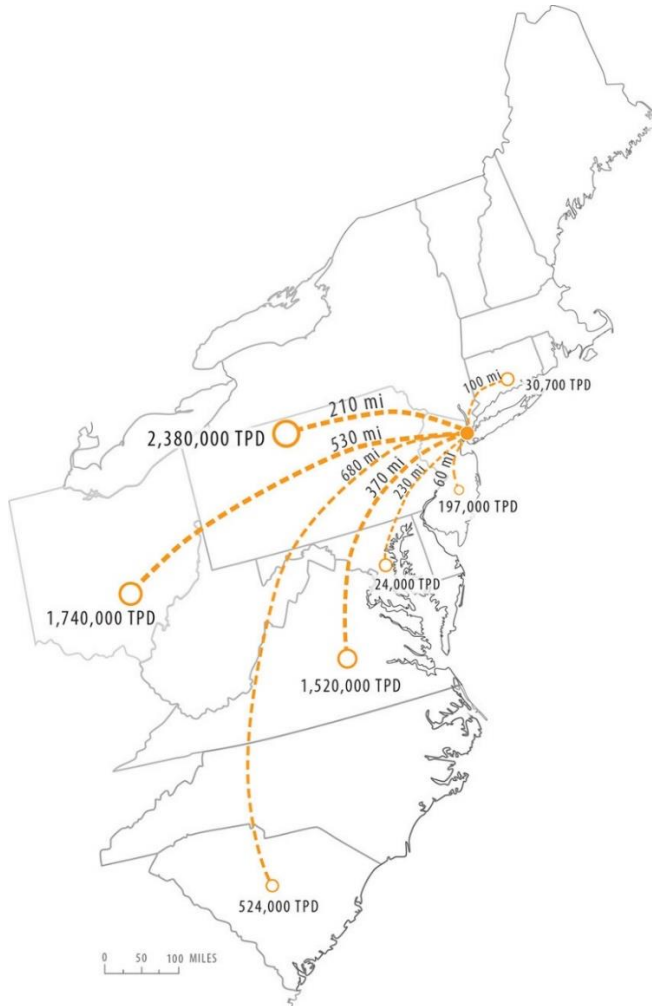


Figure 24: Export of NYC Trash
Image by Author

The annual volume of trash being disposed of is currently 3 million tons of residential waste and 3 million tons of commercial waste. Residential waste is collected by Department of Sanitation of New York (DSNY) and commercial waste is

collected by private waste collection companies. In terms of exporting waste, the bulk of NYC Municipal Solid Waste is exported to landfills, and a small percentage is sent to a nearby Waste-to-Energy facility: Essex County Resource Recovery Facility in Newark, NJ. The MSW that is sent to landfills is exported primarily by truck to Pennsylvania and Ohio, and by rail to Virginia and South Carolina. Figure 24 maps the volume and location of the MSW New York City exports. The following states are the receiving states of New York City's Municipal Solid Waste: Pennsylvania (37%), Virginia (24%), Ohio (27%), South Carolina (8%), New Jersey (3%), Connecticut (0.5%), and Maryland (0.5%)¹⁹.

Initiatives

Solid Waste Management Plan

The Solid Waste Management Plan (SWMP) developed in 2006 establishes the structure of New York City's solid waste management, for 2006 through 2025.²⁰ After the closing of Fresh Kills Landfill in 2001, the city of New York needed to develop a new system of managing waste. Since there is no other landfill within city limits, the city must export 100% of its Municipal Solid Waste (MSW) to other states. Consequently, in 2002 May Bloomberg outlined a new approach to the City's Long

¹⁹ Zak Accuardi, Micah Babbitt, Rex Chen, Esther Lee, Tim Mayo, Elizabeth Rice, and Kelly Westby, "Waste-to-Energy Design Proposal for Red Hook, Brooklyn," (Earth and Environmental Engineering, Columbia University), 2011, 16.

²⁰ Committee on Sanitation and Solid Waste Management, *Final Comprehensive Solid Waste Management Plan*, (New York, NY, 2006) 1-1.

Term Export Program and directed the Department of Sanitation of New York (DSNY) and implement a Marine Transfer Station (MTS) Conversion Program.

Prior to the Long Term Export Program, the Interim Export Program was established to provide structure to the city's solid waste management. Key features of this program were that 48% of DSNY-managed waste was moved to out-of-City disposal sites by transfer trailers, 14% was moved by rail, and 38% was moved by DSNY collection vehicles. The Long Term Export Program seeks to reduce dependence on transport by transfer trailers to disposal sites.

“Some 93% of all truck-transferred DSNY-managed waste is disposed in landfills and most of the landfills under contract are within a radius of 200 miles of the City. A combination of factors is causing the depletion of this capacity and an increase in disposal price.”²¹

The Long Term Export Program seeks to improve this issue by increasing use of barge and rail as a method of exporting waste. While the City acknowledges the far distance its' exported waste is traveling and the liabilities of increased cost, both economically and environmentally, it proposes fixing the issue by changing the method in which the waste is moved rather than thinking about the larger issue of finding an alternative to landfilling.

In addition to implementing barge and rail removal, the SWMP proposes combining functions of the four new Marine Transfer Station, owned and operated by the Department of Sanitation of New York. A current issue of having separate residential and commercial trash collection is the truck traffic and multiplicity of

²¹ Committee on Sanitation and Solid Waste Management, *Final Comprehensive Solid Waste Management Plan*, (New York, NY, 2006). 3.6

transfer stations. In order to address this, the SWMP proposes sharing the four new facilities between DSNY operations and private hauler operations. DSNY trucks would use the facility between 8:00 am and 8:00 pm, and private haulers would use the facility between 8:00 pm and 8:00 am.

OneNYC_Zero Waste

Mayor Bill DeBlasio released OneNYC: The Plan for a Strong and Just City in 2015, establishing bold goals and specific targets for a “strong, sustainable, resilient, and equitable city.”²² The plan sets forth goals and targets, the majority of which are to be reached by 2050. A pertinent goal under the ‘Our Sustainable City’ vision is Zero Waste. It states the goal as such: New York City will send zero waste to landfills by 2030. A specific target of this goal is to reduce the volume of DSNY-collected trash by ninety percent relative to the 2005 baseline of 3.6 million tons per year. The initiatives set forward with clear timelines thus far are two-fold. The first is expanding the NYC Organics curbside collection and drop-off site programs to serve all New Yorkers by the end of 2018. The second is to implement single-stream recycling collection for metal, glass, plastic, and paper products by 2020.

While both of these plans will decrease the volume of Municipal Solid Waste that needs to be disposed of, these measures alone will not be significant enough to reach the Zero Waste goal. If the city wants to completely eliminate the need to export trash to landfills, a major investment of alternate technologies, primarily Waste-to-Energy, will need to be made. Investing in this infrastructure while costly

²² Mayor Bill de Blasio, *One New York: The Plan for a Strong and Just City*. New York, NY, 2015, 7.

upfront, will afford the city of New York the ability to eliminate its dependence on landfilling. Accomplishing this lofty goal will need some serious power behind it, something that cannot simply be done through an increase in recycling and organics collection.

Chapter 5_Site Selection

The City of New York

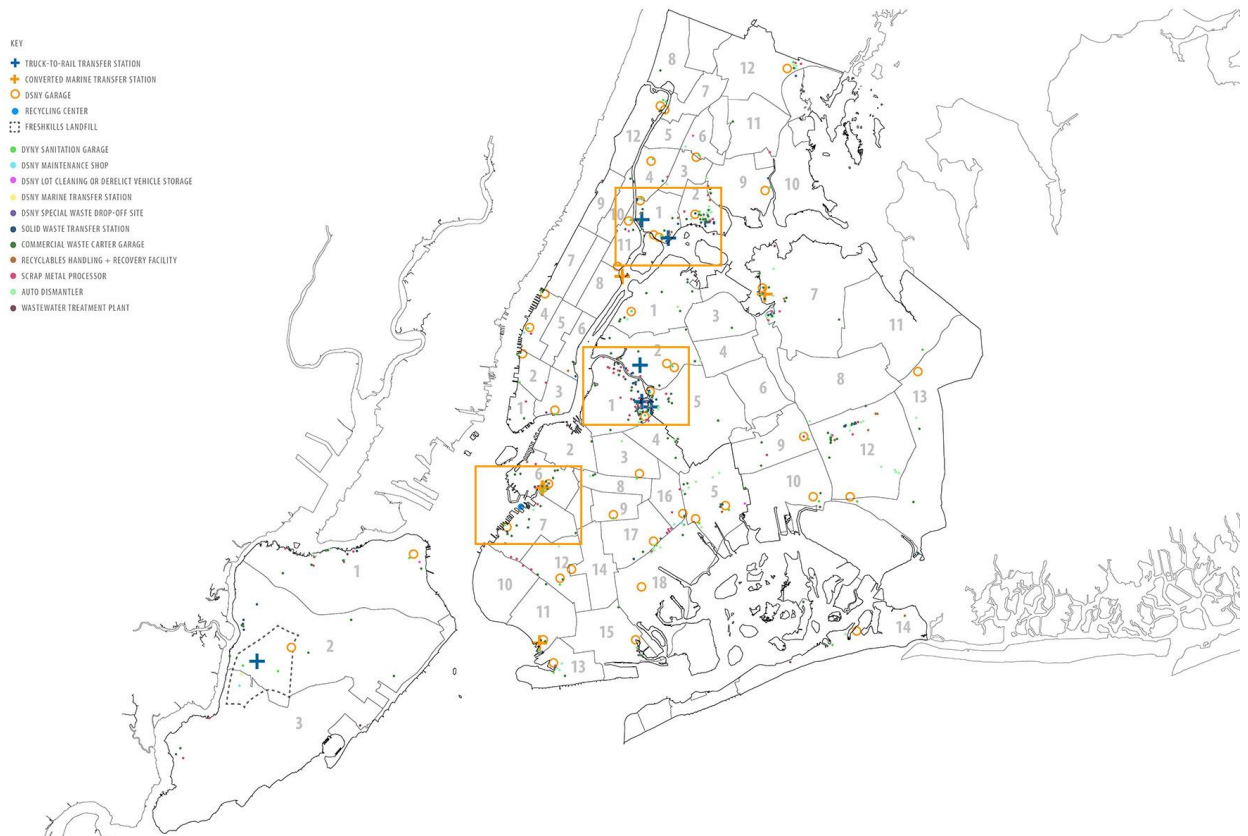


Figure 25: New York City Waste Infrastructure Densities
Image by Author

In order to locate the best site for this WTE plant, all types of waste infrastructure in the city were mapped as seen in Figure 25. Through mapping, one can see that points of waste infrastructure begin to form several areas of high density in the outer boroughs (Bronx, Queens, and Brooklyn). Key locations are DSNY transfer stations, indicated with crosshairs. These transfer stations serve a watershed of certain Community Boards, which are numbered in the above map. These areas of activity propose further investigation in selecting a site for this design proposal. From here, three sites are examined in order to determine the site to work within.

Criteria for selecting site originate from waste infrastructure density as a way to tie the project into the existing waste infrastructure, but more importantly other criteria go beyond existing waste capacities to seek ways to bridge these industrial sites into the public realm and plug the site and proposed design into the network of the city. This includes connectivity to parkland, residential neighborhoods, community nodes, commercial nodes, transportation modes, and vistas.

Site 1_ Port Morris, Bronx

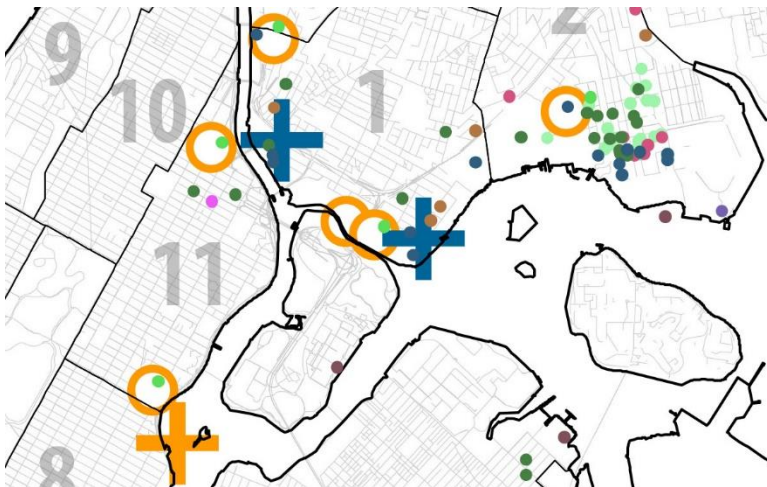


Figure 26: Detail of Port Morris Waste Management Locations
Image by Author

Working from north to south, the first trash hot-spot site to investigate is the Port Morris neighborhood of South Bronx, highlighted in orange in Figure 27. It is a mixed use, primarily industrial neighborhood, part of Bronx Community District 1.



Figure 27: Port Morris, Bronx Site Context
Image by Author, Google Earth aerial underlay

It is bounded to the north by the Major Deegan Expressway and Bruckner Expressway, to the south by the Bronx Kill, to the east by the East River, and to the west by the Harlem River. Directly across the Bronx Kill is Randall's and Wards Island, with the Robert F. Kennedy Bridge, also known as the Triborough Bridge, and Randall's Island Rail Connector joining the two. Randall's Island is an interesting area, as it is mainly recreational, with a stadium, sports fields and facilities but also contains a massive wastewater treatment facility.



Figure 28: Port Morris, Bronx Figure Ground
Image by Author

While there are two transfer stations in the area, seen as blue crosshairs in Figure 26, as well as a number of recycling facilities, commercial waste carter garages, and auto dismantlers there are not a lot of opportunities for connectivity to other neighborhoods. The expansive network of highways, rails, and bridges sever the area, leaving it feeling disjointed, seen in the figure ground (Figure 28). It is a very challenging post-industrial water's edge condition to work within.

Site 2_Newtown Creek, Brooklyn/Queens

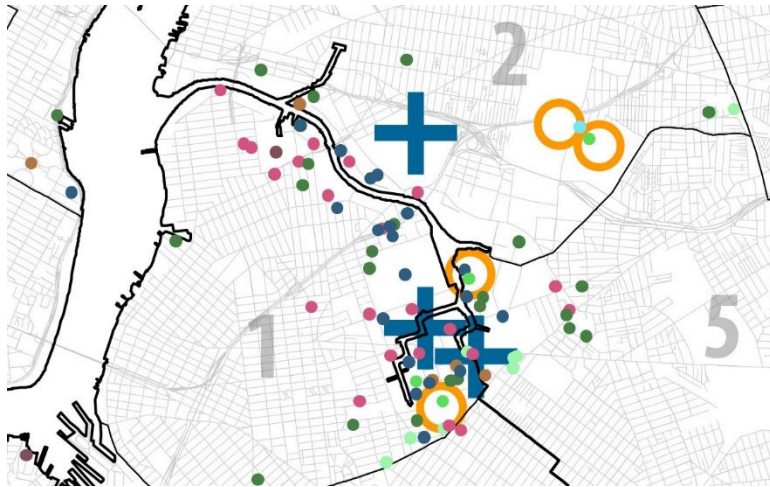


Figure 29: Detail of Newtown Creek Waste Management Locations
Image by Author

The next trash hot-spot is the Newtown Creek Industrial District, which straddles the boroughs of Brooklyn and Queens. This area contains three transfer stations—two operating in Brooklyn Community District 1 and the other operating in Queens Community District 2. Other trash-related activities include commercial waste carter garages, scrap metal processing, and auto dismantlers.

