2014

The Brooklyn Waterfront: Building for a Resilient and Sustainable Future

Ian Leidner

THE BROOKLYN WATERFRONT:
BUILDING FOR A RESILIENT AND SUSTAINABLE FUTURE

Ian Leidner
April 21, 2014

Senior Thesis

Submitted in partial fulfillment of the requirements
for the Bachelor of Arts in Urban Studies

_____
Adviser, Brian Godfrey

_____
Adviser, Tobias Armborst

Table of Contents

LIST OF FIGURES

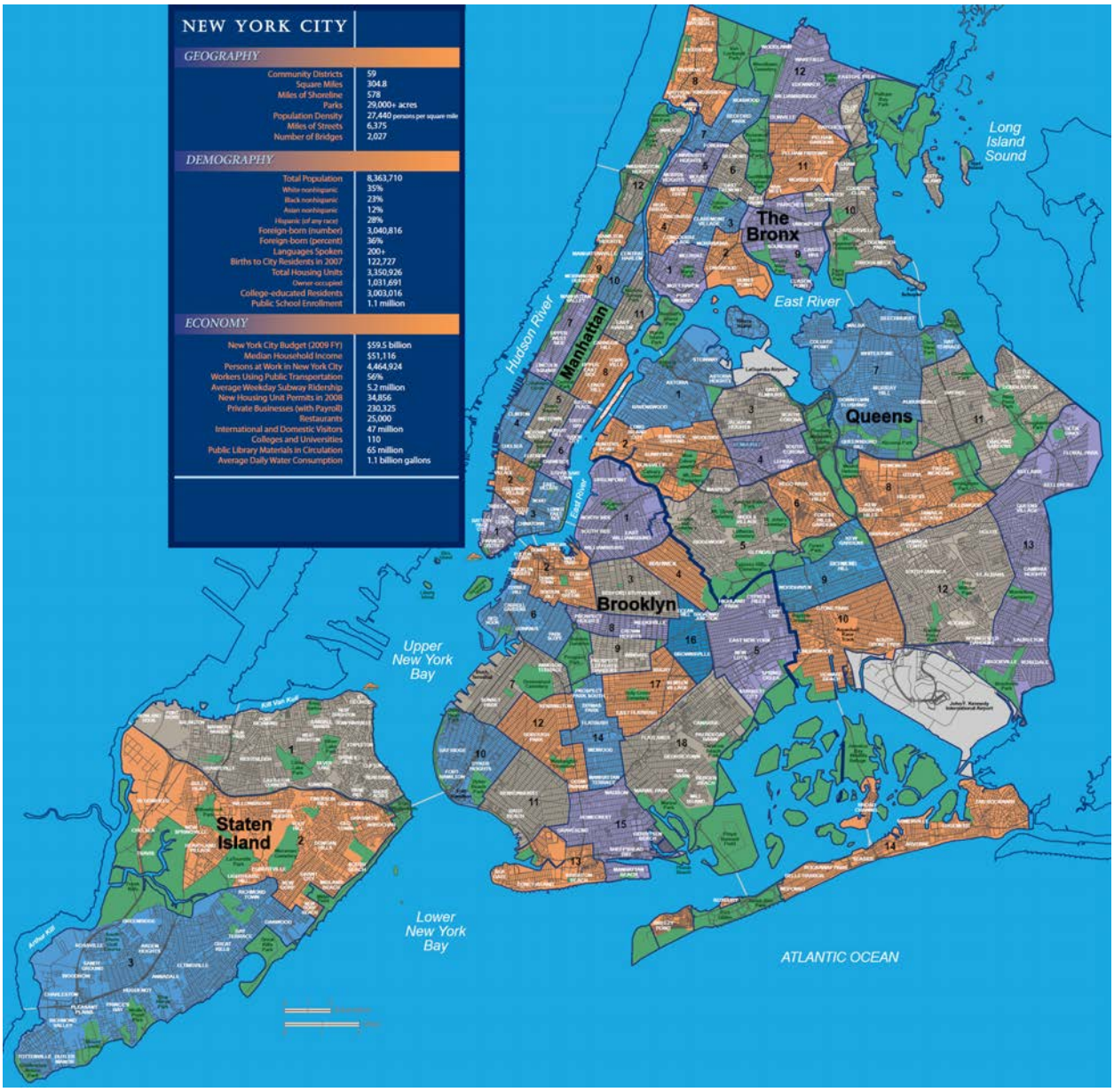

Figure 1: New York City

CHAPTER 1: INTRODUCTION

Hurricane Sandy dramatically and tragically revealed the extreme vulnerability of New York City's expansive shoreline in late 2012. The "super-storm," which made landfall in the New York metropolitan area on the evening of October 29th, battered the city and its surrounding areas with high winds, rain and powerful waves and storm surges. Fifty-one square miles, equivalent to 17 percent of New York's total landmass, was flooded by Sandy's storm surge, which exceeded 15 feet above mean low tide in South Beach Staten Island and 13 feet at Sea Gate, Brooklyn (DCP 2013, 13). From New Yorkers to City Government to the Federal Government, the havoc wreaked by Sandy on America's largest metropolis was a stern and uneasy wake up call. The storm added new urgency and direction to discussions regarding climate change, sea level rise and the survival of urban shorelines. In an opinion piece for the New York Times published a year after Hurricane Sandy hit, author Kevin Baker perhaps best expresses the atmosphere of a post-Sandy New York, writing, "One of the great things about New York used to be how easy it was to ignore the natural world…No More"(Baker 2013, 1).

In the decade preceding the storm, New York and New Yorkers had been fostering a relationship with the waterfront that was healthier than it had ever been in the past. New Yorkers were utilizing and enjoying the amenities the waterfront has to offer like never before, establishing a mutually beneficial rapport. The man with the vision and the responsibility for New York's push towards the waterfront in the 21st Century was former Mayor Michael Bloomberg. Mayor Bloomberg called the waterfront New York's sixth borough and championed its rehabilitation throughout his 12 years in office. Through numerous initiatives and partnership with the Department of City Planning, Bloomberg facilitated the construction of parks, luxury high rises and small businesses along a then derelict waterfront that had lain dormant for much of

the second half of the 20th Century. In 2011, the Department of City Planning released *Vision 2020:New York City Comprehensive Waterfront Plan*. This 10-year plan outlined a comprehensive wide-range and site-specific course of action for opening up the New York waterfront in conjunction with the vision of then Mayor Bloomberg. Vision 2020 exhibits the city's commitment to transforming New York's 520-mile shoreline into a safer, more accessible space that serves a diverse range of activities.

In the middle and late 20th Century, the New York waterfront and the city as a whole experienced significant deindustrialization. The once productive shores of Lower Manhattan and Northern Brooklyn were rendered obsolete by a need for more space and by modern technology such as the standard shipping container. New York experienced a serious identity crisis; once the most productive port in the world, the city's development subsequently pointed inward and shifted its focus from blue collar to white-collar work. Although sea level rise and climate change were not yet a major concern, serious doubt was cast over the waterfront's future. The waterfront in New York slipped into a period of dereliction; crime and vice ran rampant in

Figure 1.1: Waves at Rockaway Beach, Queens

the shadows of abandoned factories and machinery that had formed the backbone of the city's economy for centuries.

Today the shady, lawless waterfront of the late 20th Century is increasingly becoming a distant memory. Although it is both encouraging and captivating to see the waterfront restored as it has been, the threat of storms like Sandy is a startling reality moving forward. Bloomberg rightly described Sandy as "the worst natural disaster ever to hit New York City"(DCP 2013, 1). Although a devastating storm, all signs from climate experts point to the prospect of significantly stronger and more frequent storms in the near future. Forty-three New Yorkers died as a result of Hurricane Sandy and if nothing is done in response, more can be expected to perish in the years to come (DCP 2013, 11). With these things in mind, is it irresponsible and foolish to continue pushing people and businesses closer to the water's edge? Has reopening one of New York's great resources put people in danger under the guise of bettering their way of life? What can we and what have we learned from the experience of Hurricane Sandy to better defend New York from the inevitability of climate change?

In this thesis I address these questions and others regarding the past, present and future of the New York waterfront. Examining the current dialogue regarding the city's defense against rising sea levels and stronger storms, I focus particularly on the political ecological debate over the best and most responsible ways to fortify the shoreline. I look at a select number of infrastructural proposals from public and private entities and analyze their feasibility and supposed efficacy. The waterfront area of Northern Brooklyn stretching from the Newtown Creek and the Greenpoint neighborhood, south to the Gowanus Canal and the Red Hook neighborhood serves as an area of particular focus. This choice of focus is based on an interest in the new layers of population growth and physical development in this waterfront area. The

unique mix of history, industry and contemporary development makes the Northern Brooklyn waterfront a fascinating area of study. In this specific area and New York as a whole I look at some of the implications of climate change while contemplating the role of shoreline design in the city's struggle to survive. Although Hurricane Sandy was an incredible tragedy, it also represents an important opportunity to change and protect New York and its waterfront for the future especially in the context of contemporary growth along the shore.

The focus of discussions regarding waterfront development has inexorably been changed to one regarding how to protect the city from flooding. Every aspect of city life is threatened by extreme weather as Hurricane Sandy demonstrated. In the interest of being as concise and to the point as possible, I have chosen to focus my discussion on a select number of flood protection measures along the Northern Brooklyn waterfront. Rather than chronicling the individual measures store and building owners can take to protect themselves, I look at infrastructural plans from private and public institutions that address a multiplicity of potential climate dangers. Every part of the waterfront is different and therefore requires unique and individualized attention. The Department of City Planning and private firms like SCAPE Landscape and BIG TEAM recommend a wide variety of infrastructural measures to cope with New York's complex geography. In some places, low-tech solutions are sought such as beach nourishment whereas in other areas, a hi-tech piece of machinery like a moveable floodgate is warranted. In this thesis I go beyond a summary of infrastructural proposals to a discussion of the circumstances that directed certain firms and agencies towards the solutions they recommend.

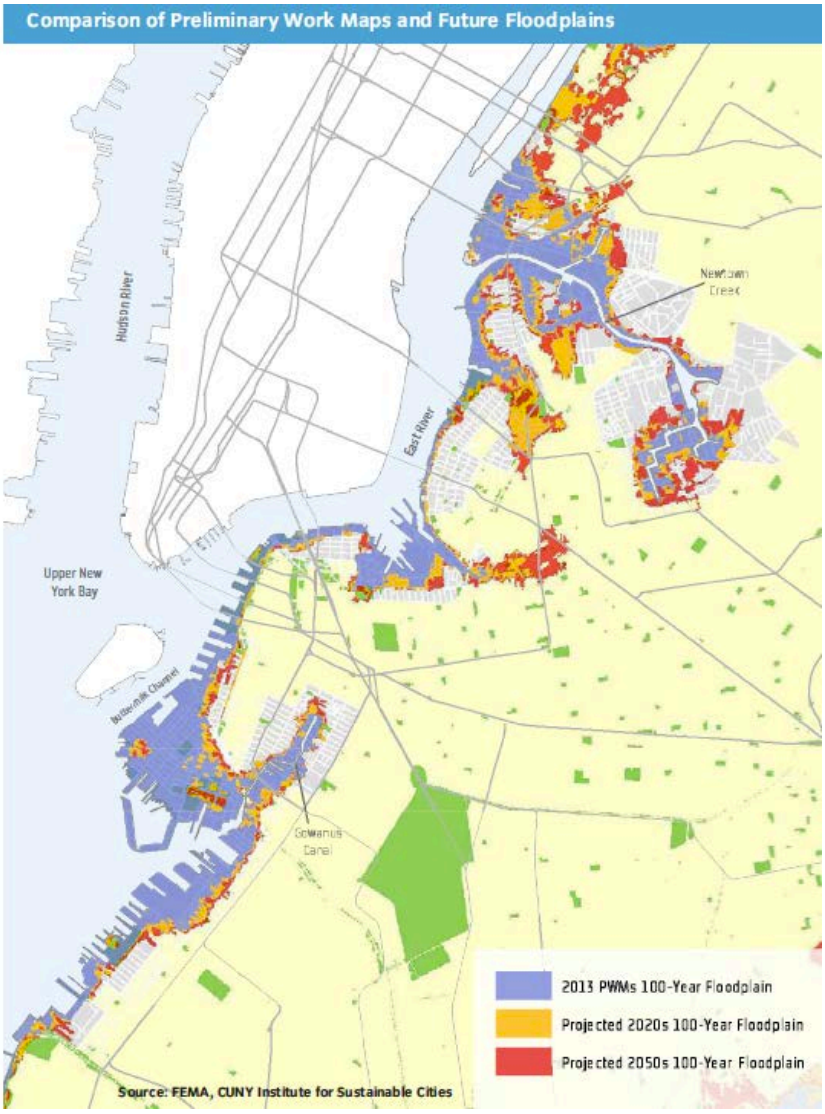

Figure 1.2: Brooklyn Waterfront Floodplain Projections

Guiding my discussion of history and contemporary design solutions is an interest in how flood preventative design can serve a variety of functions. This thesis explores the potential for the discourse on flood preventative design to include concerns regarding how the built environment can be improved as well. In New York, flood preventative design has been pushed to the forefront due to recent extreme weather events. What I advocate in this context is that we not lose sight of the elements of the built environment that make New York so special. We must ensure that the inevitability of infrastructural improvement doesn't harm the city's everyday social and built ecology. This thesis ponders the possibility for flood preventative attitudes and design to not just maintain the status quo, but to actually improve the city's built environment through thoughtful and creative planning and design. Before previewing the chapters to come, I want to pose two questions that will guide later discussion and debate. *First, what elements of the built*

environment protected the shoreline during Sandy by working beyond their intended use? Second, can designing for flood protection benefit other areas of the built environment?

Chapter 2 covers the history of the New York waterfront, starting with the founding of New Amsterdam by the Dutch in the 17th Century. Although the 17th Century might not seem to bear any significance for a contemporary conversation, it is important when considering the inexorable link between New York and its waterfront that persists today. The waterways of New York and the surrounding areas form one of the finest natural harbors in the world. When the Dutch and later the British took over Manhattan island, the small city that would become New York grew quickly due to the ample space and ease of access this harbor provided. New York was indeed destined to be a waterfront city, its economic health and strength tied directly to the commercial activity the shoreline supported.

Even from its earliest days, development along the waterfront flourished in the form of small wooden piers for the on loading and offloading of ship borne cargo. By the early 19th Century New York had surpassed Philadelphia as the largest city in the United States and was due for exponential growth by the middle of the century. New York rose to national and global commercial supremacy primarily due to the blue-collar work along the Lower Manhattan and later Northern Brooklyn waterfronts. In the context of my waterfront discussion, the most important impact was major physical growth along the waterfront and the filling in of marshy areas to create more space for commercial activity. The piers, concrete bulkheads and landfill that expanded and hardened the shoreline increased the size of Lower Manhattan by 33 percent (Bone 2003, 35). Marshes, wetlands and beaches that could have protected the city from storm surges and waves were obliterated, enabling people and businesses to move closer to the waters that would later threaten it. As then Commissioner of the now defunct Department of Docks said

in 1919, “the city has encroached at nearly every point on the original high water line” (Bone 2003, 41).

Chapter 2 concludes with a look at the period of deindustrialization that occurred in New York during the 20th Century following the conclusion of the Second World War. As New York’s waterfront was rendered obsolete by new technology and a need for more space. The void left by the evacuation of commerce was quickly filled by crime and vice. I examine the waterfront’s history through this period of destitution and conclude at the turn of the 21st Century, which represents the starting point of its contemporary revival. This chapter looks primarily at Manhattan because it was the focus of the early history of waterfront development in New York. In the next chapter I look closely at the projects and policies of Mayor Bloomberg followed by a specific discussion of Northern Brooklyn, the development of which lies squarely in the future.

Chapter 3 examines the role of former Mayor Michael Bloomberg, in changing perceptions and spurring development along New York’s shore. Bloomberg described the waterfront as the city’s sixth borough and made its revitalization a priority during his time in office. In all five boroughs, major improvements were made to waterfront parks and new ones such as Brooklyn Bridge Park were begun, allowing the general public better access to the water than ever before. Along with the Department of City Planning, the Mayor worked to rezone almost 40 percent of the city, including many waterfront neighborhoods (Schuerman 2013). The most noteworthy resolution came in 2005, pertaining to the Williamsburg-Greenpoint waterfront, which now boasts luxury high rises and esplanades in an area formerly known more for dormant industry and polluted waters.

Contemporary Brooklyn has experienced a population and development boom; the streets of Northern Brooklyn are dotted with new housing developments, shops and restaurants. In neighborhoods like DUMBO, Williamsburg and Red Hook, much of this development has occurred very close to the water's edge. Brooklyn is following a timeline similar to that of Manhattan regarding industrialization, deindustrialization, dereliction and today massive growth. By the turn of the 20th Century, Brooklyn was home to the most commercially productive waterfront in the city. When industry evacuated Brooklyn in the middle of the 20th Century, it left dangerous and unsightly scars. The waterfront today is littered with industrial fossils like the Domino Sugar Factory. Furthermore the waters of the Newtown Creek and Gowanus Canal have been labeled as superfund sites based on their high contaminant levels. Contemporary Brooklyn development along the waterfront is now concerned with how to negotiate the fractured landscape industry left behind.

Chapter 4 addresses the particularities of Hurricane Sandy with regard to the storm's unique characteristics and the destruction it caused in the New York metropolitan region. Hurricane Sandy's storm surge flooded 51 square miles or 17 percent of New York's total land mass. In places like Far Rockaway and Coney Island, powerful waves battered developments that were built right up to the shore, inundating businesses and residences. Neighborhoods as far from the ocean as East Harlem were flooded due to low land elevation and no protection along the shoreline. As the authors of the *Stronger, More Resilient New York* plan note, "The storm was a reminder of how interconnected the city's systems are"(DCP 2013, 14). Indeed what affected one part of the city often had ramifications for many others due to this infrastructural and ecological reality. Although Hurricanes are often associated with pouring rain and high winds, neither of those were major factors in the destruction Sandy caused. It was the storm

surge and subsequent flooding, as high as six feet in parts of Northern Brooklyn that resulted in the greatest loss of life and property.

Chapter 4 deals with the particular characteristics of Hurricane Sandy and what made it such a damaging and powerful storm. Partnered with that discussion is a brief look at the realities of climate change and sea level rise. Although it is easy to call Sandy a once in a lifetime storm due to its unlucky arrival at high tide, undeniable facts regarding earth's changing climate render this assumption false. From what we know about global warming, more powerful and frequent extreme weather events like Hurricane Sandy can be expected to impact the New York metropolitan area in the near future. At a local level, this chapter looks at the specific ways in which Sandy affected the city and serves as a basis for discussion in the next chapter about what flood preventative design principles are being adopted to prevent flooding from storms like Sandy in the future.