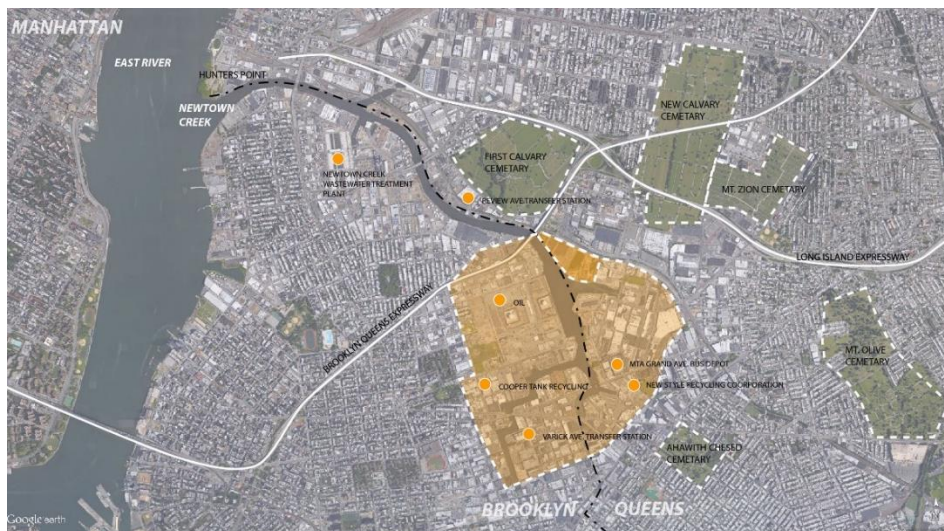


Figure 30: Newtown Creek Site Context
Image by Author, Google Earth aerial underlay

The Newtown Creek Wastewater Treatment Plant, located north of the area highlighted in orange in Figure 30, is the city's largest sewage treatment facility. The industrial district straddles both banks of the creek and is bound to the north by the Long Island Expressway. Also located north of the industrial area are a series of cemeteries. Newtown Creek has a long history of environmental abuse by industrial dumping, oil spills, and sewage overflow. Consequently, in 2010 the federal Environmental Protection Agency designated Newtown Creek as a Superfund site. Below is a description of the state of the creek to paint a picture of the site:

“The creek has little natural inflow and all of its outflow, 14 billion US gallons per year, consists of combined sewer overflow, urban runoff, raw domestic sewage, and industrial wastewater. The creek is largely stagnant, one cause being the 15-foot-thick layer of polluted sludge that has congealed on the creek bed.”²³

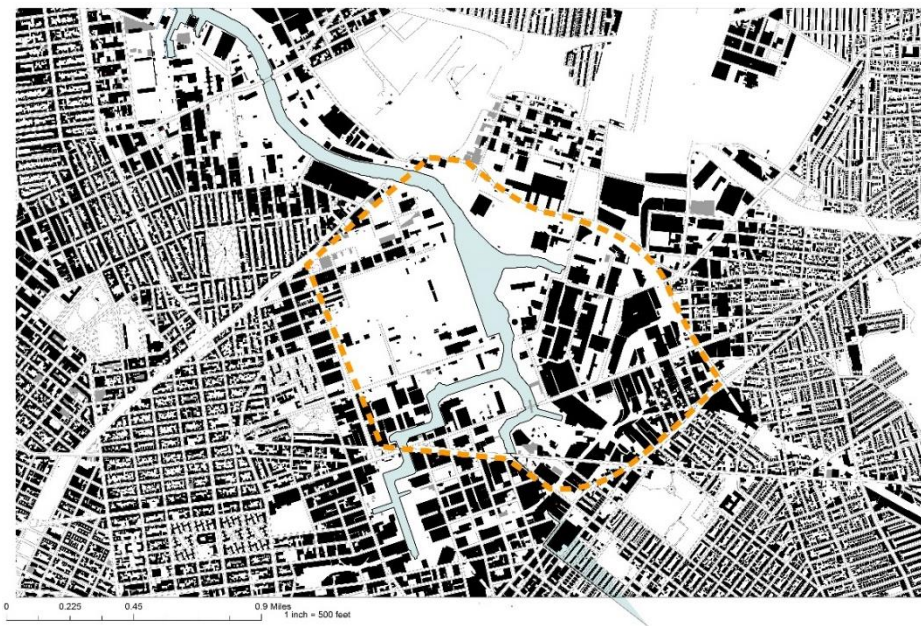


Figure 31: Newtown Creek Figure Ground
Image by Author

²³ “Newtown Creek Clean-Up Efforts” *The City Concealed*. Thirteen (WNET.org) December 12, 2008.

Because of the highly industrialized nature of the site and its large scale, it would be very challenging to bring a meaningful public amenity to this space. With its negative environmental conditions, such as toxic water, there is little potential for meaningful connection to nearby neighborhoods, greenspace, and communities.

Site 3_ Sunset Park, Brooklyn



Figure 32: South Brooklyn Waste Management Locations
Image by Author

The last site to investigate is the South Brooklyn waterfront area, located in the Sunset Park neighborhood of Brooklyn and Community District 7. The large site, highlighted in orange in Figure 33, is bound to the east by 3rd Avenue, with the Gowanus Expressway, an elevated highway, running above. The site is bound to the west by water—Red Hook Channel, and Gowanus Bay. To the north of the site, across the bay is the Red Hook neighborhood of Brooklyn, an industrial neighborhood.



Figure 33: South Brooklyn Site Context
 Image by Author, Google Earth aerial underlay

There are several pieces of waste infrastructure nearby including a recycling facility, a DSNY transfer station, DSNY sanitation garages, commercial waste carter garages, and a wastewater treatment plant. Located just to the north of the site scope defined in Figure 34 is the Sunset Park Material Recovery Facility. This is a new facility that was completed in 2014. It contains an education center that has programs for students and the public including classrooms, exhibitions, interactive demonstration displays, and a viewing platform above the processing area. The building features several sustainable measures that go beyond typical recycling facilities. Recyclables arrive by barge instead of truck and site fill was made from a combination of recycled glass, asphalt, and rock reclaimed from the Second Avenue

subway construction. Other features include a photovoltaic array, a wind turbine, and bioswales for stormwater management²⁴.



Figure 34: South Brooklyn Site Figure Ground
Image by Author

Further to the north, located at the mouth of the Gowanus Canal is the Hamilton Avenue Marine Transfer Station. This is a relatively new transfer station, put forward in the Solid Waste Management Plan of 2006, discussed earlier in Chapter 4. This is the end collection point for a watershed that is comprised of ten Brooklyn Community Districts. From here, the waste is transported by barge to intermediate transfer stations or to out-of-state landfills. Also located on site is the South Brooklyn Marine Terminal. This functions as an intermodal shipping, warehousing, and manufacturing complex.

²⁴ "Sunset Park Material Recovery Facility / Selldorf Architects" ArchDaily, last modified May 27, 2014, accessed December 3, 2015. <http://www.archdaily.com/509387/sunset-park-material-recovery-facility-selldorf-architects/>

In terms of green space, there are several parks nearby. Within the site area is Bush Terminal Piers Park, which was once part of the port complex, Bush Terminals. It was cleaned up and opened as a public park in 2014, with two soccer fields and offers views to the Statue of Liberty and Lower Manhattan. One and a half miles northeast of the site is Prospect Park. Sunset Park is located east of the site and just south of Green-Wood Cemetery. To the south of the site is also Owl's Head Park. These landscapes provide potential connectivity for this project.

Selecting Site 3

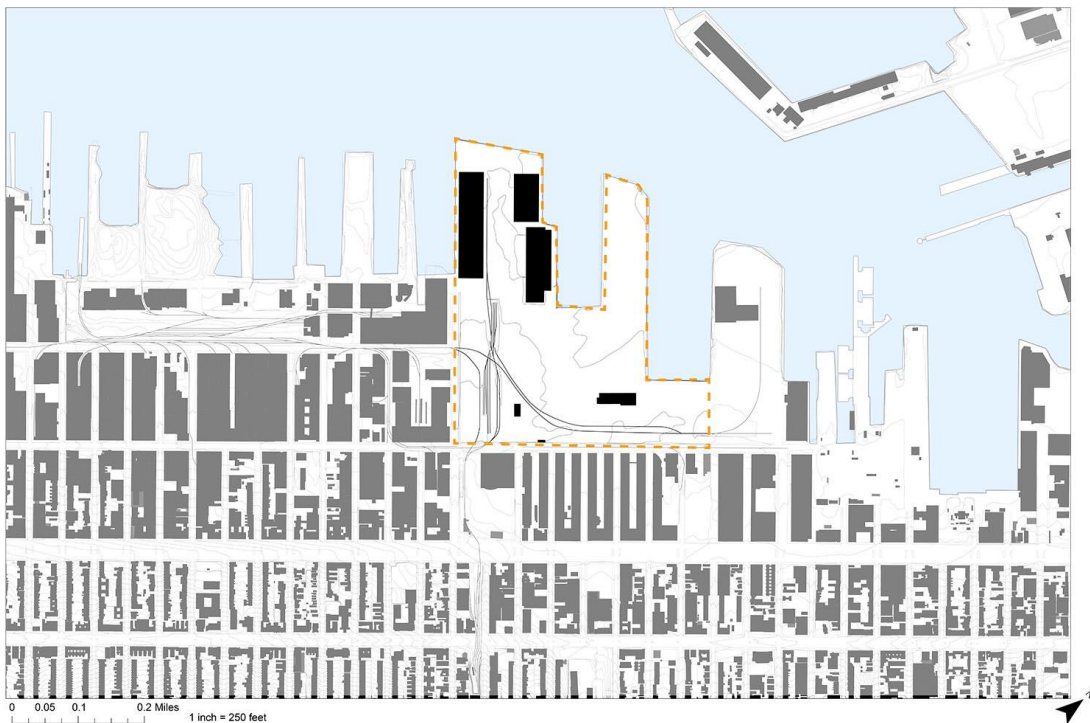


Figure 35: Site Boundary
Image by Author, with City of New York GIS Underlay

After examining the three potential sites, Sunset Park in Brooklyn stands out as a site full of potential to plug into networks of waste infrastructure, public green space, and a growing renewal of the industrial waterfront. The site is ripe with

potential in these regards, as well as ample area to work in for this large industrial project of a Waste-to-Energy Plant. Within the industrial waterfront of Sunset Park, this project will be situated within the largely derelict South Brooklyn Marine Terminal, outlined in orange in Figure 35: Site Boundary.

Chapter 6_ Sunset Park's Industrial Waterfront

Background

The industrial waterfront of South Brooklyn has an important economic, cultural, and environmental history. From its extensive transformation during the Industrial Revolution to serve as one of New York City's major shipping and manufacturing centers, to its decline as manufacturing relocated, to its slow transformation today, the waterfront is constantly evolving. New York's relationship with its waterfront is a long and tumultuous history, but the immediate area of the South Brooklyn Marine Terminal in Sunset Park serves as a microcosm of this relationship in which we can understand this history.

Past_Bushwick Piers

In the late nineteenth century, as industry continued to skyrocket in New York, shipping and industrial needs were no longer able to be met in the crowded island of Manhattan, and investors turned to Brooklyn to continue expansion.



Historically, the area that is currently known as South Brooklyn Marine Terminal was named Bush Terminals and can be seen from above in Figure 36. The complex consisted of piers and buildings designed to provide

Figure 36: 1930 Aerial Photograph of Bush Terminals
Credit: Brooklyn Historical Society

wholesales in Manhattan an inexpensive location from which to import, export, and manufacture goods.



Figure 37: Industry City, 1940s
Credit: Industry City

As explained by Kevin Bone in his historical analysis, *The New York Waterfront: Evolution and Building Culture of the Port and Harbor*, “Begun in 1890 with one pier, the complex eventually occupied 200 acres and became what its founder, Irving T. Bush, had intended—an ‘industrial city within a city’.”²⁵ Bush’s quote can be seen plastered on the side of one of his buildings, serving as an advertisement, seen in Figure 37.

²⁵ Kevin Bone, *The New York Waterfront: Evolution and Building Culture of the Port and Harbor* (New York: Monacelli Press, Inc., 1997), 176.

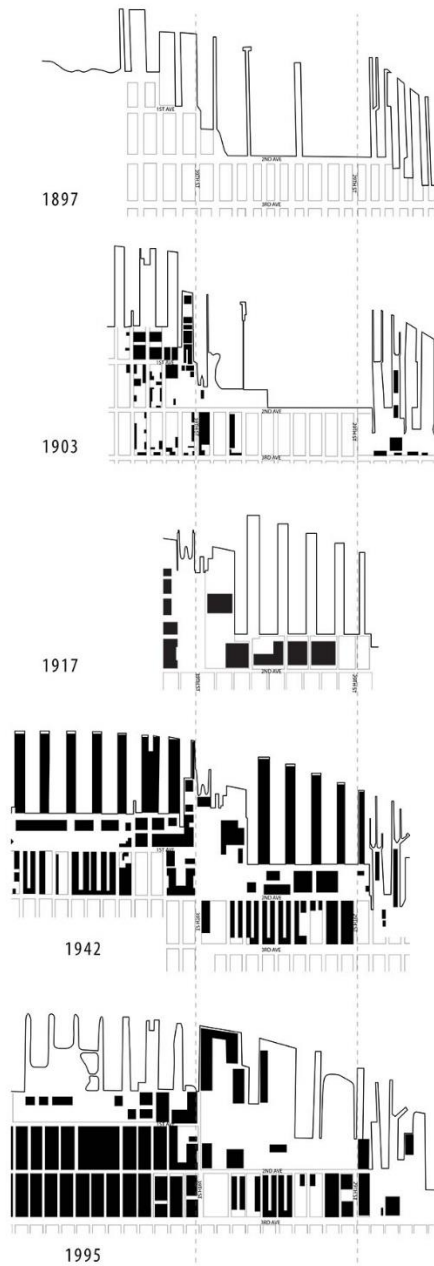


Figure 38: Transformation of Waterfront Condition
Image by Author

To understand the site not only as it currently exists, but how it has existed throughout time, an investigation was made into the formal edge of the waterfront throughout history. Through research of historical maps, a series of evolutionary figure-grounds was constructed, Figure 38, that maps the shifting form of the area's waterfront over time.

Beginning in 1897 and ending in present day, one can see that the water's edge is not a static condition. It has a dynamic and temporal quality that is

fundamental in envisioning the

future of the site that will be proposed with this thesis design. Figure 39 shows the composite of this transformation through time. Overlaying these historical water's edge + pier conditions, we can read the dynamic quality of the relationship between

land, water, and the in-between. There is a constant shifting of the formal edge of land as well as the shape and number of piers that act as fingers reaching into the water, blurring the line between land and water. Figure 40 shows how this design proposal will be the next layer of this continual transformation.

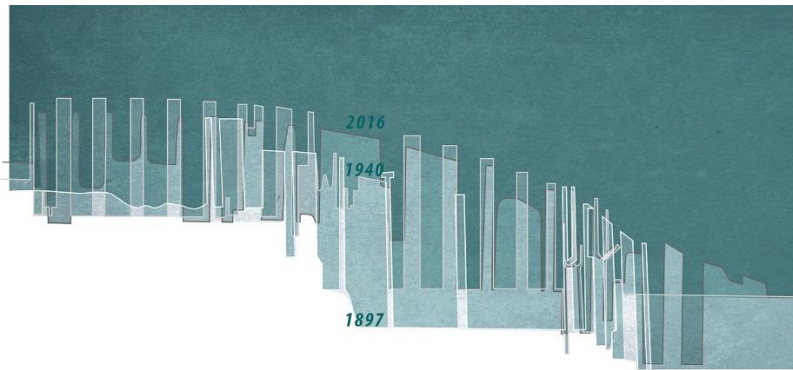


Figure 39: Composite of Water's Edge
Image by Author

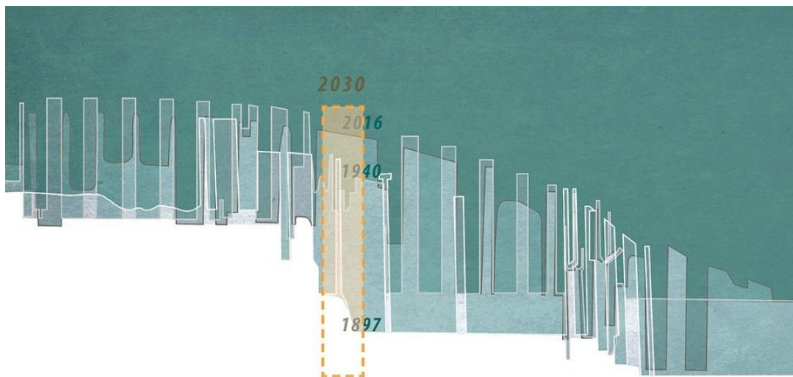


Figure 40: Composite of Water's Edge with Proposal
Image by Author

Present_Industry City

Today, there is interesting commercial activity in this industrial district of Sunset Park. The eight block area of 19th century warehouse buildings that were formerly part of Bush Terminal have recently been rebranded as Industry City, mixing light

manufacturing with with rental spaces for small start-ups. It draws on the area's history of industrial strength and pushes it forward as a space for 21st century 'makers' to gather to work, play, and create. This rebranding effort can be seen when visiting the complex, in murals painted inside several of the buildings (Figure 41 & Figure 42).



Figure 41: Industry City Mural in Lobby; Image by Author (left)
Figure 42: Industry City Mural in Food Hall; Image by Author (right)

The mission of the current owners is as follows: “Today, Industry City is on the cusp of a rebirth as a dynamic 21st Century innovation and manufacturing community, one that balances existing manufacturing tenants with those centered on creative and innovation economy fields.”²⁶

²⁶ “History,” Industry City, last modified 2014, accessed December 2, 2015, <http://industrycity.com/history/>

Future_Vision Plan

As Industry City and other nearby buildings along Sunset Park's industrial waterfront begin to transform to serve the next generation of designers and innovators, the New York City Economic Development Corporation (NYCEDC) has developed the Sunset Park Vision Plan to help guide the economic growth of the area. Working with a group of stakeholders such as the NYC Department of City Planning, the NYC Department of Small Business Services, elected officials, community organizations, and local businesses the Vision Plan was issued in 2009 with an aim to strengthen Sunset Park as a center for industrial growth. "Today, the main challenge is to figure out ways to adapt and re-use this antiquated industrial infrastructure and develop Sunset Park into a 21st century model for diverse, dense, and environmentally-sustainable industry"²⁷

Further, the goal of the Vision Plan is to:

"develop physical and policy-based strategies that reconcile active industrial uses with public waterfront access while also enabling sustainable industrial growth. The vision for the Sunset Park industrial waterfront is to balance neighborhood, city, and industrial development goals within this framework."²⁸

²⁷ "Sunset Park Vision Plan" NYCEDC. last modified October 27, 2015, accessed January 8, 2016, <http://www.nycedc.com/project/sunset-park-vision-plan>

²⁸ NYCEDC. "Sunset Park Vision Plan."