Figure 1.3: Water Topping Bulkheads in Bay Ridge, Brooklyn

Chapter 5 addresses the design ideas and initiatives from the Department of City Planning and private firms that seek to limit the damage of flooding from storms in the future. In the past few years, "resiliency" has become the mantra of rebuilding and protecting the waterfront after Hurricane Sandy. The Department of City Planning (DCP) sees waterfront

infrastructure plans designed with "resiliency" in mind as the most cost-effective and flexible method for protecting the New York waterfront from extreme weather. Resiliency entails building shoreline infrastructural elements that do not necessarily keep out every drop of water; instead they bend but do not break. Therefore the DCP proposes a more integrated approach, which uses ideas for protecting the city from flooding as an opportunity to improve other aspects of the built environment. Protecting New York from disaster should not entail sacrificing the built and social environment that makes it worth saving. In the context of this thesis's focus on the Northern Brooklyn waterfront, I scrutinize the many facets the Department of City Planning's flooding initiatives for the area. For example these initiatives propose movable levee systems for Red Hook along the water while concurrently advocating better transportation connections with the neighborhood. This exemplifies an approach that seeks to improve life in New York during the vast majority of the year when extreme weather is not an imminent threat.

Flood resilient design goes beyond the planning of the City government; private landscape architecture and architecture firms form a major component of the dialogue. This chapter looks at some of the proposals from design firms that seek to add their varied expertise to the task of protecting New York. Competitions such as Rebuild by Design, funded by the Department of Housing and Urban Development (HUD) have brought together a diverse array of architecture and design teams ranging from European imports such as Rem Koolhaas's OMA and New York based Interboro Partners. Plans from the firms in this competition warrant discussion because of their multifaceted approach and understanding of urban ecology beyond a singular built levee or wall. While some have jumped to conclusions about the necessity for massive floodgates and levees like those in Rotterdam or London, this thesis intends to highlight the unique circumstances of flood protection in New York. Indeed there is no "one-size-fits-all"

when it comes to these matters, a fact emphasized by the diversity and ingenuity of proposals from the DCP, SCAPE Landscape Architecture and the Rebuild by Design Competition. New York is stronger than the sum of its parts and this attitude extends to protecting the city from flooding, a movement that looks to integrate with everyday life rather than serve as an affliction.

In the final concluding chapter, this thesis proposes a better understanding of the New York waterfront, its vulnerabilities and the people who are working to ensure its prosperity in the future. Hurricane Sandy brought the seemingly mighty city to its knees, fundamentally changing the conversation about development in New York. As the former head of the Department of City Planning Amanda Burden said, "We are a water city…we have to embrace it"(Baker 2013, 7). Although I do not propose any design solutions of my own, I hope to further an understanding of New York's waterfront history and how flood protection can be parlayed into improving our neighborhoods and communities. *Through my discussion and analysis, I demonstrate how we can embrace the waterfront with a development approach that is mindful of flood protection and how it can benefit the built environment at the same time.*

CHAPTER 2: NEW YORK WATERFRONT HISTORY

Before I delve into the complexities of contemporary issues regarding the waterfronts of New York City and more specifically Brooklyn, I look into the history of the waterfront to substantiate an informed discussion of its present and future. Although the focus of this paper is the Brooklyn waterfront and climate change implications for that specific edge, the history of the New York waterfront is a much wider discussion than that of just Brooklyn. Indeed Manhattan was the center of commercial activity along the waterfront until its small size rendered it obsolete in the face of new technology like the standard shipping container and increased scale. Compared with its historic roots as a major shipping port, New York's waterfront commercial activity is a mere fraction of its former self. Today economic activity occurs primarily inland, which raises issues regarding what to do with the skeletons of industry that dot the waterfront. I seek to answer questions regarding the history of New York's waterfront and what events resulted in the creation of the waterfront in its contemporary form and function.

The waterways and waterfronts of New York City are perhaps its most valuable asset. The rivers, tidal straits and landmasses of New York form one of the world's great natural harbors, allowing for a variety of commercial, industrial and infrastructural activities along its 520-mile long coast. The New York waterfront is a dynamic and constantly evolving space that has undergone many changes in function and form since merchants of the Dutch West India Company received a grant for all of the land of Manhattan (then Nieu Nederlandt) in 1623. Indeed New York owes its meteoric rise from a small Dutch trading port in the mid-17th Century to its status as the largest commercial port in the world by the turn of the 20th Century to its complex and diverse geography. As in any major urban area, the geography of New York City has been drastically altered over the course of its modern history to support its constant

evolution. For New York to expand in such rapid fashion, hills had to be leveled, holes dug and trees uprooted. The New York Bay that Giovanni Verrazano gazed upon, calling it the "beautiful lake" has been rendered unrecognizable by the efforts of urban development (Bone 2003, 19). Indeed no inch of New York has been left untouched by human development, however the element of its geography that has experienced the greatest and most drastic alteration is the waterfront.

Manhattan Island south of City Hall is today 33 percent larger than it was in 1623 when the Dutch first acquired the land (Buttenwieser 1987, 21). Although the shape and size of the five boroughs that we know today is primarily the result of efforts that began in the early 19th Century, the extension of land beyond existing borders is a practice as old as the city itself. Following the transference of ownership of unencumbered lands to the City of New York under the Dongen Charter of 1687, the city's limits were extended from the high to the low water mark. This permitted the extension of inhabitable land into space formerly underwater at the discretion of the land's owner. The construction of a new wharf between the high water mark at Pearl Street and the low water mark at Water Street marked the first instance of the use of landfill in the city following the Dongen Charter's passage. Although early 17th and 18th Century waterfront development was on a

Figure 2.1: Lower Manhattan Circa 1920

relatively small scale, it is important to consider the significance of the precedent that such waterfront infill and building set. To this end, Bone comments, "In spite of its hospitable terrain, enlarging and transforming the shape of New York City has been a persistent endeavor since the earliest times" (Bone 2003, 156).

To serve the demands of a rapidly expanding metropolis and port, the physical boundaries of the small island of Manhattan, and to a lesser extent Brooklyn, also had to expand. According to Kevin Bone, "By 1800, most of the southern tip of Manhattan had been ringed with bulkhead and landfill…adding 729 acres of new land"(Bone 2003, 27). Beyond the addition of land to the island's perimeter, marshy areas further north were also filled. 14th Street in Manhattan, today a bustling thoroughfare with a Subway line beneath its roadbed, was allegedly bisected by water at high tide before being filled in. The earth and rubble used to fill in marshes and add land to the shoreline was made conveniently available by extensive and rapid inland construction and excavation. Earth excavated to make way for office and residential buildings was quickly returned to the earth in the form of shoreline additions. As New York rose to commercial preeminence during the course of the 19th Century, the waterfront was transformed to accommodate the activities that accompanied such a status. Waterfront infrastructure was built in an unorganized and frenzied fashion that played host to the equally frayed human activity of loading and unloading ships.

The finger pier became the most popular form of waterfront infrastructure, extending land as far as 1,000 feet into the water in some cases. Hundreds of piers lined the coastline of Manhattan, developing what Anne Buttenwieser described as its "sawtooth appearance"(Buttenwieser 1987, 39). Kevin Bone noted that the "Haphazard design stood opposed to the rational landscape of gridded streets and vertical towers" of Manhattan (Bone

2003, 135). Though important infrastructural elements of a growing shipping and commercial power, these piers were not well built and were subject to theft, fire and weather, which took a particular toll on those with wooden supports and frames. The greatest detriment to the waterfront was the complete lack of organization; there was no coherent plan or vision for what shape the waterfront would take. Leisure activity was far from mind on the generally unpleasant waterfront which, harbored crime, filth, disease and garbage. In response to the poor conditions and disunity of the waterfront, the city established The Department of Docks in 1870. As Mary Beth Betts writes, "The need to regulate and plan the physical fabric of the booming metropolis had by now been recognized"(Bone 2003, 42). The establishment of the Department of Docks was an extraordinary step for the New York Waterfront, which led to the implementation of the first comprehensive waterfront plan the city had ever seen.

Charge of The Department of Docks was given to George McClellan, a former Civil War general and a formidable engineer. In 1871 under his supervision, the department released its master plan for the New York waterfront, exercising unprecedented power to unify the disjointed coastline of the mid-19th Century. His master plan included guidelines for the improvements of dock construction through the use of modern materials and building practices. The infrastructure required to support modern pier building was the centerpiece of the master plan; a riverwall stretching around Manhattan from West 61st Street to East 51st Street. The Department of Docks committed itself and the city to commercial shipping along the waterfront, their fates inexorably linked. When shipping and commercial activity in Manhattan became obsolete at the turn of the 20th Century, so too did the Department of Docks (Bone 2003, 80). A need for more land than the small and crowded East Side of Manhattan offered spelled the beginning of the end for its commercial prominence. With space a primary concern, commercial activity shifted to

Manhattan's West Side and Brooklyn, which could provide the land and facilities commercial interests required.

While the commercial prowess of Manhattan was in decline by the end of the 19th Century, Brooklyn was rising. Just like in Manhattan, widespread landfill and pier construction completely changed the landscape of the Brooklyn shoreline in the interest of fostering commercial activity. Bone comments that landfill added "literally hundreds of acres of port-related facilities to Brooklyn that included enormous basins, dry docks, storage warehouses and thousands of feet of piers"(Bone 2003, 167). The Brooklyn waterfront from the Newtown Creek to Sunset Park was extremely productive during the first half of the 20th Century following the incorporation of the City of New York in 1898. One of the most productive periods for the waterfront was the years the United States was involved in World War II. The Brooklyn Navy Yard employed nearly 100,000 men and women who were responsible for the construction of a large portion of the Naval fleet employed during the conflict. The post World War II period was however not nearly as productive for the Navy Yard and the waterfront of the city as whole. Indeed the waterfront as a commercial entity was quickly shrinking towards the point of

Figure 2.2: Brooklyn Navy Yard

obscurity, an unfathomable prospect considering its productivity just a decade before. However the straw that broke the camel's back was the advent of the modern shipping container. This technological advancement in shipping quickly became an industry standard, rendering the piers, warehouses and wharves of the New York waterfront obsolete.

The modern shipping container demanded certain infrastructure that the narrow Manhattan and Brooklyn waterfronts could not supply. Most importantly shipping operations required vast amounts of open space for loading and unloading of massive cargo ships. With New York unable to provide what the shipping industry needed, the container port was moved to Elizabeth, New Jersey. Aside from shipping, New York and in particular Brooklyn also experienced serious deindustrialization. Although some light and heavy industries still exist in the five boroughs today, it is a mere shadow of those operations of the 19th and early 20th Centuries. New York City had become too expensive and more importantly could not offer the amount of land corporations craved. Many moved to inland areas of the United States while some left altogether for overseas. Indeed New York on many different levels was forced to reckon with the prospect of a deindustrialized and non-commercialized waterfront. Furthermore other questions were raised as to what was to come of the massive steel and concrete vestiges that industry left behind.

What would become of the New York waterfront post industry? Although there were no comprehensive plans for the waterfront's future in the decades immediately following the conclusion of the Second World War, there was one man with a vision and the power to have it take shape. That man was Robert Moses, the master builder of New York, who held numerous positions from 1924 until 1968 and singlehandedly reshaped much of the city's built environment. According to Bone, Moses' projects "were driven primarily by the need to provide

anchorage or to connect his complex network of bridges and expressways…" any park or waterfront esplanade was a mere byproduct of other massive projects (Bone 2003, 177). Moses contended in defense of his projects, "Instead of blocking off waterfront from the public, the most casual honest survey will show that 106 miles of waterfront property have been opened up and preserved for public use." Many were skeptical, particularly those with an eye towards the environmental impacts of large-scale topographical alteration. Regardless of the factualness of Moses' statement, his projects and others were increasingly reviewed and discussed in an environmental context; for the first time the environmental impact of years of industry and massive building projects was considered.

Environmental awareness about the New York waterfront reached an important point in the early 1970's with the passing of the Clean Water Act of 1972. Bone remarks that the passing of the Clean Water Act was an important first step in the reclamation of waterfront for public use. He writes, "Its restoration to health suggests that its primary post-shipping era use will most likely accommodate New Yorkers' great need for recreational options"(Bone 2003, 204). Following the passage of the Clean Water Act, New York once again began to think about its relation to the water and the waterfront, both of which were rendered invisible by commerce and industry. Although it was an important step, Raymond W. Gastil contends that the completion of two major waterfront building projects and the blocking of another were the true signifiers of a changing relationship with and perception of the New York waterfront.

On December 15th, 1973 a dump truck plunged through the old Miller Highway, which stretched the length of Manhattan's West Side. In a controversial decision, the federal government proposed a new 4.2 mile, six-lane highway with a projected price tag of $2.3 billon (Bone 2003, 217). After a protracted legal battle, plans for "Westway" were

defeated and a proposal for a more modest road with significant parkland was instituted instead. Defeating another project that aimed to keep New Yorkers away from their waterfront demonstrated how attitudes were changing. It also highlighted the newfound power of the community to trump federally supported infrastructural projects. There were however two major development projects that were completed along the waterfront on Manhattan's Westside, the World Trade Center complex and Battery Park City that as Gastil argues, restored New York's status as a waterfront metropolis.

Completed in 1973, the seven building World Trade Center (WTC) complex was an impressive addition to the New York City skyline. At the center of the WTC were two massive skyscrapers that stretched 1,350 feet into the sky, surpassing the Empire State Building as the two tallest buildings in America. At first the buildings were much reviled due to their scale, design and perceived impact on Lower Manhattan. Although they later became to be seen as a defining symbol of the city and a major tourist attraction, Raymond W. Gastil insists that from the start their presence completely reshaped New York City. He writes, "While they [WTC] had a great presence on the skyline from every direction, their most powerful and iconic impact was from the water, where the blue horizontal foreground meets the vertical city. With the twin towers' completion in 1973, the towers had, with two monumental strokes, revived New York's image as a waterfront metropolis (Gastil 2002, 25). Indeed the most iconic view of the buildings and of the city itself became that of Lower Manhattan from across the Hudson River; water gave way to land, which gave way to two steel behemoths. The WTC was a monument to work, but a different kind than traditionally occurred on the waterfront. The WTC was a white-collar place of work that reminded New York of the potential for a working waterfront while also providing space for leisure and serving as an "iconic front yard for the city"(Gastil 2002, 26).

The second development Gastil focuses on is Battery Park City (BPC). First conceived of in 1966, Battery Park City was built entirely on landfill excavated to make way for the World Trade Center. BPC demonstrated that New York had recovered from the "long drunk of industrialization," which denied the realization of the waterfront's potential (Gastil 2002, 39). BPC combined residential, work and leisure interests into a well built, well kept neighborhood that extended the Manhattan grid to the newly formed shoreline rather than rejecting inland areas. Perhaps the most important element of BPC is the mile long esplanade that hugs the coast of the Hudson River. Gastil commented that the esplanade of BPC "restated the possibility of pleasure without menace or desuetude for the city's waterfront." In the context of a discussion about Hurricane Sandy, Battery Park City deserves praise. While dozens of square miles of the city flooded, BPC survived because of the esplanade and parkland buffer included in its design. Although BPC is located in a particularly vulnerable location, the esplanade, elevation, flora and benches that its designers included to serve leisure ends also turned out to be valuable assets for flood protection. Indeed Battery Park City has set an important example for current and future developments in how to save lives and protect valuable assets under the moniker of everyday improvement.

Figure 2.3: Battery Park City

In the decades following the opening of Battery Park City, thousands of plans have been proposed for waterfront housing, office space and parks. Hudson River Park now runs from Rector Street to 59th Street instead of a six-lane highway. Just to the North, a massive luxury condominium complex, the work of billionaire real estate magnate Donald Trump, sits almost at the water's edge. New York's failed bid for the 2012 Olympics included extensive use of waterfront areas for the construction of the Olympic village and other sporting infrastructure. In 1993, Mayor Dinkins proposed a comprehensive waterfront plan that mandated the inclusion of public space in any private development project along the waterfront. This mandate has become an important part of 21st Century waterfront development in the city.

In the Williamsburg neighborhood of Brooklyn as recently as 2003 there was only half of a square mile of waterfront legally available for public use. (Bone 2003, 277) Today a public esplanade, built by private developers in exchange for the construction of residential towers offers magnificent, panoramic views of Manhattan. Mayor Bloomberg has made public waterfront accessibility a centerpiece of his mayoral tenure and personally oversaw the rezoning of 40 percent of the entire city, much of that land along the shore. Indeed New York City has entered a new era of waterfront accessibility and development. The piers, warehouses and wharves of industry have been repurposed and now better the existence of all New Yorkers, rather than barring them from experiencing their waterfront as in the previous two centuries.

The shoreline today is still lined with relics of industry, rotting piers, abandoned warehouses and toxic waste. In Greenpoint, Brooklyn a 17 million-gallon underground oil spill was discovered, just one of many scars industry left behind (Bone 2003, 275). Most importantly however for a discussion of Brooklyn and New York's vulnerability to flooding is how waterfront development has hardened the edges of the city. Between 1953 and 1973 the New

York shore lost over 5,000 acres of tidal wetland and 47,000 acres overall since the practice of landfilling was begun (Bone 2003, 31). Tidal marshes were the five boroughs' natural defense against flooding; with the potential to absorb the energy from storm surges and manage flooding. Today the edges of Manhattan and Brooklyn are nearly completely artificial, lacking any of the flooding defense nature provides. Therefore we must ask: by developing the waterfront and building further into the sea, is the city and developers putting more people at risk?

Although the city's lack of natural defenses renders it vulnerable to flooding damage, a hard edge is not necessarily a bad thing, if it is utilized in a constructive manner. Battery Park City by all geographic indications is located directly in harms way. But when waves battered and flooded other coastal areas in the city, BPC survived because esplanades, trees, benches and other park elements soften its hard edge inland. Similarly in Williamsburg, while other parts of the Northern Brooklyn waterfront flooded, the most built up waterfront areas persevered because of a similar built character. What these two examples demonstrate is how a variety of well-placed and well thought out designs can work in concert to protect an area even if the edges are hard and there are people in harms way. *Though Industry and wanton development stripped the waterfront of its natural defenses a century and a half ago,*

Figure 2.4: World Trade Center

today the opportunity to build a resilient coast has presented itself. Later in this thesis I explore some of the best ideas from public and private interests that propose everything from oyster farms to movable levees to effectively protect the waterfront and the future of its development.