Characteristics of Site Context

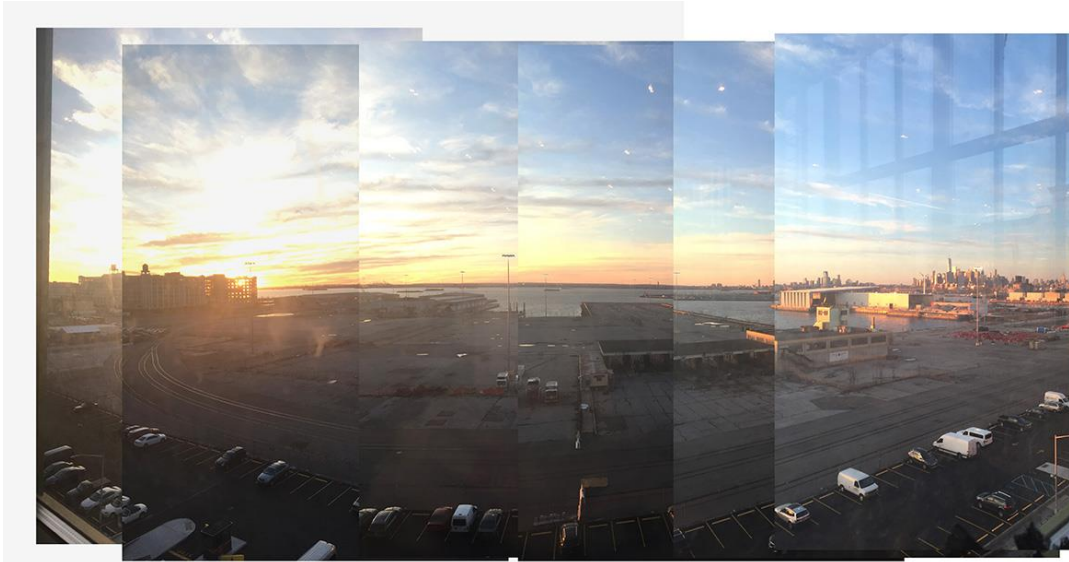


Figure 43: Panorama of South Brooklyn Marine Terminal
Image by Author

The panorama above (Figure 43), taken from the eighth story of an Industry City building during a site visit, highlights several key features of the site context. To the far left, one can see a derelict building part of the Industry City complex. The two large piers in the center make up the South Brooklyn Marine Terminal and continuing to the right, the next pier is home to the newly constructed Sunset Park Material Recovery Facility. The site offers great vistas to Lower Manhattan to the far right of the frame, and distant views to the Statue of Liberty.

Three key characteristics, discussed below, succinctly describe the context of the site. They are: 1) a place of former industry, 2) a place of new growth, and 3) a changing waterfront. These three characteristics each offer a lens of opportunity that can be read into the site. After quickly examining each of these lens, paired with the knowledge of the economic investment discussed with the Sunset Park Vision Plan,

this site offers all of the potential for this hybrid Waste-to-Energy Plant & Public Waterfront Access to successfully plug into.

Former Industry



Figure 44: Abandoned Industrial Buildings Near Site
Image by Author



Figure 45: Open Unused Land on South Brooklyn Marine Terminal
Image by Author

As seen in the photographs in Figure 44 and Figure 45, taken during a site visit, much of South Brooklyn Marine Terminal and its surroundings are in a state of dereliction. The majority of these large scale buildings fell into a state of disrepair and neglect as economic opportunities left the area in the mid twentieth century.

Since then, much of the industrial waterfront remains in a state of abandonment. The building on the left of Figure 44 is one of the manufacturing buildings in the Industry City complex. It is the last of the Industry City buildings to remain derelict, as the other buildings have slowly been getting renovations. The majority of the buildings located within the South Brooklyn Marine Terminal, seen in Figure 45 have been abandoned and have fallen into disrepair. The large site, fenced off from the public remains mostly empty, brimming with possibilities.

New Growth

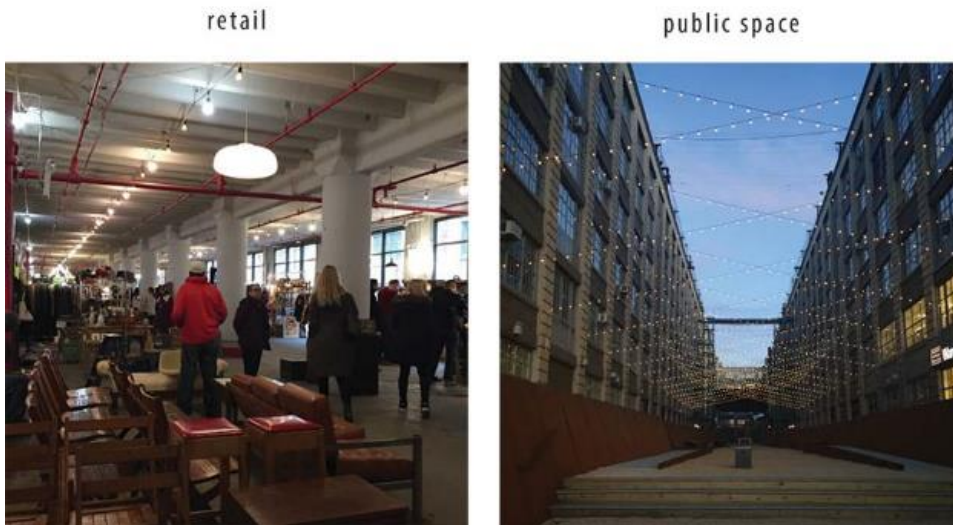


Figure 46: Site Characteristics of Industry City—retail, public space, & craft
Image by Author

tenant space



design + craft



Figure 47: Industry City Courtyard & Signage
Image by Author

However, as discussed earlier in this Chapter, the Sunset Vision Plan, paired with private investment is slowly turning this negatively perceived area around. Eight of the 11 buildings that are part of the Industry City complex have been updated and are being rented out to tenants. The photographs above in Figure 46 show the character of Industry City. In addition to its main function of renting space to manufacturers, designers, and start-ups, it hosts several additional features such as a Food Hall, courtyards, exhibition spaces, and retail spaces. Events are hosted such as a weekly Brooklyn Flea, annual NYCxDesign lectures, and films. The complex is slowly becoming a new district of innovation for creatives in New York.

Waterfront

industry

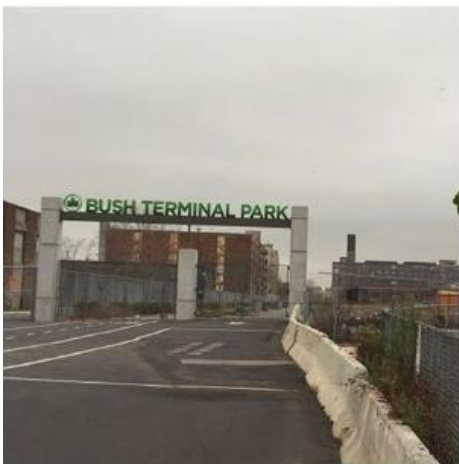


derelict piers



Figure 48: Waterfront Industry & Derelict Piers
Image by Author

Bush Terminal Park



recreation



Figure 49: Bush Terminal Park
Image by Author

The waterfront of Sunset Park as discussed earlier, is constantly in a cycle of evolution. The majority of the piers that were once the forefront of the manufacturing and shipping have since fell into a state of neglect. The two large piers that make up the South Brooklyn Marine Terminal have been left inactive in recent years, sitting unused along the water's edge. The 3 narrow piers that sit adjacent to the site have fallen into a sad state of dereliction, seen in the image on the right of Figure 48. This abandonment largely reflects the years of neglect this area suffered from after the

manufacturing and shipping industries left the area. However, if we continue down the waterfront, the next series of piers make up Bush Terminal Park, opened in 2014, seen in Figure 49.

Bush Terminal Park

The making of this park is unique, as it serves as a microcosm of much of New York’s abandoned industrial waterfronts. Its story spans 30 years. A history of the park’s site from the *Environmental Restoration Record of Decision for Bush Terminal Landfill Piers 1-4 Site* shows how this 17.3-acre site was landfilled to create “approximately 14 acres of urban land that was created by landfilling between four piers (Piers 1-4) that were part of the former Bush Terminal warehouse complex²⁹”.

The description of the area’s environmental degradation follows:

“Prior to 1974, the site was an active port facility, with vessels that docked between its piers. In 1974, the City of New York Department of Ports and Terminals contracted with a private company to fill in the areas between the four piers with clean construction-related fill. In 1978, the private fill contractor was cited for violations related to the quality of the construction-related fill... and in 1982 the City learned of alleged illegal disposal of liquid wastes at the landfill including oils, oil sludges, and wastewaters.”³⁰

Since the 1980’s the site has been remediated, and through work with the local community and NYCEDC, the park has been a culmination of the efforts of the Sunset Park community to have access to their waterfront. An excerpt of an article by Nathan Kensinger in *Curbed New York*, reviewing the park when it opened, shows the struggle the community went through to get this park.

²⁹ “*Environmental Restoration Record of Decision: Bush Terminal Landfill Piers 1-4 Site.*” New York State Department of Environmental Conservation, Division of Environmental Remediation. March 2004. 2

³⁰ “*Environmental Restoration Record of Decision: Bush Terminal Landfill Piers 1-4 Site.*” 3

“ ‘I’ve heard stories from people who grew up here who weren’t even aware that it was a waterfront community, because they never went to the waterfront,’ said Jeremy Laufer, the District Manager for Sunset Park’s community board. ‘This is a community that is in desperate need of parks,’ said Laufer. ‘The community insisted on a waterfront park, because we have this heavy manufacturing area, which isn’t necessarily conducive to public health.’”³¹

The transformation of this waterfront park from a post-industrial hazardous waste site to a site for the local community to have access to their waterfront shows the potential for this transformation to continue into this thesis project site through the design that follows.

³¹ Nathan Kensinger, “*Finally, A Park Grows in Brooklyn’s Last Industrial Pocket*,” *Curbed New York*, March 5, 2015, accessed March 23, 2016, <http://ny.curbed.com/2015/3/5/9984436/finally-a-park-grows-in-brooklyns-last-industrial-pocket>.

Site Analysis

Figure-Ground

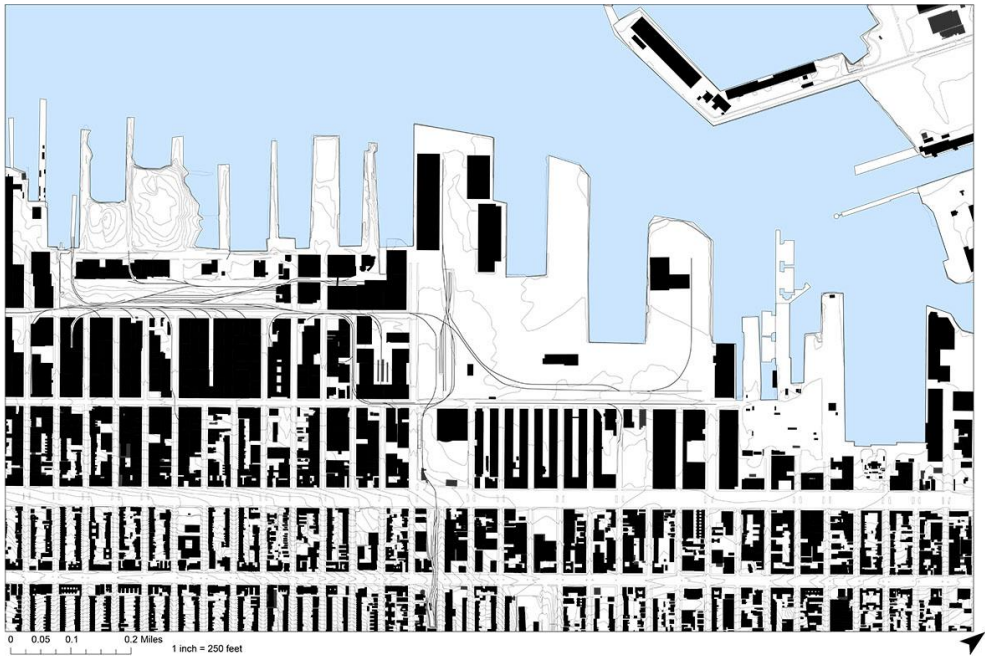


Figure 50: Figure-Ground of Site
Image by Author, with City of New York GIS Underlay

In the figure-ground above, Figure 50, the large scale of the industrial waterfront can be measured against the small grain of the residential blocks of Sunset Park. While the dimensions of the blocks remains in tact for the most part, the scale of building shift from two story row houses and detached homes to large scale warehouse buildings that range in scale from three to eight stories. There is also a large shift in scale from the narrow piers that populate much of the waterfront to the massive scale of the three piers that make up the South Brooklyn Marine Terminal, located in the center of the figure-ground. The Terminal acts as a large monolith that disrupts the scale and grid of streets.

Zoning

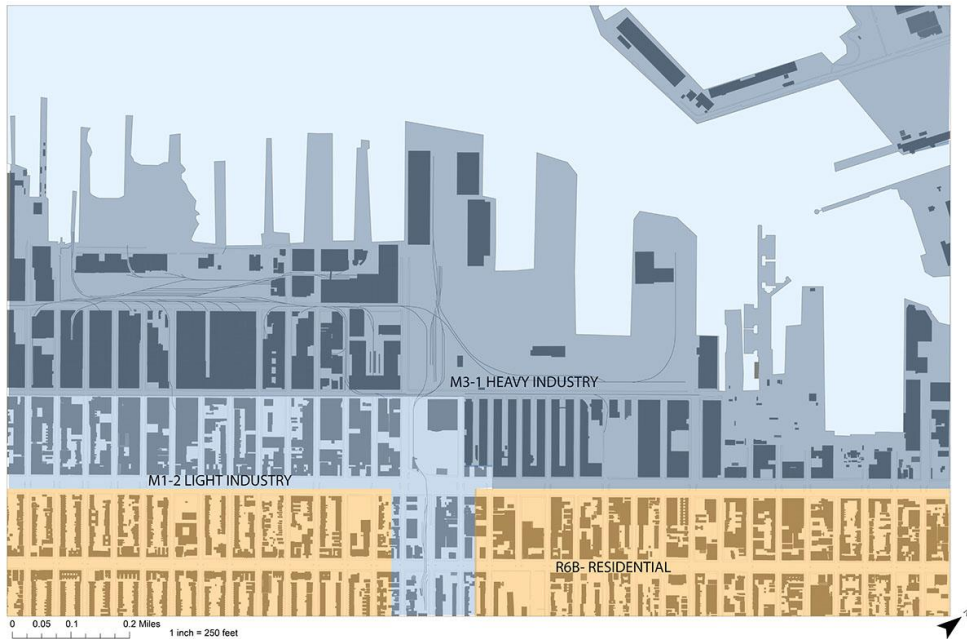


Figure 51: Site Context Zoning
Image by Author, with City of New York GIS Underlay

The zoning of the site context, seen in Figure 51, allocates the waterfront as M3-1: Heavy Industry. This Heavy Industry continues for the most part, right up to 3rd Avenue where it becomes R6-B Residential. There is a number of blocks where there is zoning of M1-2: Light Industry. This stark change, without any transition occurs on 3rd Avenue where an elevated highway, the Gowanus Expressway, runs above. The Expressway marks this stark separation between community and industry and shows how the community is completely cut off from the waterfront.

Site Access & Size

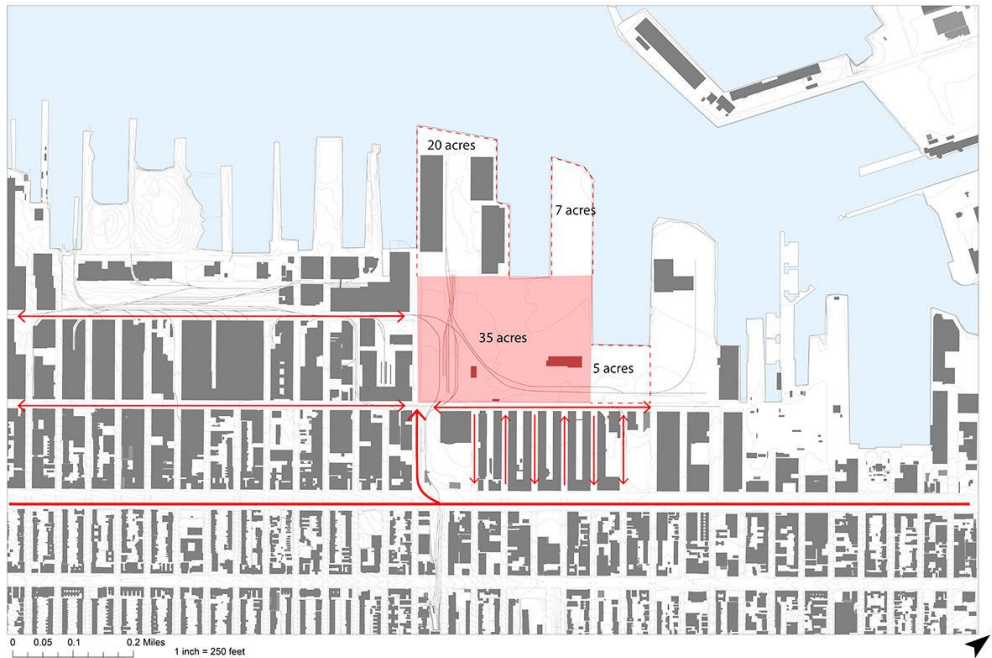


Figure 52: Site Access & Size
Image by Author, with City of New York GIS Underlay

This site access & size diagram, Figure 52, shows both the access- both pedestrian and vehicular, to the site as well as the scale of the site. The streets that run north to south are primarily one-way, with the avenues running east to west that are two-way. The primary access point to the site is at the southwest corner of the site, at the intersection of 2nd Avenue and 39th Street. Running parallel to 39th Street is an off-ramp of the Gowanus Expressway. This serves as an important artery for the flow of trash, mainly by garbage trucks, to the site. Also noted here, is the acreage of the South Brooklyn Marine Terminal, broken down into pieces, to better understand scale. The major piece of land is thirty five acres, with the major pier occupying an additional twenty acres, and the smaller pier, an additional seven acres. Again, the scale of this site is massive, in terms of open land available in the city as well as in

relation to the residential scale of buildings not far from the site. The issue of site scale is a theme that will arise later in the design chapter.

Major Site Context Nodes

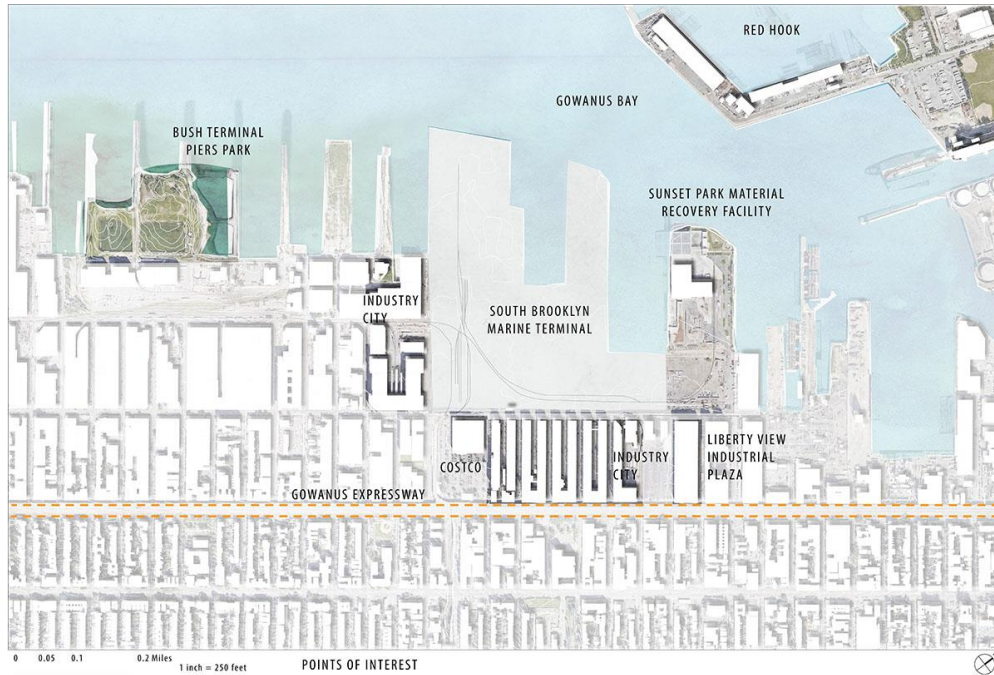


Figure 53: Site Context Nodes
Image by Author, with City of New York GIS Underlay

This diagram, Figure 53, identifies the major nodes near the site. Some of the key features of the site and its context are the industrial elements such as Industry City and Liberty View Industrial Plaza and the relatively new recycling center-Sunset Park Material Recovery Facility. The recycling facility is located on a pier directly adjacent to the proposed site area. To the other side of the site is Bush Terminal Park, with three derelict piers separating the site from the park.

Environmental Considerations

With this project located along the waterfront of New York, resiliency is a topic that garners much attention. Since Hurricane Sandy in 2012, investing energy and resources into research, policy, and action to protect New York against future sea level rise and storm surge is of the utmost importance. There are many avenues of investigation into strategies of resiliency, ranging from conventional defensive infrastructural tactics to new and more innovative techniques. While this thesis does not fully delve into resiliency tactics, a layer of this understanding was brought to the table in schematic design.

Sea Level Rise



Figure 54: Sea Level Rise: 4', 5', 6'
Image by Author, with City of New York GIS Underlay

The most extreme conditions of sea level rise, (SLR) for the site context are shown in Figure 54. Amounts ranging from 1' SLR to 3' SLR do not pose a

significant threat to the area. The middle range of SLR predictions, according to the NYC Panel on Climate Change Climate Risk Information of 2013 are as follows³²:

- 2020s: 4-8 inches SLR
- 2050s: 11-21 inches SLR
- 2080s: 18-39 inches SLR
- 2100s: 22-50 inches SLR

Storm Surge

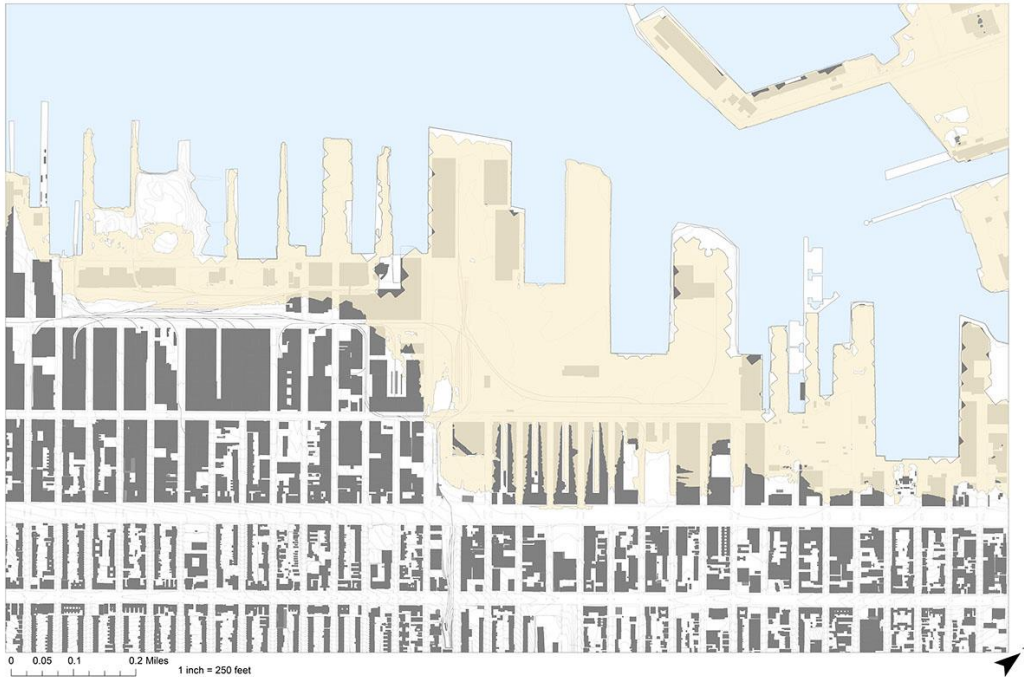


Figure 55: Hurricane Sandy Inundation Levels
Image by Author, with City of New York GIS Underlay

Storm surge pairs with Sea Level Rise as a major concern when looking at how the New York is affected by global climate change. Figure 55 shows how storm surge, specifically the inundation levels from Hurricane Sandy, affect the site.

Because of how flat the site is, the entirety of the South Brooklyn Marine Terminal is inundated. Resiliency efforts such as soft infrastructure can begin to address these

³² “Climate Risk Information 2013: Observations, Climate Change Projections, and Maps” New York City Panel on Climate Change, June 2013. Accessed February 15, 2016.

issues, and it is something that needs to be done at the macro scale of the Upper Bay of New York.

Chapter 7_Program

Waste-to-Energy Facility

Process

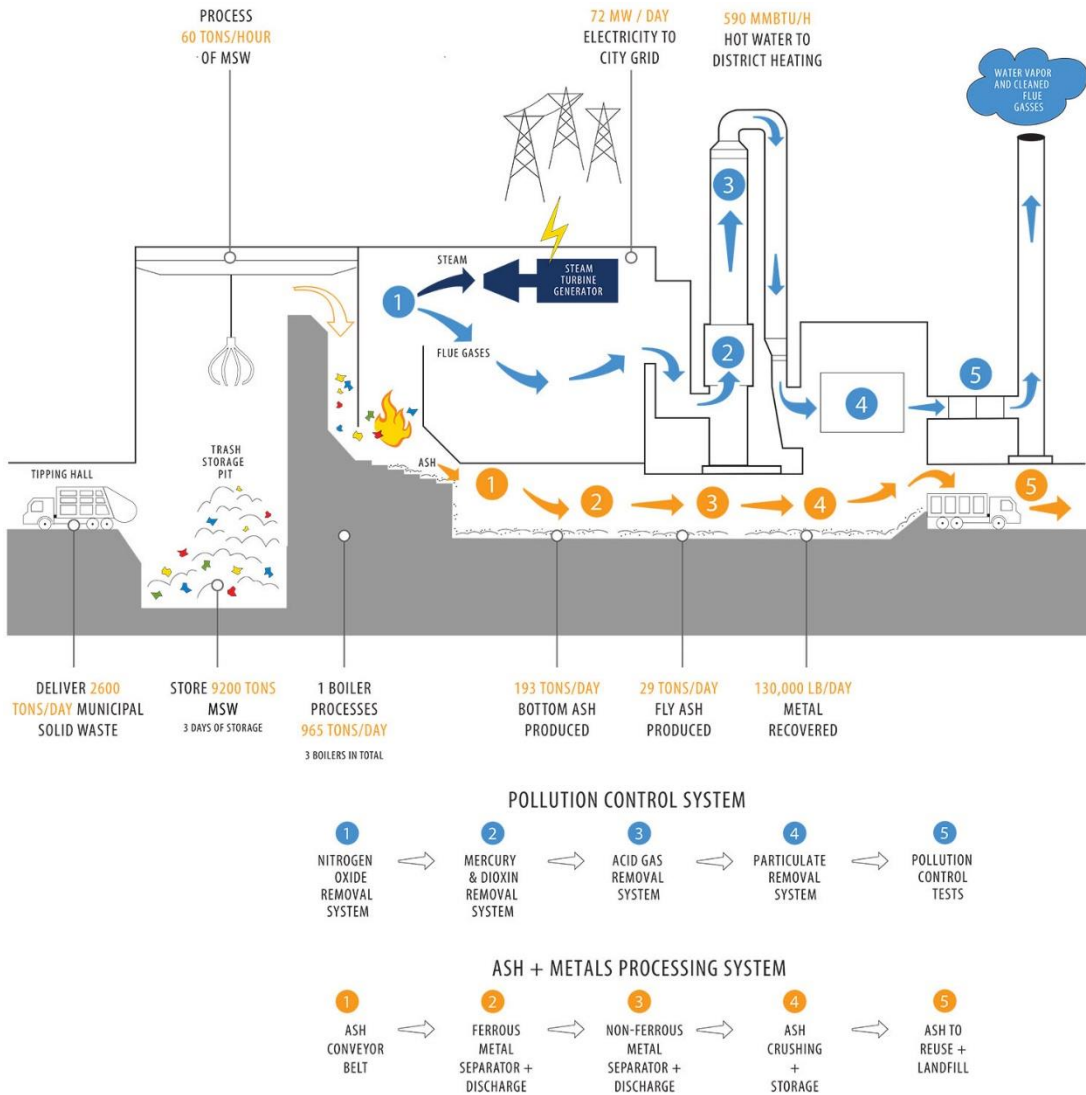


Figure 56: Diagram of WTE Process
Image by Author

The standard process of a Waste-to-Energy Plant is shown in Figure 56. It begins when a truck enters the site and is weighed at a weigh station in order to record accurate data on the amount of Municipal Solid Waste (MSW) being

processed. Next, the truck enter a deposit bay where it empties its load of trash onto the tipping floor.

This area is controlled with negative airflow so its odor does not spread outside the facility. Once the waste has been unloaded onto the tipping floor, it is moved into a storage pit. It is from here that the trash is moved into the combustion chamber by an overhead crane. “A typical overhead crane for WTE storage pits can handle approximately 60 tons per hour and can pick up approximately 1 ton of MSW per scoop.”³³ It is also the job of the crane operator to mix the waste, in order to get a more homogenous stream of waste entering the combustion chamber and ensure an even temperature within. Once the waste is dumped into the combustion chamber, a moving grate moves the waste continuously through the chamber. From here, there are two byproducts: steam and ash. Steam is generated from the heat of burning the



waste. From here, the steam powers turbines that generate electricity. The electricity is sent through a generator and out towards the city grid. The other byproduct, bottom

Figure 57: Process of WTE Plant, Credit: Deltaway Energy

ash and fly ash go through environmental controls that eliminate ash from the air that leaves the smoke stack. These various environmental controls significantly reduce the

³³ Accuardi, “Waste-to-Energy Design Proposal for Red Hook, Brooklyn,” 18.

amount of fly ash left in the carbon dioxide, resulting in an environmentally responsible smokestack. The ash that is collected goes through a process in which metals are removed before the ash is sent off site to be used for aggregate or sent to a landfill. This process reduces the volume of waste ten times.

Layout

The arrangement of the rooms for this process follows a linear logic along the sequence of events from tipping floor to storage pit to boilers to turbine, air pollution control, and ash treatment and collection. A layout for a WTE facility, completed by Earth and Environmental Engineering at Columbia University can be seen in Figure



Figure 58: Typical WTE Facility Layout
Credit: Earth and Engineering, Columbia University

the 13-acre Gowanus Industrial Park in Red Hook, Brooklyn. It thoroughly designs and analyzes the WTE facility, including environmental and economic considerations. While the Red Hook design proposal is strictly engineering based

58.

The document *Waste-to-Energy Design Proposal for Red Hook, Brooklyn*³⁴ serves as a resource for this thesis. The proposal was conducted by students in the Department of Earth and Environmental Engineering of Columbia University in 2011³⁵. This design proposes a Waste-to-Energy facility for

³⁴ EEE Columbia

³⁵ EEE Columbia

design and nothing beyond, this body of knowledge brings quantitative data to this architectural thesis as a basis for design. By using the Red Hook design proposal as a structural framework for WTE functions, this thesis can go beyond the programmatic functions of the energy plant and incorporate public functions within the program, and tie into the community through a hybrid building-landscape relationship.



Figure 59: WTE Process Flow
Credit: Earth and Environmental Engineering, Columbia University

The main take-away from the Red Hook proposal is the basis used for sizing its WTE facility. It bases its capacity on the amount of MSW that is currently being processed at the Hamilton Avenue Marine Transfer Station, which is located at the mouth of the Gowanus Canal, and identified in Figure 33. This transfer station receives 2,600 tons per day of MSW and an additional 1,300 tons per day of commercial waste. The Red Hook proposal has been sized to accommodate 2,600 tons per day of MSW, and could therefore allow for a reduced burden on the Hamilton Avenue transfer station or even a further redistribution of waste collection sheds in the Brooklyn area. In addition, the “volume of processed waste (949,000 tons/year) is

capable of generating upwards of 72 MW of electricity, and approximately 590 MMBtu of heat.”³⁶ Figure 59, from the Red Hook proposal, analyzes the volume of trash at each stage of the WTE process. It identifies and quantifies the inputs and outputs of the WTE process. 2,600 TPD of Brooklyn’s MSW are put into the system and the outputs include 72 MW of electricity, 597mmBTu/hr of heat, 142.68 TPD of ferrous and non-ferrous metals, and ash for sale and to landfill.

Scale

In order to understand program requirements relative to site size and restraints, existing Waste-to-Energy facilities in the U.S. were analyzed in Figure 60, with data gathered from the Energy Recovery Council’s *2014 ERC Directory of Waste-to-Energy Facilities*³⁷. The basis for the selection of the WTE plants analyzed was their capacity of processing MSW, quantified as tons per day (TPD). As the driving factor for program, the capacity has a direct impact on the size of the facility.

³⁶ EEE Columbia

³⁷ Ted Michaels. “The 2014 ERC Directory of Waste-to-Energy Facilities,” *Energy Recovery Council*, May 2014.

WASTE-TO-ENERGY SIZING & CAPACITY ANALYSIS

FACILITY	MASSING	BUILDING FOOTPRINT (acres)	(square feet)	CAPACITY (tons per day)
NIAGARA RESOURCE RECOVERY FACILITY Niagara Falls, NY		3.7 acres	161,300 sf	2,250 TPD
WHEELABRATOR WESTCHESTER Peekskill, NY		3.2 acres	137,000 sf	2,250 TPD
ESSEX COUNTY RESOURCE RECOVERY FACILITY Newark, NJ		4.7 acres	205,470 sf	2,277 TPD
COVANTA HEMPSTEAD Westbury, NY		4.7 acres	205,000 sf	2,505 TPD
DETROIT RENEWABLE POWER Detroit, MI		7 acres	311,600 sf	3,300 TPD

1"=200'

Figure 60: Waste-to-Energy Plant Sizing & Capacity
Image by Author

The majority of the facilities examined, Niagara Resource, Wheelabrator Westchester, and Essex County Resource Recovery Facility, are slightly smaller than the target 2,600 TPD, but are located in New York and New Jersey so they can serve as local references. Covanta Hempstead operates at a similar capacity of 2,505 TPD and is located nearby in Long Island. Detroit Renewable Power is the largest capacity WTE plant in the U.S. and therefore represents the extreme capacity at 3,300 TPD. According to estimates, a WTE plant operating at 2,600 TPD would have a footprint between 200,000 and 300,000 square feet.