CHAPTER 3: NEW DEVELOPMENT AND BROOKLYN WATERFRONT HISTORY

During his 12-year tenure as Mayor of New York City, former Mayor Michael Bloomberg was responsible for one of the most remarkable building booms in New York City's history. The sheer number and scale of the buildings and infrastructural projects started and completed during his time in office are undoubtedly the greatest and most tangible elements of his legacy. Under the direction of Mayor Bloomberg and Amanda Burden, the director of the Department of City Planning, 40 percent of the entire landmass of the City of New York was rezoned (Schuerman, 2013). Among the largest projects Bloomberg had a hand in was the rebuilding of the World Trade Center site, jump-starting of the Second Avenue Subway Project and the building of three new sports stadiums in The Bronx, Queens and Brooklyn. Bloomberg's built vision for New York is for the moment continuing unabated during the first months of his successor, Bill de Blasio's term. Other ongoing projects include East Side Access for the Long Island Railroad and several "super-tall" residential towers for the "superrich" along 57th street in Manhattan.

The massive building projects of the Bloomberg era have attracted billions of dollars in investment and helped New York keep pace with global competitors such as Shanghai and London. While positive in many ways, Bloomberg's policies are not undeserved of criticism. He inarguably promoted the agendas of the superrich while neglecting the needs and concerns of poor minorities. Indeed behind the facade of skyscrapers and luxury hotels is an endangered populace, often forgotten by Bloomberg's initiatives. Bloomberg was however very brave in his promotion of big projects considering the tragic precedent to his mayoral inauguration, the 9/11 attacks. Steve Spinola, president of the Real Estate Board of New York recalls, "There was

clearly concern after 9-11: would the city be safe? What would we do about terrorism?" (Schuerman, 2013). By building big and trying to attract big events such as the Olympics in 2012, Bloomberg restored faith in the city.

Mayor Bloomberg always thought big in his efforts to raise New York's status. Although New York's bid for the 2012 Summer Olympics failed and the games were awarded to London, an international urban competitor, it had significant consequences for the future of the city. The Olympic games are one of the most capital intensive and challenging infrastructural events that a city and greater metropolitan area can take on. In order to support an international event of an Olympic magnitude, a great building boom was required. New York's Olympic bid is relevant to this thesis because of its unique building plan. Many of the large infrastructural projects required to support the games were slated for construction along the water's edge. Among them was the main Olympic Stadium, which was to be located over train yards on Manhattan's West Side, steps from the Hudson River. These plans signaled Bloomberg's and the city's commitment to revitalizing the waterfront, which became one focus of his building and rebuilding efforts during his Mayoral tenure.

In 2011 the Department of City Planning released *Vision 2020*, a comprehensive approach to revitalizing the decrepit post-industrial waterfront that was once the driver of the city's commercial prowess. Bloomberg described the waterfront as the city's "sixth borough," intrinsically tying its health and future development to that of the city as a whole (New York City, 2011). As the previous chapter conveyed, since the middle of the 20th Century, much of the formerly industrial New York waterfront has laid dormant. *Vision 2020* takes aim at the crumbling waterfront, offering an assortment of improvement strategies and policies. The plan officially defines itself as "an unprecedented effort to prepare the city for one million more

residents, strengthen our economy, combat climate change, and enhance the quality of life for all New Yorkers"(New York City, 2011).

In Chapter Two of the *Vision 2020* plan, the authors address some achievements along the waterfront since the first Comprehensive Waterfront Plan was released in 1992 under Mayor Giuliani. Since 1992, nearly half of the New York Waterfront has been made publicly accessible, 220 miles in total and 1,250 acres of land were acquired on the waterfront for conversion into parkland. A 350-mile greenway plan was laid out for the five boroughs in 1993, which has exceeded expectations in terms of breadth and success. One such greenway that runs the length of Manhattan on its West Coast is now the busiest bike thoroughfare in the world. Under Bloomberg, $6 billion was allocated for upgrading of wastewater treatment plants and another $1 billion set aside for dealing with sewer overflow. Perhaps the most prominent aspect of waterfront improvement initiatives since 1992 and especially since 2002 when Bloomberg came to office is the rezoning of waterfront areas for major residential development.

Figure 3.1: Vision 2020

A walk along one of the new waterfront greenways or parks in any of the five boroughs will reveal the consequences of recently enacted zoning changes. Buildings for commercial and residential use are developed closer and closer to the water's edge and in some cases create new borders by use of landfill. 20 years ago the waterfront was defined by dereliction, crime and vice; today it draws high real estate prices in tune with the prospect of unmatched and unobstructed

New York vistas. Battery Park City, a revolutionary concept in its time, has been joined by hundreds of new luxury towers along the Queens and Brooklyn waterfront, which have so recently shaken the stigma of industry.

Before addressing development along the Northern Brooklyn waterfront in the 21st Century, a look back to its industrial and commercial past is essential. Issues related to Brooklyn were briefly addressed in the previous chapter, which focused primarily on Manhattan's waterfront history. Brooklyn's waterfront however developed later than Manhattan's, with the former reaching its most productive point owing in part to the latter's decline. In the first half of the 19th Century, decades before the incorporation of the City of New York, Brooklyn was a sparsely populated area made up primarily of farmland. The first significant population increases to occur were concentrated primarily in Northern Brooklyn in the neighborhood known today as Brooklyn Heights. Residents of Brooklyn Heights were primarily commuters of some financial stature who worked in Lower Manhattan during the day and returned to the quieter, less densely populated shores of Brooklyn by way of the old Fulton Ferry. Technological advancement and industry's need for more space would soon replace the idyllic shores of Brooklyn and ferry rides with working piers and massive bridges.

Following the completion of the Brooklyn Bridge in 1883 and subsequent completion of the Manhattan and Williamsburg Bridges, people and business burst out of crowded streets of Lower Manhattan and across the East River into Brooklyn. Toward the end of the 19th century, manufacturing enterprises drastically increased in scale. In 1890, Brooklyn had 10,623 factories, according to the Census, with 93,275 full-time workers; by 1909, there were over 145,000 people employed (Ambrose, Crowley and Ward). Just 50 years removed from its divorce from the town of Bushwick, the neighborhood of Williamsburg ballooned to 250,000 residents making it one of

Figure 3.2: Williamsburg Waterfront Development

the city's most populated areas. Residents there were employed by a number of large factories such as the iconic Domino Sugar Factory. Other heavier industries such as oil refinement were attracted to the three-mile long Newtown Creek, just to the north of Greenpoint, which separates Queens from Brooklyn. Following in Manhattan's footsteps, Brooklyn became one the most productive waterfronts in the world. Technology and a need for space, which first attracted industry to Brooklyn would inevitably lead to its and the waterfront's downfall.

Brooklyn maintained its industrial and commercial prowess up through the end of World War II, although the seeds of deindustrialization had already been sown. The war was a lone bright spot for industry in Brooklyn particularly in the Navy Yard, which occupies a significant portion of the waterfront between the Vinegar Hill and Williamsburg neighborhoods. A workforce that reached a peak of 70,000 during United States involvement in the conflict built hundreds of warships in the Brooklyn Navy Yard (Ambrose, Crowley and Ward). After the war however the Navy Yard along with the rest of the Northern Brooklyn waterfront experience significant deindustrialization. By 1966 all military activity had left the Navy Yard and it was decommissioned. The cramped quarters of Brooklyn's piers were rendered inadequate as industries and commercial entities sought larger land plots and better connections with sea traffic

and rail lines. The evacuation of industry from the waterfront resulted in significant job loss and loss of livelihood for residents of neighborhoods that had depended on Brooklyn factories and warehouses.

As the rate of deindustrialization began to increase during the 1950's and 60's, major infrastructural projects began to replace the once productive factories and warehouses that powered New York's economy just decades before. Master builder Robert Moses erected the Brooklyn-Queens Expressway along the Brooklyn waterfront, taking advantage of derelict industrial sites. The massive highway proved a death sentence for many of the waterfront neighborhoods addressed in this paper. A quick glance at the path it carved through Brooklyn reveals the extent of the damage it caused and the isolation it cast the waterfront into. Red Hook in particular was completely cut off from the rest of the borough by new highway construction. In addition, substations and power plants such as those in Vinegar Hill and Ravenswood, Queens were constructed at the water's edge, physically barring residents from interaction with it. Even if one could make it to the waterfront, the water had become horribly polluted by a century of unchecked industry, which flourished at the expense of New York's water ecology.

By 1980 the Brooklyn waterfront reached its lowest point. With the advent of the modern shipping container, Brooklyn's commercial facilities were rendered nearly obsolete. Shipping operations moved across New York Harbor to Elizabeth, New Jersey, which above all else had ample space rendering it a more productive spot than cramped Williamsburg or Red Hook. The Brooklyn waterfront lay dormant, scarred by decades of industry that left behind toxic waste, vacant buildings and rusting mechanical eyesores. At the turn of the 20th Century however, the Brooklyn waterfront and New York as a whole were headed towards a period of rebirth and prosperity. Although industry left behind aged buildings and waste, some of the better-made

structures in neighborhoods such as DUMBO proved appealing to adventurous New York professionals. The rebirth and repopulation of the Northern Brooklyn waterfront was however just a trickle at the time. It took the 2005 rezoning resolution in the Williamsburg-Greenpoint neighborhood to open the floodgates for population development throughout the entire borough.