Scale Relative to Site

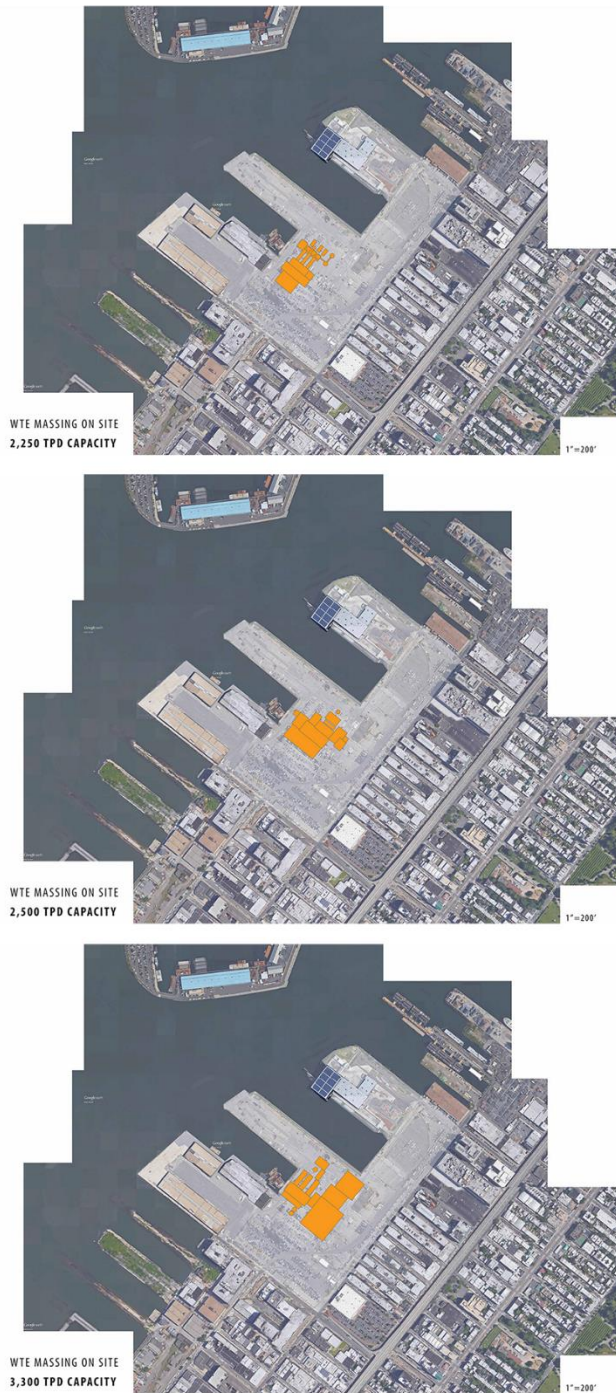


Figure 61: WTE Capacities Testing on Site
Image by Author, with Google Earth aerial underlay

To understand the relationship between program and site, three WTE plants from Figure 60 were selected ranging in scale and capacity and placed on the Sunset Park site. Figure 61 shows a comparison of these three facilities. The top image is a 137,000 square foot WTE plant with a capacity of 2,250 TPD. The middle image is a 205,000 square foot WTE plant with a capacity of 2,505 TPD. The bottom image is a 311,600 square foot WTE plant with a capacity of 3,300 TPD. Approximately 80-100 square feet are needed for every ton per day of MSW processed.

The middle image is the closest

capacity to the proposed 2,600 TPD Sunset Park WTE facility.

Public Component

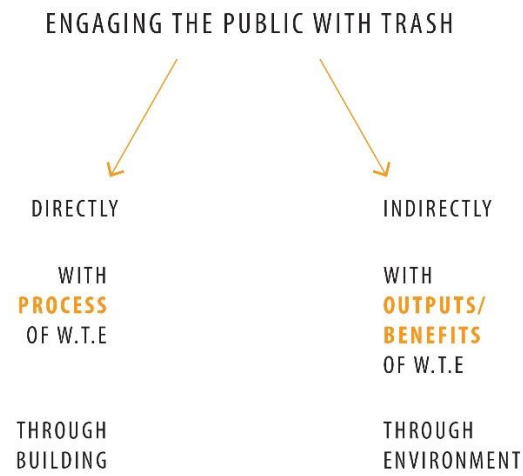


Figure 62: Design Goal of Public Engagement
Image by Author

The goal of this thesis is to design avenues for the public to engage with trash in a new way. By adding a public component to this Waste-to-Energy plant, the project seeks to act as a didactic element for the community and the city to understand the technology and benefits of WTE. By exposing and promoting people to have positive interactions with trash in new ways, they can begin to value garbage as a source of energy and a source of generating public space. This will attempt to promote garbage as a valuable resource that can be incorporated into the functioning of the city, not just a negative end product that needs to be sent away to a landfill. **Figure 62** breaks down the driving design goal of engaging the public with trash into two main branches: engaging them directly with the process of WTE through the building and engaging them indirectly with the benefits of WTE through the landscape.

Program Tabulation

The program tabulations generated in Table 1 began by sizing the Waste-to-Energy Plant based on the volume of incoming trash. By taking the amount of trash the current transfer station handles (26000 Tons Per Day) the program is right-sized to serve the community. The programmatic elements that make up the Public Component of the WTE Plant are scaled appropriately from the Industrial Component.

Table 2 breaks down the program of the Visitor + Recycling Center. This building developed later in the design process as a separate building with functions that support and enhance the WTE Plant as a sequential process for the public.

Table 1: Program Tabulation of Waste-to-Energy Facility

<i>Type</i>	<i>Program</i>	<i>Area (sqft)</i>	
<i>WTE Plant</i>	Industrial Component of WTE Plant		
	Weigh Station	11,800	
	Tipping Floor	21,000	
	Storage Pit	13,500	
	Control Room	600	
	Furnace	14,400	
	Super-Heater & Economizer	14,400	
	Flue Gas Filtering	32,000	
	Turbine + Generator Room	7,800	
	Sampling Station	2,000	
	Emissions Control Station	2,000	
	Offices	7,000	
	Operation + Maintenance	16,000	
	Smokestack	2,500	
	Ash Conveyor Belt	8,000	
	Ash + Metal Processing Plant	110,000	
		Subtotal	263,000
		Public Component of WTE Plant	
		Entry Lobby	5,000
		Crane Theaters (3 @ 1,700 each)	5,100

Shop	1,300
Cafe	1,300
Support	1,300
Turbine Room	2,000
Furnace Room	2,000
Ash Stair	2,000
Ash Walk	27,000
Park Pavillion	11,000
Circulation	6,000
	Subtotal 64,000
	Total 327,000

Table 2: Program Tabulation of Visitor + Recycling Center

Type	Program	Area (sqft)
Visitor + Recycling Center	Auditorium (3 @ 1,500 each)	4,500
	Exhibition Space	5,500
	Recycling Center	35,000
	Parking	35,000
		Total 80,000

Landscape

The goal of the landscape portion of this program is to provide waterfront access and recreation amenities to both the Sunset Park community and the greater New York City community. The design aims to provide both programmed and flexible spaces to accommodate various activities. Table 3 shows the program of the landscape design, which has been broken down geographically into the Urban Park, Elevated Linear Park, and Pier Park.

Program Tabulation

Table 3: Program Tabulation of Landscape Design

<i>Type</i>	<i>Program</i>	<i>Area (acres)</i>
<i>Urban Park</i>	Recreation Fields	3
	Visitor Center Plaza	1.3
	Bridge Plaza	0.15
	Subtotal	4.45
<i>Elevated Linear Park</i>	Elevated Linear Park	1
	Roof Deck	0.67
	Skylight Plaza	3.4
	Subtotal	5.1
<i>Pier Park</i>	Barge Theater	1.25
	Barge Point	0.6
	Barge Channel	2
	Pier Park	1.5
	Boardwalk Promenade	1
	Fishing Piers	0.25
	Natural Cove	1.5
	Park Pavilion Lawn	2
	Subtotal	10
Total	20	

Chapter 8_Design Approach

Design Objective

The design objective of this thesis is to design new avenues for public engagement with trash through the design of a Waste-to-Energy Plant, a public educational component, and waterfront landscape. Urbanistically, the design looks to stitch the community and the waterfront into a cohesive, accessible sequence of events. Architecturally, the design looks to provide moments in which the realms of the public promenade and the trash promenade intertwine in interesting, juxtaposed, and provocative ways.

Approach to Site



Figure 63: Placement of WTE Plant on Site
Image by Author

In beginning to work with the program of the WTE plant and public park component on site, the placement of the WTE plant drove design decisions. In order to assess placement, the flows of trash and the flows of public were examined, as seen in Figure 63. It makes the

most sense for all systems of flows to place the WTE plant on the corner of the site near the intersection of 2nd Avenue and 39th Street (the middle left scenario in Figure 63).

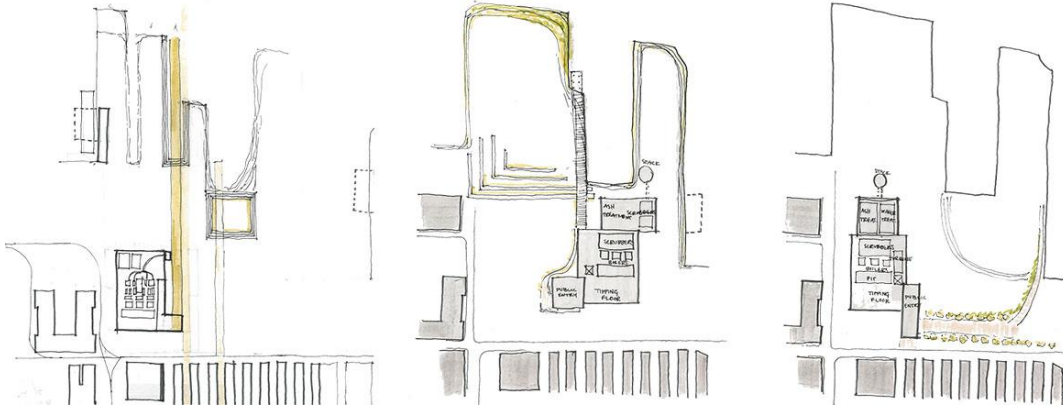


Figure 64: WTE Process on Site Studies
Image by Author

Upon examining strategies for developing a meaningful design approach that incorporated building and landscape design together, as seen in Figure 65, the entirety of the South Brooklyn Marine Terminal site proves to be too vast to accomplish this. The scale of the empty site proved to put of focus on designing a very large landscape component with a relatively small building. The scales of the site and program seem at odds, so a decision is made to re-shift the scale and definition of site in order to accomplish the goals set forth earlier.

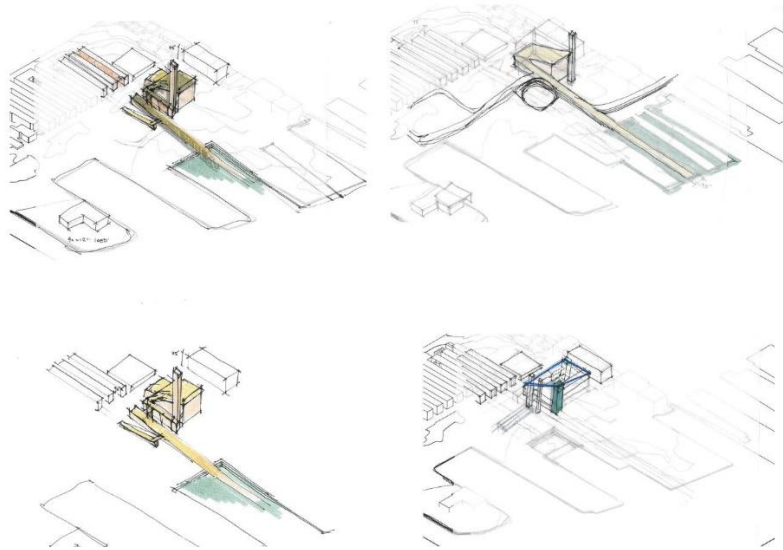


Figure 65: Studies of Building Form + Landscape Integration
Image by Author

Redefining Site Boundaries

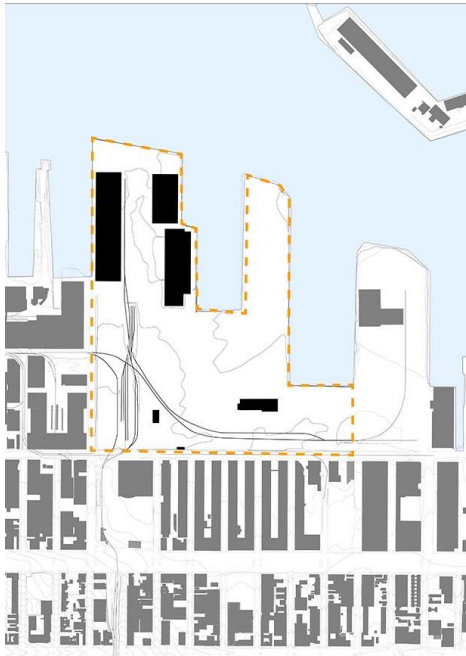


Figure 66: Working Site Boundary (left)
Image by Author, with City of New York GIS Underlay

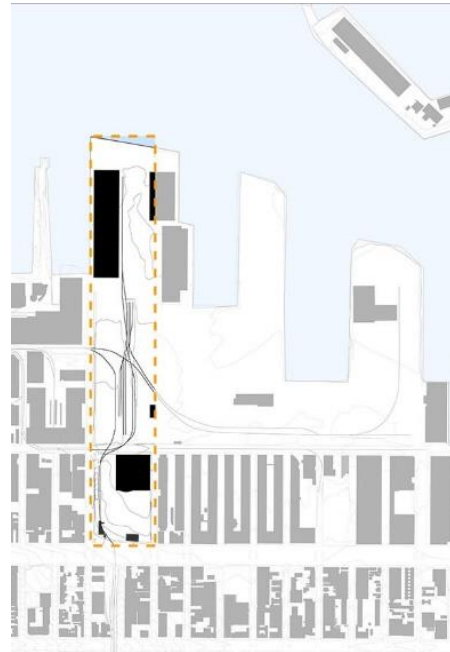


Figure 67: Redefining of Site Boundary (right)
Image by Author, with City of New York GIS Underlay

Redefining the site boundaries of this project brings clarity to the project in terms of meeting design objectives set forth earlier on an urban, landscape, and architectural level. This also shifts the scale of the project from sixty-two acres to twenty-two acres. The redefined site, as outlined in Figure 67, takes a swatch of urban fabric that comes in contact with many thresholds of urban condition. At one end, it begins at the edge of the small scale residential urban fabric, engaging with the elevated expressway, passes through the large scale industrial fabric, engaging with the off-ramp of the expressway, and makes its way out to the edge of the water, and finally protrudes as a finger out into the water. As diagrammed in Figure 68, the

organizing element of the project is a linear transition from the urban condition to the pier condition, from land to water.

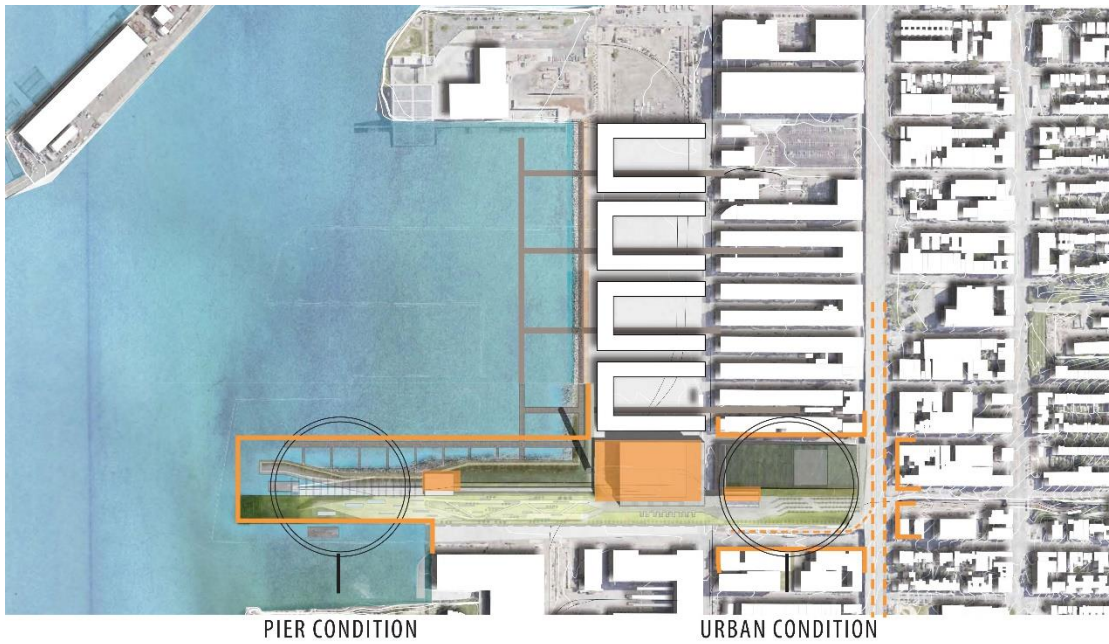


Figure 68: Diagram of Design in Urban Context
Image by Author

Urban Context



Figure 69: Aerial of Design in Urban Context
Image by Author

This design, centered on the linear motion of connecting the city to the water at the urban scale, can be understood from an aerial view, Figure 69. From this view, it is possible to see how this publicly accessible park space joins the series of green space pier elements along Sunset Park's waterfront. It is also possible to place the green space within the larger network of green spaces including Sunset Park, off to the distance in the center of the image, as well as Greenwood Cemetery, off to the distance to the left of the image. Finally the shift in scale from residential to heavy industry can be understood in this image.

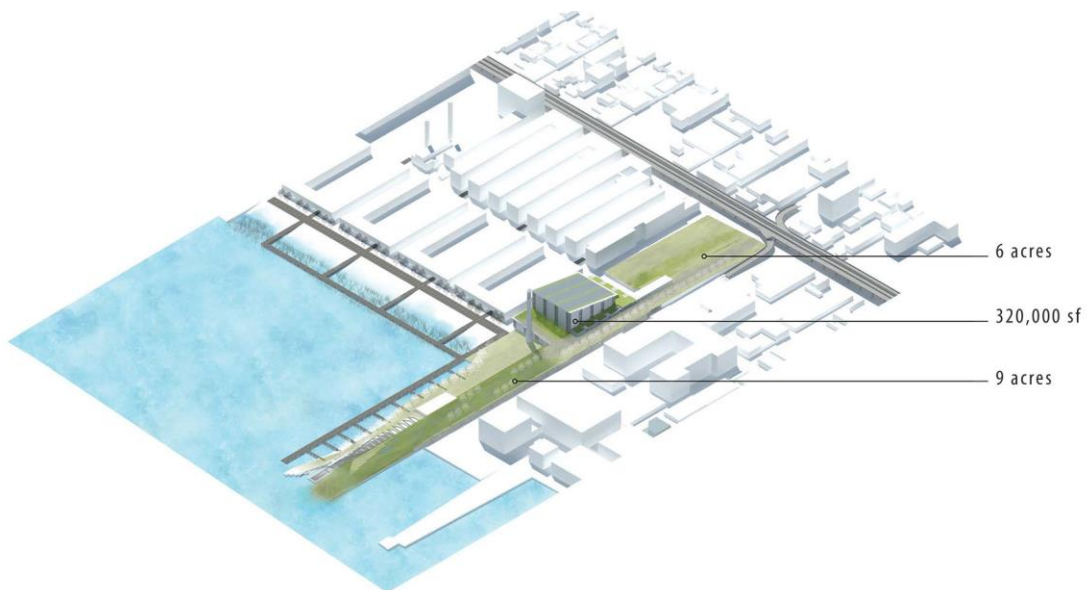


Figure 70: Axon of Design in Urban Context
Image by Author

In regards to scale and, the design can be broken down into three segments: the Urban Park block (six acres), the Waste-to-Energy facility (seven acres / 320,000 sf), and the Pier Park (nine acres) for a total of twenty-two acres.

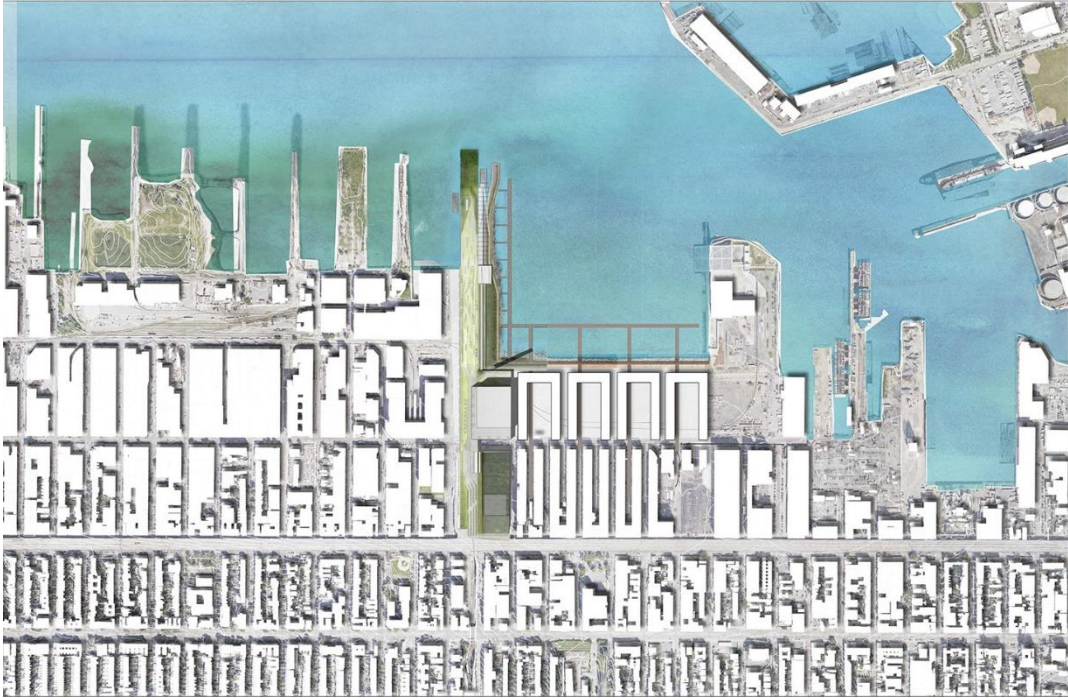


Figure 71: Site Plan in Urban Context, 1:250
Image by Author

By shifting the site boundaries and scale down to a smaller linear sequence, one important question that needs to be addressed at the urban level is what to do with the rest of the South Brooklyn Marine Terminal site. The design proposed here, while focuses on the linear site boundary, offers a solution for the entire Marine Terminal Site. The proposal is to add infill buildings in the block of land between existing Industry City buildings and the water's edge, as seen in Figure 71. These buildings continue the dimensions of the existing linear Industry City buildings, but are designed at a lower density and height to not impede on the existing city fabric, which can be understood in Figure 69. The courtyards that exist between the Industry City buildings continue into the larger courtyard spaces of the infill buildings and through porticos to extend out to the water, becoming boardwalks. The series of boardwalks are connected into a network of boardwalks that is developed in the Pier Park of the design. Additionally, the infill buildings form a built edge that is protected by a 'soft

edge' waterfront. The goal is to create an urban wetland edge condition in this newly formed inlet that will help protect the area against future sea level rise and storm surge.

Design as Layered System of Flows

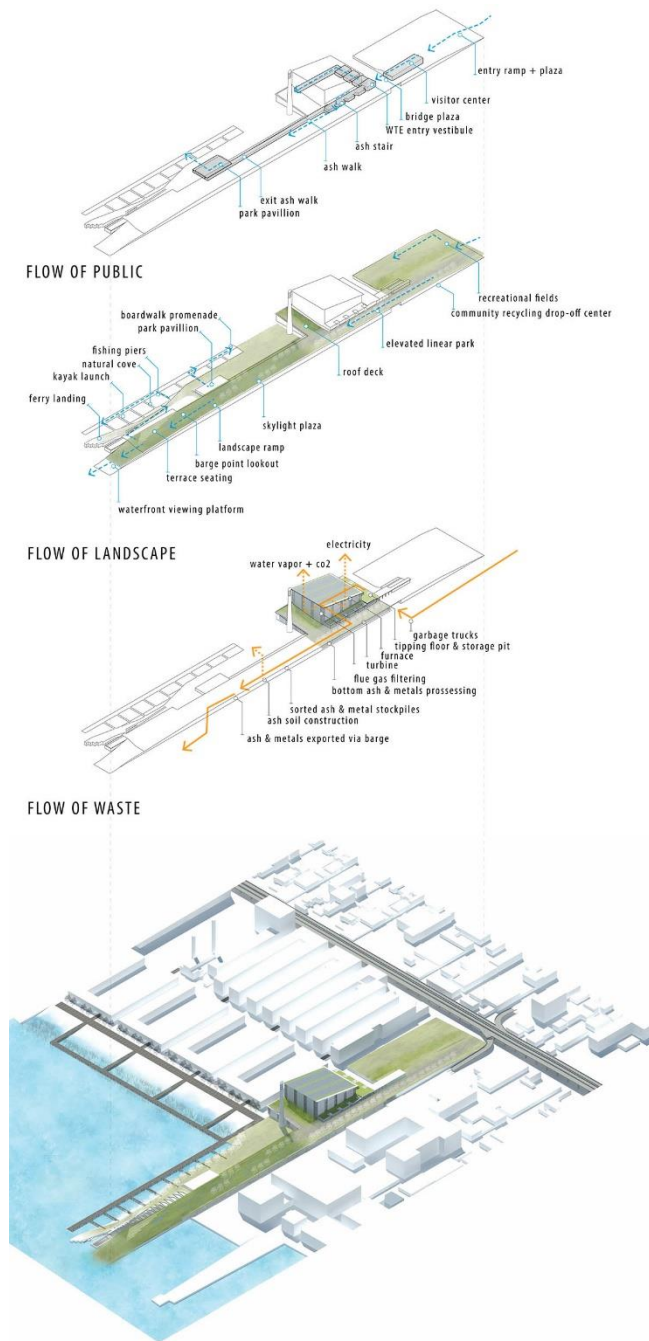


Figure 72: Exploded Axon Diagram of Layers of Flows
Image by Author

This design proposal attempts to integrate multiple systematic infrastructures into a singularly cohesive design. In order to understand the design in these terms, Figure 72 peels apart the layers of the design. The flows that guide the project are: 1) the flow of waste, 2) the flow of landscape, and 3) the flow of public.

These flows operate in multiple directions and dimensions, however the overarching linear nature of the design emphasizes the flows operating from the city out to the water, often read from right to left in the following diagrams and plans.

Flow of Waste

FLOW OF WASTE

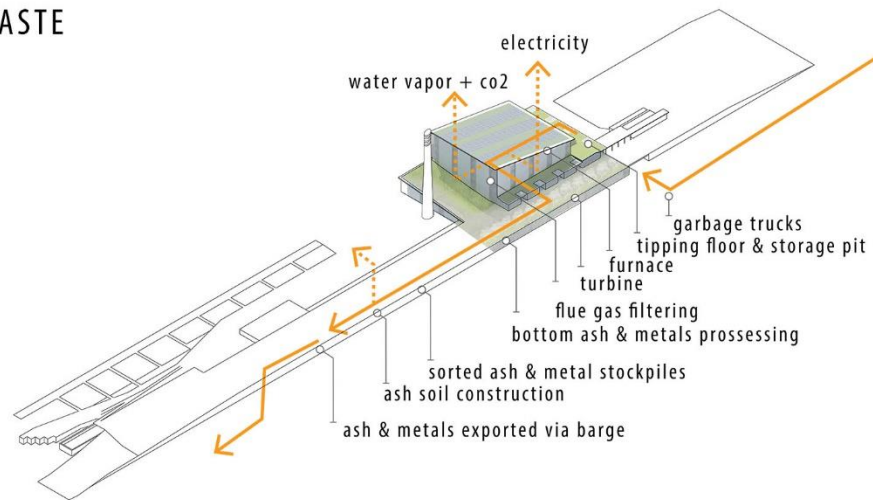


Figure 73: Waste Program Elements Diagram
Image by Author

The flow of waste, the driver of this thesis proposal, can be read in the diagram, Figure 73, and in the ground floor plan, Figure 74. Waste enters the site in the form of garbage trucks. The trucks move into the building at the entrance on 39th Street, where they move through a sequence from weigh station to tipping floor where they unload their trash. From here, the trash moves through the process described earlier in Chapter 7: Process, from Storage Pit, to Furnace, to Flue Gas Filtering & Ash Conveyor Belt. The ash conveyor belt, which is the collection mechanism of the bottom ash left over from the incineration process, acts as a transition element from the main volume of the WTE plant to the secondary volume, the Ash and Metal Processing Plant. In this part of the building, ferrous and non-ferrous metals are sorted out from the bottom ash. The metals and ash reside in stockpiles at the end of this linear sequence. From here they are loaded onto barges that enter through a constructed channel and dock at the edge of the building. Once loaded, the barges leave through an exit channel, allowing a continual cycle to develop. From here, the

ash is used as soil additive for the construction of the landscape of this park design.

Additional ash can be reused elsewhere or sent to monofills and the recovered metals can be sold and exported for reuse.

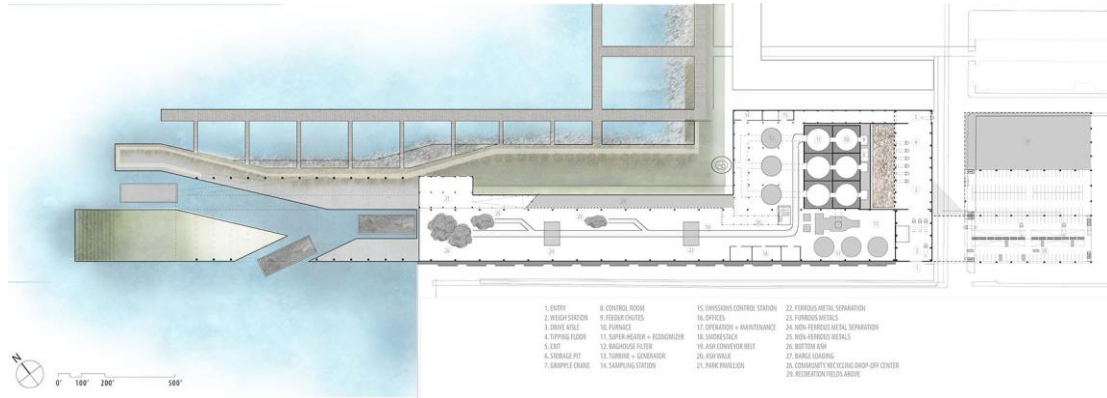


Figure 74: Ground Floor Plan
Image by Author

Flow of Landscape

FLOW OF LANDSCAPE

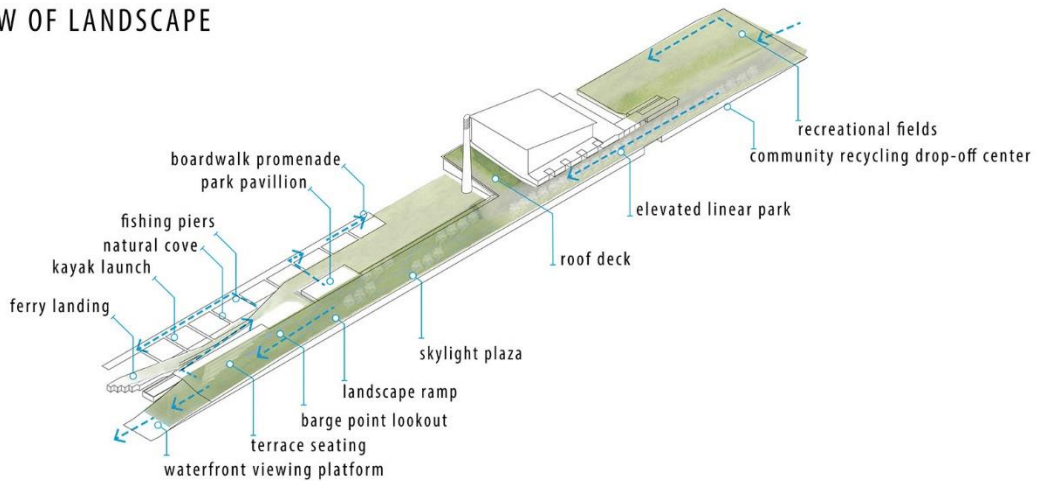


Figure 75: Landscape Program Elements Diagram
Image by Author

The flow of landscape within this design acts as a mediator and facilitator between trash and people. The landscape is what enables this project to become an amenity for the public, allowing waterfront access, as well as a hybrid model for integrating architecture and landscape design. The flow of landscape, again can be

best understood moving from the city to the water, as seen in Figure 75. This diagram highlights the programmatic elements of the landscape design, such as recreational fields, roof deck, kayak launch, and fishing piers. The programs here serve as initial design strategies, and could become more robust in further design. The landscape can be best understood as it is outlined in Table 3: Program Tabulation of Landscape Design (Chapter 7) and seen in the site plan below, Figure 76. The three major components are 1) Urban Park, 2) Elevated Linear Park, and 3) Pier Park which reinforce the linear transition from city to water.

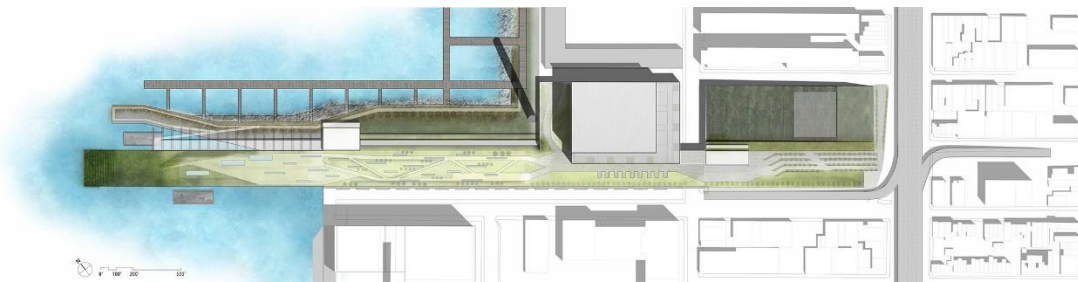


Figure 76: Site Plan
Image by Author

Flow of Public

FLOW OF PUBLIC

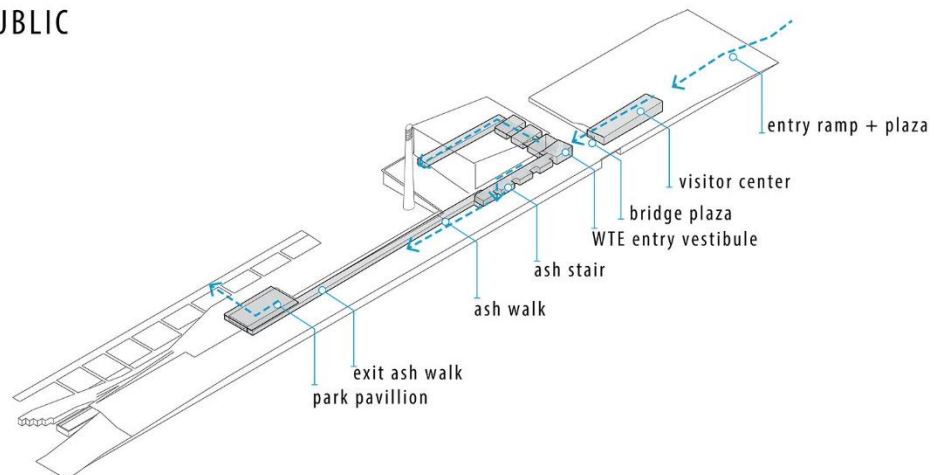


Figure 77: Public Program Elements Diagram
Image by Author

The flow of public is the final and most crucial layer to this design. It is the layer that the design objects are centered around. It is the spaces in which people are able to connect with waste in a new way. The linear nature of its design is organized into several programmatic pieces, seen in diagram above, Figure 77, and in built form in the Mezzanine Level Floor Plan, Figure 78. These are: the visitor center, WTE entry vestibule and sequence, ash walk, and park pavilion. The intention is to have people flow through the site and building in a similar manner to the waste that is being processed above and below. As the public moves through this sequence they are being informed, educated, and connected to trash in new ways; and upon exiting the sequence they can reconnect with their urban landscape through a new lens.