In 2005 the Williamsburg-Greenpoint waterfront was far from a coveted real estate location. Kevin Bone notes that in 2003, the only public waterfront access in the area was at Grand Ferry Park, which occupied a half-acre plot of land at the foot of Grand Street (Bone 2003, 277). Just to the south however, progress was being made on Brooklyn Bridge Park, which is connected to the DUMBO neighborhood and projects out into the East River. Encouraged by the major success of Hudson River Park in Manhattan, progress on Brooklyn Bridge Park was accelerated under Bloomberg and is now slated to cover five piers, stretching far south of its initial location. There were indeed major steps taken to make the waterfront more accessible to the public in Northern Brooklyn prior to 2005, but the Williamsburg-Greenpoint rezoning efforts were a major turning point. Enacted by the Department of City Planning, this rezoning opened up the derelict, formerly industrial Northern Brooklyn waterfront to large-scale residential development.

With its striking views of the Manhattan skyline and New York Harbor it is surprising that the Brooklyn waterfront didn't begin to attract major investment until less than a decade ago. Before the turn of the 21st Century however Brooklyn was a different place, poorer, more dangerous and suffering from the effects of deindustrialization. Beginning with renovated lofts in old warehouses in the DUMBO neighborhood, wealthy residents and businesses began moving to and investing in the waterfront. Today the waterfront from Astoria, Queens south to Red Hook is dotted with glass high rises, all pushing closer and closer to bodies of water that were so

recently shunned. Unfortunately, a full discussion of why luxury residential development has embraced the Brooklyn waterfront so thoroughly is beyond the scope of this work. It is important however to consider the implications of increasing development, investment and population density right at the water's edge in light of the realities of climate change and the devastation of Hurricane Sandy.

It seems counterintuitive and negligent to build residences and locate businesses in flood zones that have the highest risk for flooding, like those along the waterfront. Kevin Baker writes in his piece "City of Water," by the city's own estimates some 800,000 residents live on territory, roughly a quarter of the city, that will be on a flood plain by 2050. Yet Mr. Bloomberg has sworn to defend "every inch" of the city and dismissed any alternative strategy as "retreat" (Baker 2013, 5). In this case Mayor Bloomberg is mostly referring to areas such as Howard Beech and Breezy Point in Queens, but the circumstances of that statement also apply to Northern Brooklyn. New York has no interest in moving away from the water; a brave yet stubborn attitude the city prides itself on. In regard to the flooding caused by Hurricane Sandy, positive examples from the storm demonstrate that there is no reason for retreat. In fact along the Northern Brooklyn waterfront, new development seemingly in harms way actually helped to protect neighborhoods and its residents.

According to New York flood maps, areas of Williamsburg that lie at the edge of the East River are far less susceptible to flooding than areas further inland. "Williamsburg was protected by greater elevation and waterfront parks and esplanades that shoulder the impact of the storm surge" according to the Department of City Planning (DCP 2013, 246). Elevation aside, the waterfront parks and esplanades that protected Williamsburg were a byproduct of the 2005 zoning resolution. A stipulation for developers wanting to build big on the Williamsburg

waterfront is that they must include some form of publicly accessible park. Though seemingly a dangerous proposition, flood maps confirm that new building on the waterfront protected homes and businesses rather than putting more in harms way. New buildings which adhere to 1983-flood protection standards fare far better in harsh weather conditions, compared with older buildings that make up 91 percent of all buildings in the Brooklyn-Queens waterfront area (DCP 2013, 241).

Although Sandy caused widespread destruction, the attitude of elected officials and the lucrative nature of the waterfront will continue to fuel development. Formerly derelict industrial sites like that of the old Domino Sugar Factory, which closed down in 2004, are prime targets. In the case of Domino, staunch opposition to the construction of luxury high rises on that site is beginning to wane, outmatched by the money and resolve of private developers and government interests (Yee 2013, 2). Designed by SHoP architects the Domino Sugar plant in South Williamsburg seems destined to join the Williamsburg Edge complex to the North as part of a new luxury skyline. In the context of this thesis's discussion, the role of shoreline flood protective measures is taken into consideration when thinking about new development. Waterfront development thrives on unlimited views, access to water and relative tranquility. *It would then beguile the Department of City Planning to find*

Figure 3.3: Domino Redevelopment Renderings

flood protection measures that preserve the waterfront's best characteristics that make it so lucrative. While some call for massive mechanical levees, an integrated approach enhances the built environment and character of a neighborhood while concurrently protecting it and future investment from flooding.

CHAPTER 4: SUPERSTORM SANDY

By almost every measure Hurricane Sandy was the worst natural disaster ever to hit New York City. Although it was not the strongest or the deadliest Atlantic Hurricane to ever hit the East Coast of the United States, it caused $68 billion in damages, surpassed only by the $125 billion in damage resulting from Hurricane Katrina. In New York City alone, Sandy was responsible for 43 deaths and $19 billion of damage. Furthermore 51 square miles of the city was flooded, which accounts for 17 percent of New York's total landmass. The storm, which made landfall on the evening of October 29th, 2012, left two million residents of the New York metropolitan area without power for days and in some cases weeks (DCP 2013, 11). This chapter explores why Hurricane Sandy was so powerful and destructive and takes a brief look at the modern truths regarding global climate change.

High winds and torrential downpours is generally the destructive weather associated with Hurricanes. Storm strength is officially classified based on wind speed, which determines whether a weather system is considered a tropical storm or a hurricane, categorized level one through five. By those measures however, Hurricane Sandy was not a particularly strong storm. Sandy's winds barely reached Category One status and subjected the New York area to relatively small amounts of rainfall. The most destructive aspect of Sandy was the storm surge that accompanied its arrival on the East coast, largely as a result of the storm's massive size. At the time it made landfall in New York it was over 1,000 miles wide, three times the size of Hurricane Katrina when it struck New Orleans in 2005 (DCP 2013, 11).

Although it sounds cliché, Hurricane Sandy was in many ways a "perfect storm." Beyond its massive size, a seemingly preplanned combination of factors combined to morph Sandy from a weakening Atlantic Hurricane into the deadly storm that the Northeast experienced. Sandy

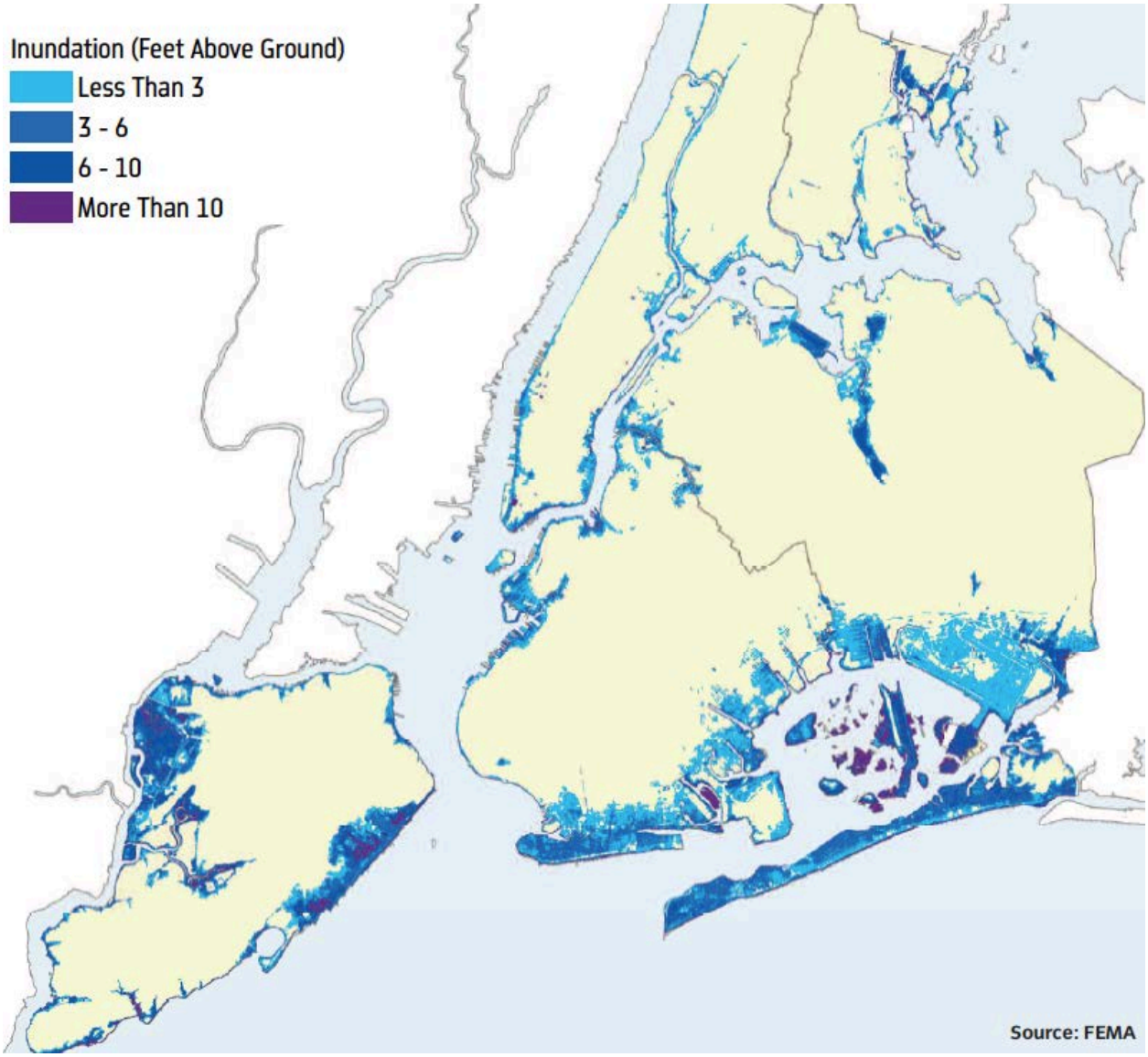

Figure 4.1: FEMA Flood Inundating Map

made landfall on the Northeast Coast at 7:30 pm on October 29th, 2012 approximately eight miles south of Atlantic City, New Jersey. High tide arrived at the Battery in Manhattan at 8:54 pm and Sandy's storm surge peaked just a half hour later at 9:24 pm (DCP 2013, 11). Furthermore the tide reached the peak of its monthly cycle that night due to a full moon. Aside from the storm's unfortunate and unlikely coincidence with high tide, it also followed an irregular path for an Atlantic Hurricane. Rather than continuing Northeast up the coast like most Hurricanes that make it that far north, concurrent weather systems drew Sandy west towards Atlantic City and New York.