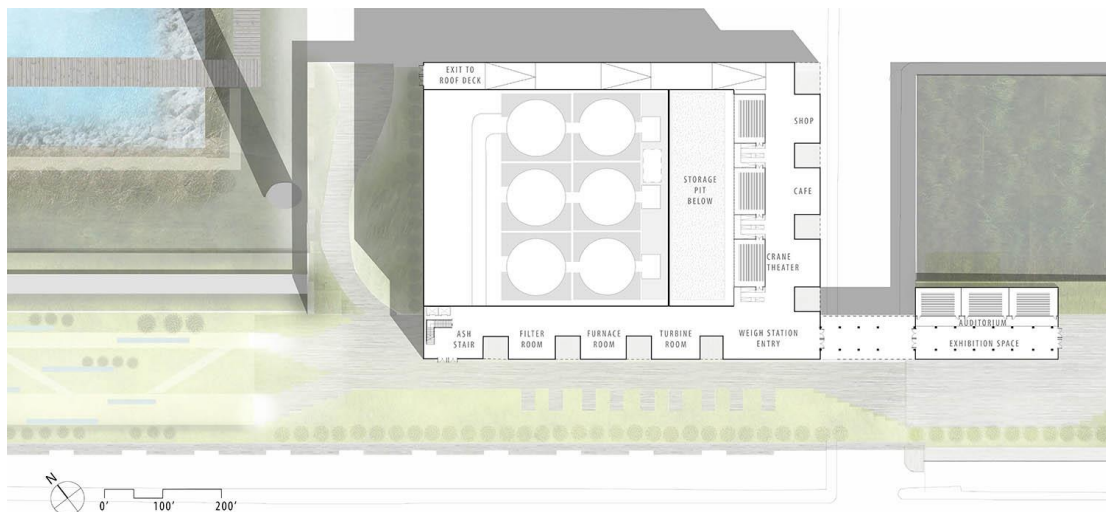


Figure 78: Mezzanine Level Plan
Image by Author

Zones of Interaction

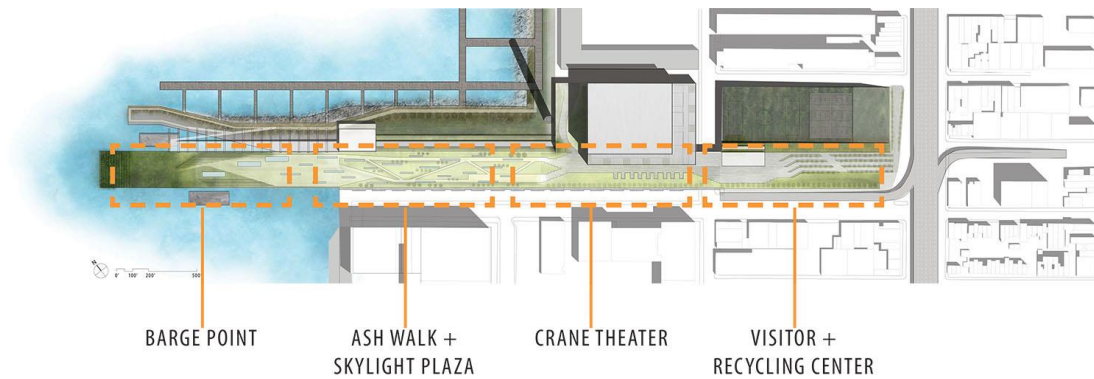


Figure 79: Zones
Image by Author

After understanding the holistic design approach as a series of layers that reinforce one another, the design can be broken down into a series of zones that allow the design objectives to be met on a human scale. Each one of these zones, identified in Figure 79, has a unique characteristic and design that allow for people and trash to engage each other. Each one of these four zones will be discussed moving from the city towards the water. Each zone has 1) a key plan that identifies the zone, the section cut, and perspective vantage point, 2) a section diagram that describes the relationship between people and trash, 3) a section-perspective that places the diagram into the design, and 4) a rendering of what the space looks like.

Zone 1_Visitor + Recycling Center

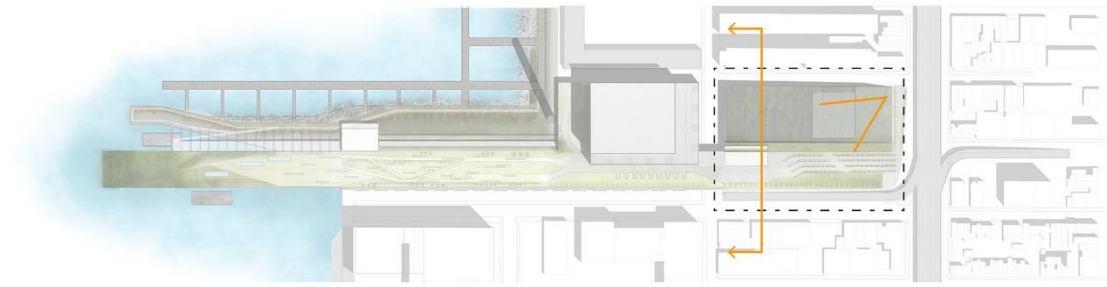


Figure 80: Zone 1 Key Plan
Image by Author

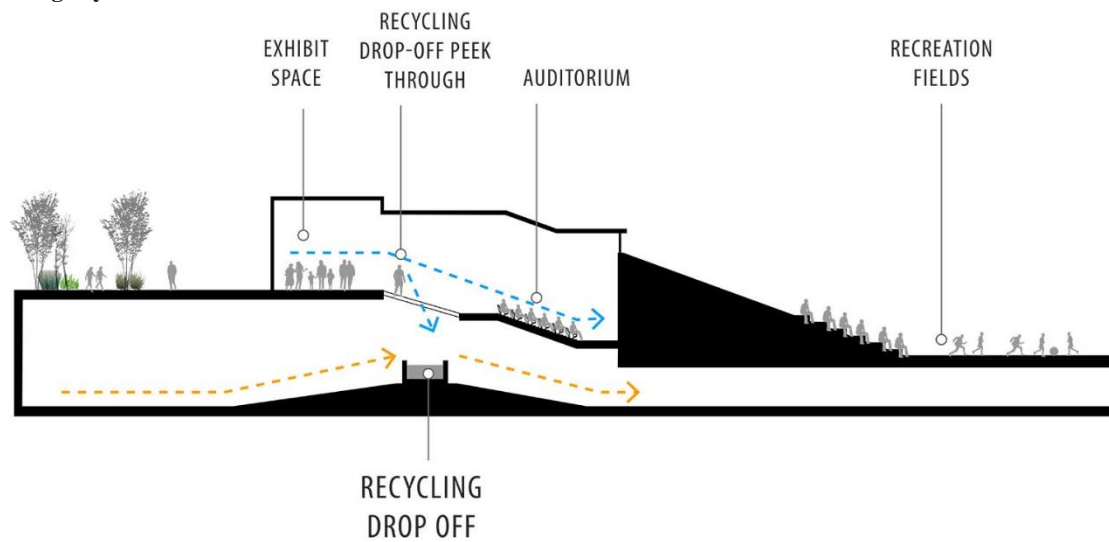


Figure 81: Visitor + Recycling Center Section Diagram
Image by Author

The first zone is the Visitor + Recycling Center, identified in Figure 80. This zone functions on two levels, as seen in the section diagram (Figure 81). The upper level is the Visitor Center where the public enter to an exhibit space and move down towards an auditorium where they can watch a video informing them of the WTE process they are about to see. Under this level is a community recycling drop-off center, where locals can bring items that are not part of the mainstream recycling collection system. There is a moment in which the public passes from the Exhibit Space to the Auditorium that they can peer down below into the recycling center

below and see cars and trucks intersecting at the line of collection bins. The architectural manifestation of this can be seen in Figure 82. The architectural language that is used to signify moments of public interaction throughout the project is marked by light, glassy structures. This glass curtain wall on the south facade of the visitor center pairs with the north façade of the building which is sculpted into an embankment yet marked with a continual strip clerestory windows to promote its visibility. The embankment continues down to become seating for the recreation fields, seen in the diagram above and the rendering below, Figure 83. The recreation fields serve as a place for community activity, setting the WTE plant in the background.

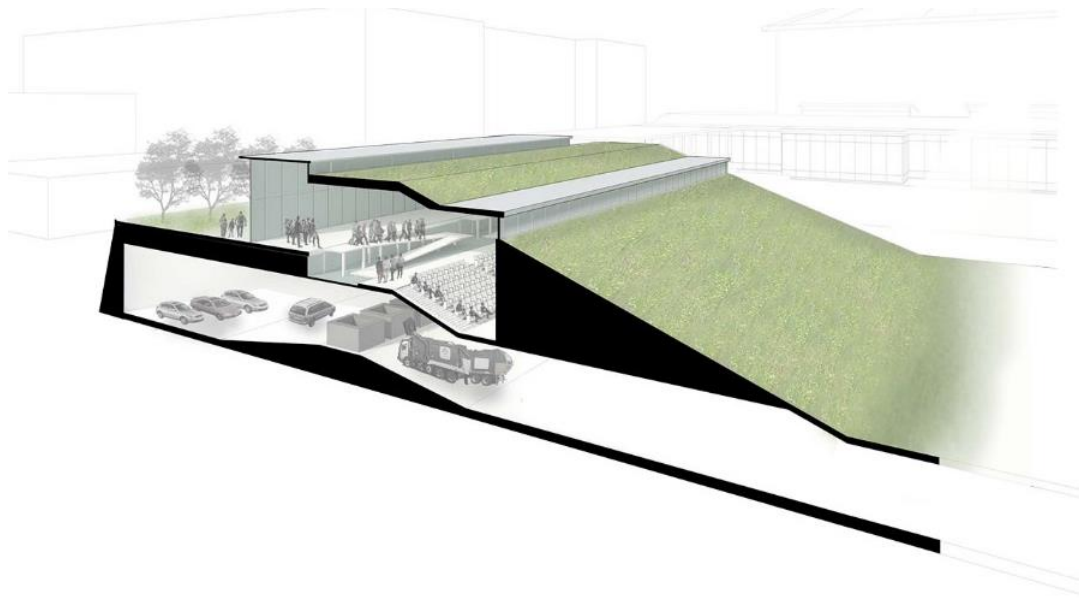


Figure 82: Visitor + Recycling Center Section Perspective
Image by Author



Figure 83: Urban Park Recreation Field
Image by Author

Zone 2_Crane Theater

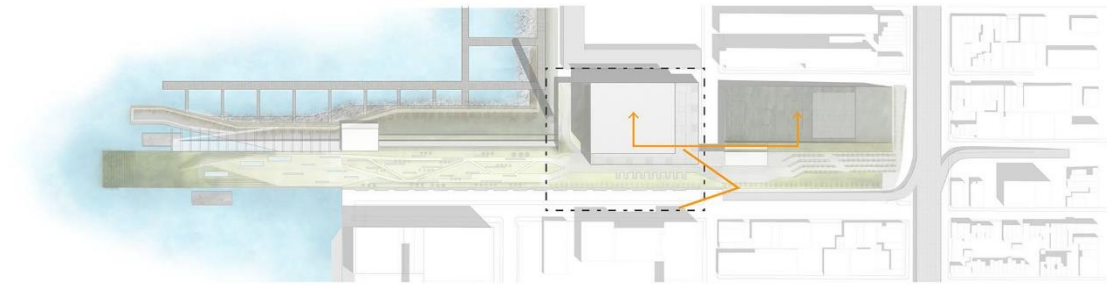


Figure 84: Zone 2 Key Plan
Image by Author

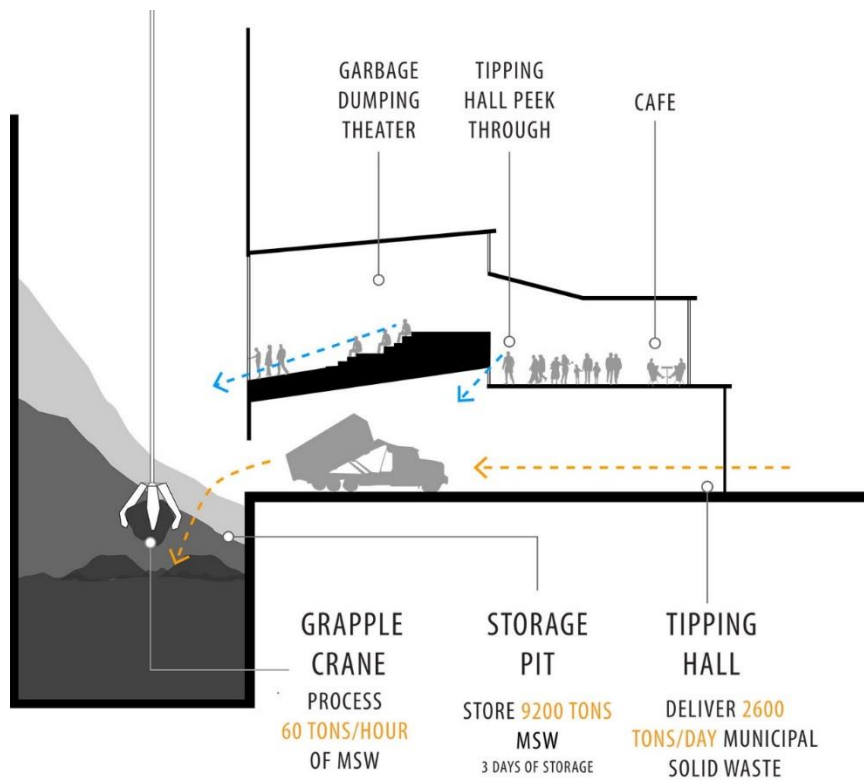


Figure 85: Crane Theater Section Diagram
Image by Author

The next zone of public engagement with trash is the Crane Theater, identified in plan in Figure 84 and section diagram in Figure 85. This moment marks the spectacle of the Waste-to-Energy Plant. It is the opportunity for the public to sit and watch the enormous grapple crane scoop up one ton of trash every minute within this massive pile of garbage. It is a moment for the visitors to visually connect and

understand the scale of this operation, as it is the most visible part of the process that the public can interact with. The magnitude of this moment can be understood in the section perspective, Figure 86. The design promotes these theaters as a place people can spend time watching this awe inspiring process and begin to have a connection with trash in a new way. In the rendering of the approach to the building from the elevated linear park, Figure 87, the rhythm of the perforated metal-clad façade can be read as an expression of process going on behind it. The more human-scaled glass façade elements of the building add to this rhythm and mark the visitor sequence through the interior of the WTE plant.

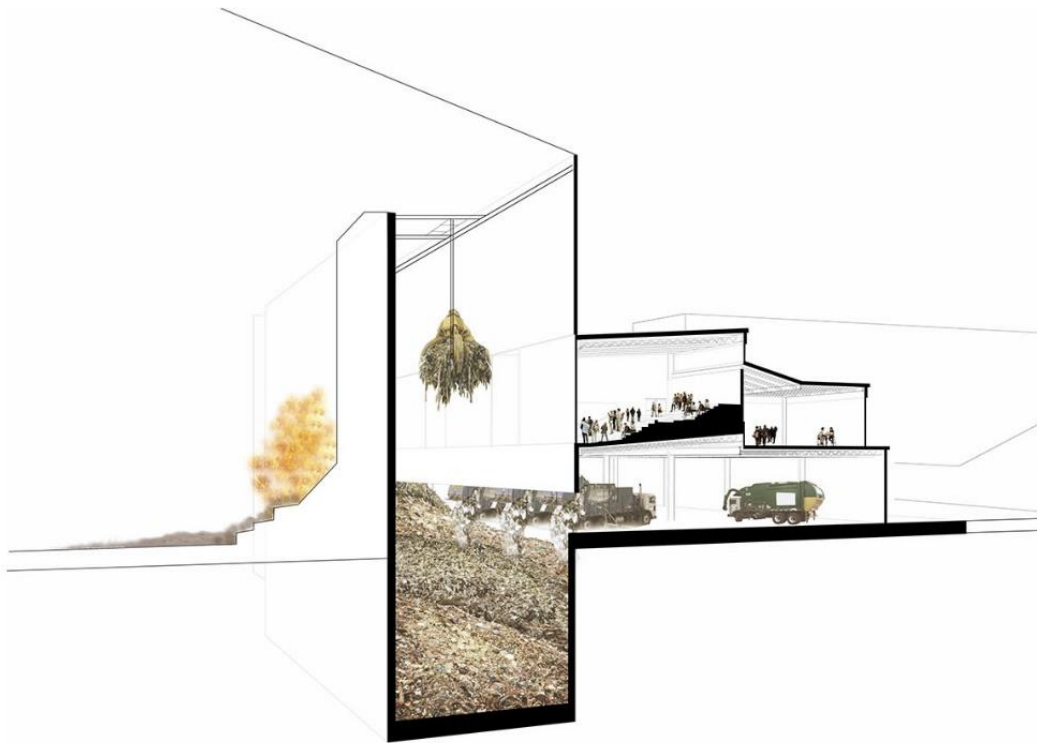


Figure 86: Crane Theater Section Perspective
Image by Author



Figure 87: Elevated Linear Park- Entry to WTE Plant
Image by Author

Zone 3_Ash Walk + Skylight Plaza

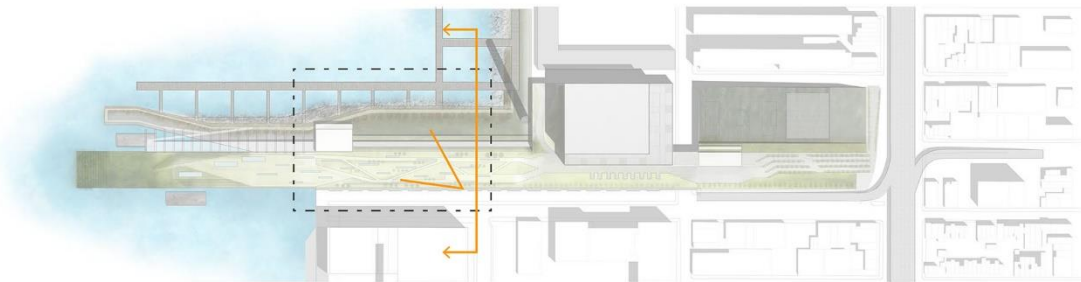


Figure 88: Zone 3 Key Plan
Image by Author

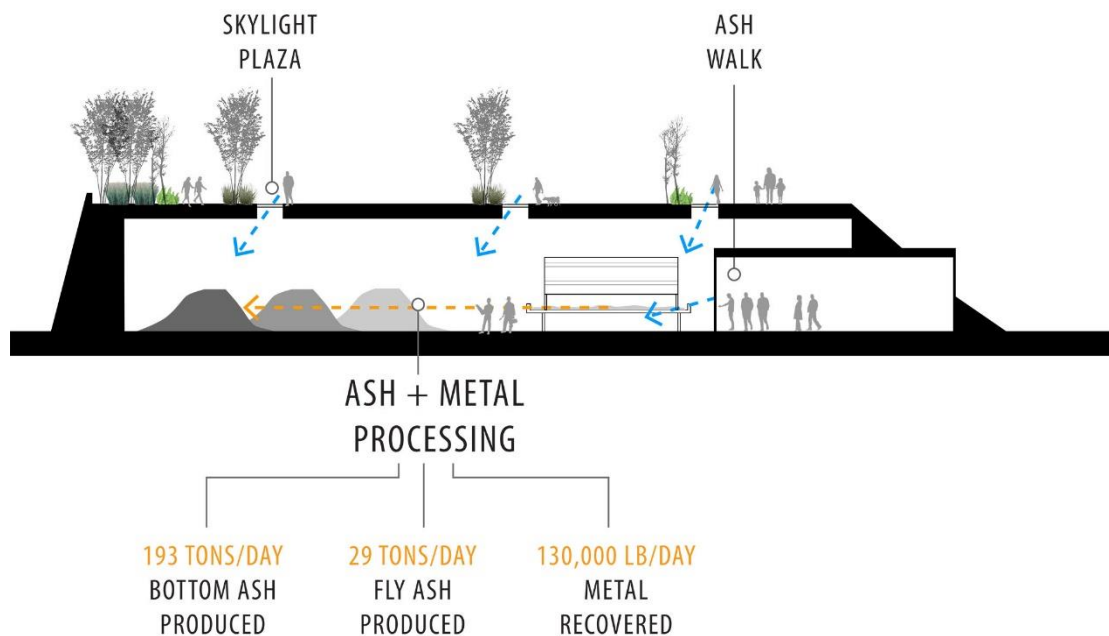


Figure 89: Ash Walk + Skylight Plaza Section Diagram
Image by Author

The next zone, the Ash Walk + Skylight Plaza, identified in plan in Figure 88 transitions past the massing of the WTE plant into the ash and metal processing part of the design. As seen in the section diagram (Figure 89) this zone occupies two levels, similarly to the Visitor + Recycling Center. However, here, the public can view the process of metal sorting and ash processing from alongside and above. The visitors that continue along the tour of the plant down the ash stair enter the Ash

Walk: a gradually sloping passage where on one side the ash processing can be viewed through a glass curtain wall. The other side of the Ash Walk is tucked into an embankment and lit via clerestory, similarly to the Visitor Center auditorium space. The Skylight Plaza is the landscape driven program to this zone. It occupies the length of the roof-scape of the ash processing building, as seen in Figure 90. The plaza is comprised of linear skylights that offer vistas down below into the building. The public can engage in the processing of the ash in a very passive way as they use the landscape as an amenity. The rendering below, Figure 91, envisions the Skylight Plaza as a place for recreation with vistas across the water to Lower Manhattan and the Statue of Liberty, while connecting the public with views below to the industrial process of WTE that acts as the foundation of the constructed landscape they inhabit.

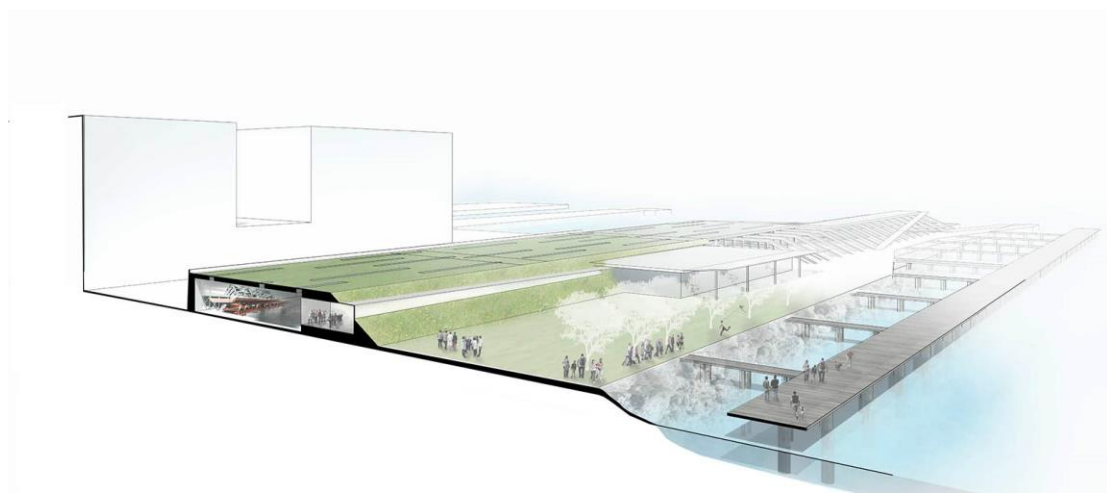


Figure 90: Ash Walk + Skylight Plaza Section Perspective
Image by Author



Figure 91: Skylight Plaza
Image by Author

Zone 4_Barge Point

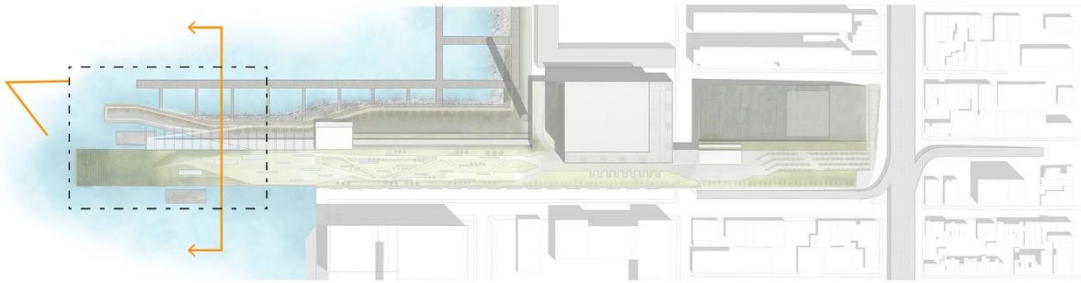


Figure 92: Zone 4 Key Plan
Image by Author

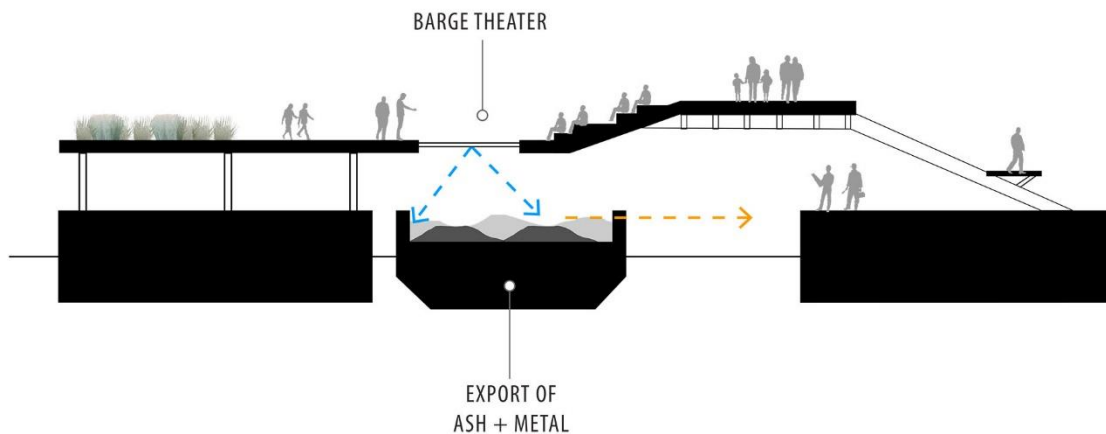


Figure 93: Barge Point Section Diagram
Image by Author

The final zone, Barge Point, identified in plan in Figure 92 serves as a major point of industrial and recreational activity. As seen in the section diagram, Figure 93, this zone is where the public has the ability to interact with the barges as they are arriving to the site to be loaded, and as they leave the site full of ash for export. Barge Theater is the spot where the landscape folds and offers terrace seating and larger skylights for the public to watch the spectacle of these industrial barges floating underneath them. As seen in the section perspective, Figure 94, the public promenade ramps down after Barge theater to reconnect people with the waters edge. The end of

the pier has terraced seating that transitions into a soft edge. From this new publicly accessible vantage point, the public can get a panoramic view of the city and water as well as turn back to the WTE Plant and the journey they took out to the water's edge. As seen in Figure 95, the end of the pier is designed to serve as a dynamic marker of this hybrid landscape and building form that stretches back into the city.

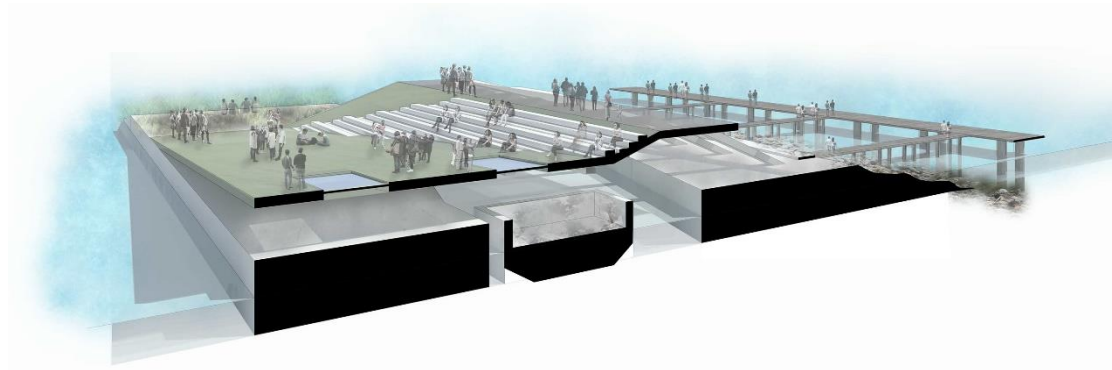


Figure 94: Barge Point Section Perspective
Image by Author

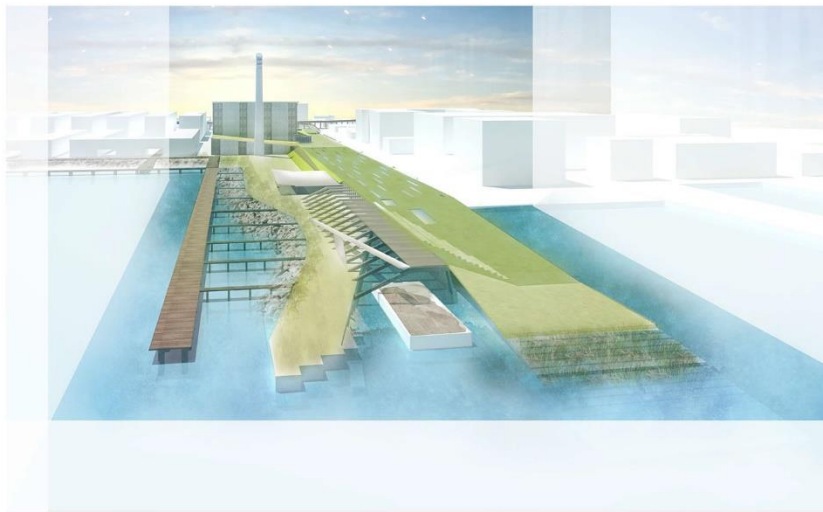


Figure 95: View of Pier from Water
Image by Author

Time + Metrics

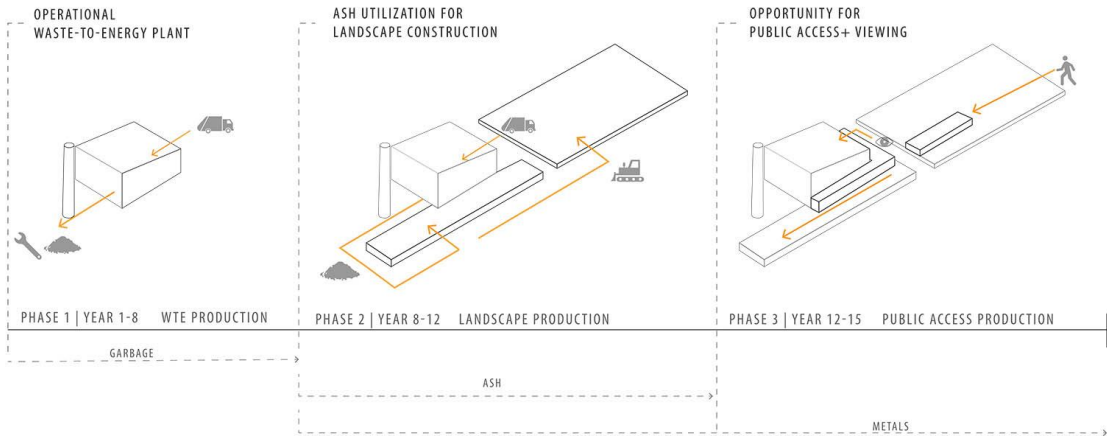


Figure 96: Phasing of Project
Image by Author

Taking a step back from design to develop a phasing approach for this WTE Plant and Waterfront landscape reinforces initial ideas of this layered systems thinking approach to design. The full realization of the project, discussed above is the end goal of the project, which must be built up in stages. Figure 96 shows a simple three part schematic phasing plan. Phase 1, Year 1-8, consists of the construction of the Waste-to Energy Plant and its operation. Phase 2, Year 8-12, consists of landscape production. In this phase, the ash that is being produced from the WTE process can be utilized for landscape construction, sculpting the land into the design outlined above. Phase 3, Year 12-15, is the production of the built forms that form the public access and viewing of the WTE process.

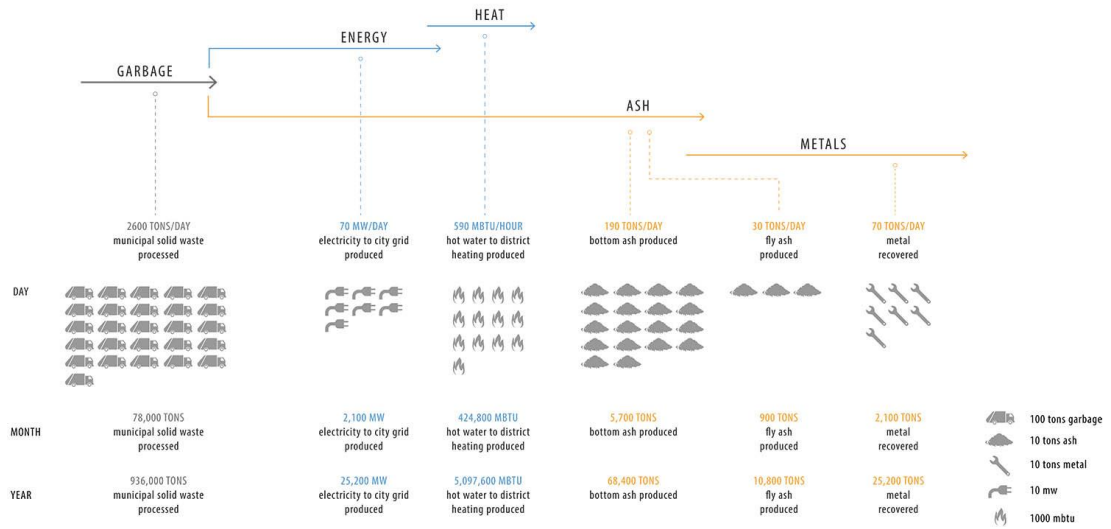


Figure 97: Process & Outputs of WTE Plant
Image by Author

Additionally, the process and outputs of this WTE serving South Brooklyn is outlined in Figure 97. The metrics of the outputs from the WTE process are graphically represented to give a sense of scale throughout time, on the basis of daily, monthly, and annual production.

Chapter 9_Conclusion



Figure 98: Thesis Defense Boards
Image by Author

In conclusion, this thesis seeks to examine ways to rethink the relationship between people, cities, and the waste they generate. By designing new avenues for public engagement with trash, this thesis serves to open the conversation of engaging designers in waste processing. This speculative design project along with the research that supports it seeks to act as a catalyst and tool for further discussion about ways to reevaluate the perception, management, and treatment of waste.

This design approach could be applied to other waterfronts throughout New York as well as in other cities across the Northeast Corridor and throughout the country. It serves to foster the much needed dialog of investing in opportunities to design productive and ecologically responsive waste infrastructures that can intersect with and benefit the public realm.

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