Figure 4.2: Sandy from Space

The storm surge and waves caused by this perfect combination of meteorological factors were by far the strongest ever experienced in New York City. Because New York is surrounded by water there are numerous ways for water to surge into its core; Sandy pushed water towards the city from New York Harbor into Jamaica Bay and towards Southern Brooklyn. Water also traveled west through the Long Island Sound towards The Bronx and the mouth of the east river. "In short, the ocean fed bays, the bays fed rivers, and the rivers fed inlets and creeks" (DCP 2013, 13). Rockaway Beach, which extends into the Atlantic Ocean, was battered by waves in excess of 30 feet. South

Beach Staten Island experienced the highest storm surge in the city, with water rising 15 feet above the normal mean water line. In Sea gate, Brooklyn, water rose 13.3 feet and at the Gowanus Canal, water levels exceeded 11 feet above the normal mean due to the storm surge (DCP 2013, 42).

The New York waterfront experienced extensive damage due to the extreme nature of Sandy's storm surge. According to the *A Stronger, More Resilient New York* plan released by the New York City Department of City Planning in July of 2013, "the urban character of New York City magnified the impact of the flooding." More than 443,000 New Yorkers were living in the areas that Sandy flooded when the storm struck. 88,700 buildings in total are located in the storm's inundation zone, consisting of over 300,000 homes and approximately 23,400 businesses (DCP 2013, 13). Furthermore much of the city's critical infrastructure like hospitals, nursing homes, power facilities, transportation facilities and wastewater treatment plants is located in flood zones. Six hospitals were closed, 500 miles of roadways were damaged and the 14th Street substation in Manhattan was completely compromised due to an explosion caused by a reaction between electricity producing machines and salt water. Although drinking water wasn't severely impacted, 10 of the 14 wastewater treatment plants operated by the Department of Environmental Protection released either untreated or partially untreated sewage into the city's waterways (DCP 2013, 17).

Although the focus of this thesis is flood protection proposals for the Northern Brooklyn waterfront that maintain resilient principles, it is important to first consider how flooding from Sandy impacted vital infrastructural elements in the city. Indeed one of the most profound impacts of Sandy's storm surge and subsequent flooding was on New York's subway system, considered to be the backbone of the city and one of its greatest assets. Every subway tunnel

between Manhattan and Brooklyn, and Brooklyn and Queens was compromised and rendered unusable for days afterwards. In the case of the R and G trains, regular subway service won't return until the end of 2014 because of the need for repairs. In a New York Times Magazine feature on the MTA's response to Sandy, the author commented, "Sandy made M.T.A. workers look like a bunch of children racing around the beach as waves came in toward their sand castle. Sometimes it felt that way to them too. The Federal Transit Administration describes Sandy as the nation's worst transit disaster"(Sullivan 2013, 3).

In the aftermath of Sandy's path of destruction, the Department of Buildings (DOB) tagged 800 buildings across the city as being structurally damaged by Sandy. Over 100 of the lost homes and businesses along the waterfront were lost to fire, another destructive but limited and indirect impact of flooding from the storm (DCP 2013, 14). Of the buildings that were tagged by the DOB, those that suffered the greatest damage were older, one story light frame buildings. Although buildings of this type make up only 18 percent of structures along the waterfront, they account for 73 percent of all buildings tagged by the DOB. High rises on the other hand suffered significantly less structural damage than smaller, older buildings. Critical design flaws in many

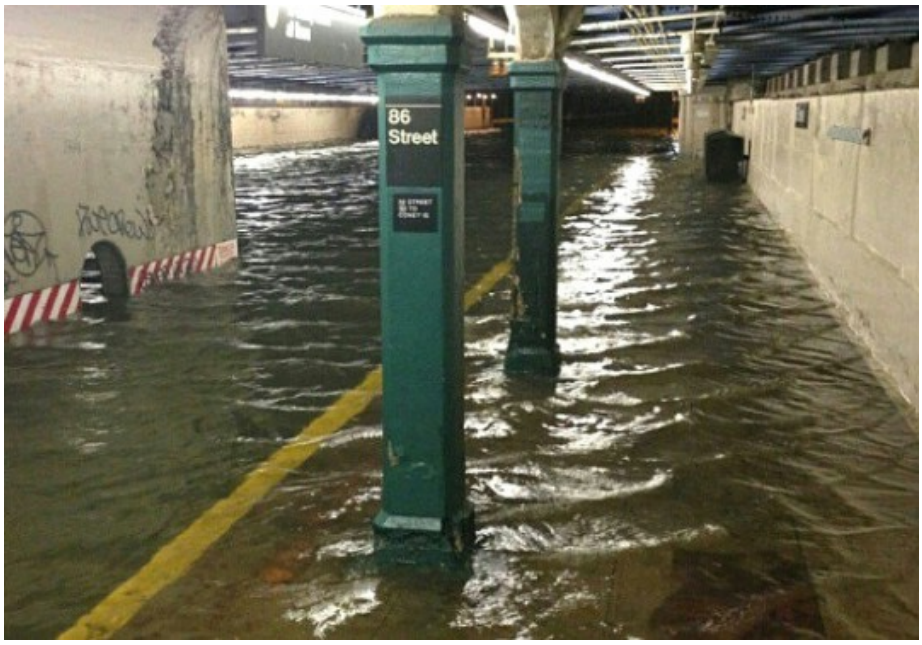

Figure 4.3: 86th Street Station. Gravesend, Brooklyn

high-rise buildings such as the location of infrastructure on basement levels still resulted in losses of power or heat.

One building type that suffered significant mechanical but limited structural damage was New York Housing Authority (NYCHA) buildings, which in many cases are located close to the water's edge. "More than 400 New York City Housing Authority buildings containing approximately 35,000 housing units lost power, heat, or hot water during Sandy"(DCP 2013, 14). NYCHA buildings, many of which are 70 years old and were in a state of poor repair prior to Sandy's arrival suffered greatly. "Perhaps more so than in any other place in the city, the loss of power for people living in public housing projects forced a return to a primal existence" (Buckley 2012, 1). The authors continue, "Thousands of public housing residents in New York City defied evacuation orders because they underestimated the ferocity of Hurricane Sandy; now they make up a city within a city, marked by acute need" (Buckley 2012, 2). One housing development, the Red Hook houses in the Red Hook neighborhood of Brooklyn, which the article specifically refers to, suffered perhaps the most from hurricane related flooding.

The Red Hook houses are just one of many vulnerable built elements along the Northern Brooklyn waterfront. The Department of City Planning locates the focus area of this thesis in a larger waterfront context that includes Long Island City, Queens and Sunset Park, Brooklyn just south of Red Hook and the Gowanus Canal. According to the *Stronger, More Resilient New York* plan, the Brooklyn-Queens waterfront area that they highlight contains 8,600 businesses that employ over 77,200 people. In the aftermath of Hurricane Sandy, nearly one third of all the businesses and more than half of the employees of those businesses were affected by the storm (DCP 2013, 244-245). Encompassed in commercial land usage along the waterfront is industry, which accounts for 22 percent of Brooklyn-Queens waterfront buildings. In the Brooklyn Navy

Yard, parts were flooded with four to six feet of water from the adjacent East River and $75 million of equipment and inventory were lost (DCP 2013, 248).

While most areas were flooded by water from the East River and New York harbor, the neighborhoods of Greenpoint, East Williamsburg and Gowanus suffered flooding from a different source. These areas were in fact relatively unaffected by the East River storm surge, yet still experienced significant flooding. In Gowanus, damage to the neighborhood was the result of storm waters topping bulkheads along the Gowanus Canal, which stretches 1.8 miles North into mainland Brooklyn. Further North in East Williamsburg and Greenpoint the Newtown Creek was responsible. Both the Newtown Creek and Gowanus Canal are narrow waterways that serve primarily industrial functions. Since the early days of waterfront commercial activity in Brooklyn, they were modified to promote a variety of light and heavy industrial practices. In both cases, the banks of these industrial canals were flattened decades before and any natural characteristics were eliminated. This all contributed to what the Department of City Planning calls "backdoor flooding." The low-lying nature of the surrounding land paired with the two waterways' altered ecology exposed adjacent neighborhoods to flood waters and caused significant inland damage.

Aside from the inland, backdoor flooding that the Newtown Creek and Gowanus Canal exposed adjacent neighborhoods to, they also pose a significant health threat. The long and active history of heavy industrial operations along the shores of these two waterways has had harmful effects on the quality of their waters. In the past 10 years, both waterways have been tagged by the Environmental Protection Agency (EPA) as superfund sites, a designation and action plan reserved for the dirtiest water in the United States. When the Newtown Creek and Gowanus Canal overflowed during Hurricane Sandy, millions of gallons of highly polluted water

flowed into the streets, homes and businesses of nearby neighborhoods. Although a study performed by the Department of Environmental Protection in Sandy's aftermath concluded that conditions in surrounding areas were generally safe, the potential of a biohazard emergency provides strong impetus for the clean up of these two waterways. This danger also increases the urgency for flood protective measures to be taken along the Newtown Creek and Gowanus Canal to prevent water, polluted or not, from flooding nearby neighborhoods.

Hurricane Irene, which made landfall in New York on August 28th, 2011, lulled New Yorkers into a false sense of security regarding the city's ability to survive dangerous weather systems. Although a significant storm, Irene didn't flood the subway and New York recovered much quicker than it has been able to from Sandy. It is however noteworthy that two powerful storms struck New York City directly in a little over a year's time, a sign of what we can expect in the future. Hurricane Sandy was a devastating storm that altered the lives of millions and changed the way politicians, planners and architects look at the city; no longer an invincible metropolis. More than anything Sandy exposed New York's extreme vulnerability to flooding. When talking about extreme weather events in the future, the question is no longer if, but when?

Figure 4.4: Flooding in Red Hook, Brooklyn

The New York City Department of City Planning has paid close attention to the realities of climate change and global warming, which tell us that Hurricane Sandy was not an anomalous occurrence. According to the resiliency report, "since 1900, sea levels have risen more than a foot in New York City, primarily due to climate change. As sea levels continue to rise, coastal storms will cause flooding over a larger area and at increased heights than they otherwise would have"(DCP 2013, 30). 2012, the year in which Sandy was spawned, was the warmest year ever recorded in New York City, a full degree warmer than the previous record holder. The authors also write, "since the industrial revolution, carbon dioxide levels have increased forty percent. Since the late 1970s, global average temperatures have increased by approximately 1 degree Fahrenheit and the volume of sea ice in the Arctic during the month of September has declined by almost 80 percent" (DCP 2013, 27). All together this paints a troubling picture of the future of our planet and provides significant incentive for creative design ideas that will help protect New York City from the near inevitability of powerful future storms and more frequent flooding.

The Department of City Planning outsourced a cost benefit and future risk analysis to the Swiss insurance company Swiss Re to aid in their plans for flood protection. According to the Swiss Re study, "models project that expected annual losses in New York City of $1.7 billion today will grow to $4.4 billion in current dollars by the 2050s"(DCP 2013, 35). What this means is that the amount of damage the city can expect on a yearly basis today nearly triples over the course of the next 40 years. By 2050 and even sooner, more and more of the city can expect to experience significant flooding and damage, while those parts inundated by Sandy will suffer more so than ever before. In the next chapter I explore some of the design solutions proposed by the Department of City Planning and private design firms to help protect New York City and the

surrounding metropolitan area. In their design efforts, private and public entities are striving to make New York more “resilient,” a fuller definition of which is forthcoming.

CHAPTER 5: RESILIENT DESIGN SOLUTIONS

The historical, geographical and meteorological discussions and analysis in this thesis underscore the imperative for good design solutions to the challenges facing the New York waterfront in the 21st Century. After decades of industrial and commercial productivity followed by half a century of dormancy and dereliction, people and businesses are moving to and investing in the New York waterfront. The "Coastal Analysis" chapter of *A Stronger, More Resilient New York* begins, "In the 21st Century, New York and New Yorkers have embraced the waterfront in a new and exciting way… New developments, parks, housing and business have all moved closer to the water's edge." The writers concede however that, "this move towards the water brings with it new Challenges, many associated with climate change" (DCP 2013, 40). It is with these challenges related to climate change that this thesis is most concerned: how can New York continue to develop its waterfront safely with the destructive force of Hurricane Sandy in mind? In this chapter I look at some of the best and most interesting ideas from public and private sources regarding how to effectively respond to the immanency of the threat of climate change.

Before Hurricane Sandy, the threat of flooding caused by a massive storm was regarded as an unlikely possibility. Parts of the city had been flooded before, but the city always bounced back quickly and was never severely inundated. Hurricane Irene, which struck in August 2011, raised the possibility of widespread destruction from an Atlantic Hurricane but damage and losses were relatively limited. Extreme weather in the form of Nor'easter storms causes limited flooding and disrupts transportation service but water has never risen above 10.5 feet, the level at which the subway floods (DCP 2013, 14). As the previous chapter noted, water reached 15 feet above mean levels in some parts of Staten Island and 13 feet in parts of Brooklyn. As a result,

the subway flooded for first time, with water rising well above the 10.5-foot threshold. The widespread destruction Sandy left in its wake left many wondering, would New York retreat or rebuild? Unsurprisingly New York decided to rebuild. The question then became how would it be done?

New York was undeniably unprepared for a storm of Sandy's magnitude. Since a storm like Sandy had never hit the city before, New Yorkers doubted one ever could; the city thought it was invincible. For the metropolises of countries like the Netherlands and England however, flooding is a historic problem and is treated as an inevitability. In the Netherlands, the government spends $1.3 billion annually on flood preventative measures, which has helped to finance the country's vast, hi-tech flood prevention system that protects the low-lying country (Higgins 2012, 1). Peter Glas, president of the Dutch Association of Regional Water Authorities told the New York Times, he was dismayed by images on television of darkened, waterlogged buildings in Lower Manhattan, and wondered how the area would have fared if it "had a Dutch approach to the problem" (Higgins 2012, 1).

Figure 5.1: Thames Flood Gate: London, England

The modern methods of the Dutch are certainly noteworthy and exemplify the type of attitude we must take towards flood prevention in New York. "The Dutch way of thinking is

completely different from the U.S., where disaster relief generally takes precedence over disaster avoidance," said Wim Kuijken a Dutch government official (Higgins 2012, 2). Mr. Kuijken is correct in his assessment of American attitudes; it is indeed time to consider how disasters can be avoided, rather than just waiting to clean up the pieces afterwards. There are those that believe we should replicate the massive flood barriers that protect cities like Rotterdam and London. A better understanding of New York's unique geography and the realities of resorting to such hi-tech and expensive measures is necessary before diving into such a massive infrastructural project.

According to the Department of City Planning, "There have been proposals for massive seawalls that would in theory protect most of the city from a storm surge" (DCP 2013, 48) One such proposal entails the construction of three walls, one across the Narrows between Brooklyn and Staten Island, one at Arthur Kill in Staten Island and a third at the Upper Reaches of the East River. These barriers would be normally navigable, raising their levees only when the threat of a storm was imminent. For some the supposed simplicity of an all-encompassing flood barrier is appealing. There are however multiple drawbacks to a massive plan such as the proposed $25 billion price tag, years of design and bureaucratic debates, potentially horrific environmental impacts and the disruption of New York attractions like Rockaway Beach and Coney Island (DCP 2013, 49). Even after they're built, there is no guarantee that such drastic measures will even work. All the potential negative outcomes associated with a massive floodwall led the Department of City Planning to make a major decision about the future of flood protection in New York. They say:

> "Given this, the City believes that the right approach to coastal protection is an integrated system of discrete coastal projects, that together would constitute the elements of a

multilayered approach also involving resiliency measures for buildings and protections for critical infrastructure" (DCP 2013, 50).

This statement reveals that the government of the City of New York intends to focus on smaller scale interventions, aimed at "resiliency." Resiliency has become one of the buzzwords of both public and private efforts to protect New York from flooding. A resilient approach to flood design does not necessarily entail complete prevention of floodwaters reaching New York streets and buildings. Instead it advocates a comprehensive, multi-faceted approach that allows the city to absorb some of a storm's impact and help it recover quickly. What we learned from the impacts of Hurricane Sandy is that different coastal areas face a different set of risks and circumstances that can't be solved by applying a single, all-encompassing solution. The Department of City Planning describes the advantages of their integrated approach as being three-fold. First, it diversifies the city's exposure to different technologies, reducing the chance of devastating total failure such as with the levees in New Orleans during Hurricane Katrina. Second, it is scalable to available resources. And third, projects can be started right now to protect New Yorkers in the short run rather than relying on a large project that won't be complete for decades (DCP 2013, 50).

The integrated approach that the DCP champions combines hundreds of smaller infrastructural elements that will work in concert to protect vulnerable parts of the city. In the Hurricane Sandy report, the authors briefly outline the use and intended effect of a dozen of the smaller-scale infrastructural elements they plan to implement and the specific areas in the city where each built entity will be placed. These projects range in scale from beach nourishment, the process of adding sand to beaches to improve their health and durability, to hard rock shoreline barriers called revetments. The Department of City Planning grouped the implementation of

some shorter term and less expensive plans into an ambitious Phase One, made up of 37 unique initiatives.

With unlimited financial support and manpower the DCP could implement all the infrastructural plans it wants to immediately. However because of budget constraints and the "fluid nature of climate change and sea level rise," the possibility of building everything at once is rendered unfeasible (DCP 2013, 57). To effectively address the Department's lengthy to-do list, a cost-benefit analysis was employed to determine which areas are at the greatest risk. The DCP writes, "some of the earliest initiatives will take place in high risk areas such as Rockaway Beach where there is a planned process of beach nourishment as well as the addition of revetments and bulkheads in other high risk areas such as Staten Island and southern Brooklyn. These are areas that are vulnerable to waves as well as flooding, the receding waters take sand with them"(DCP 2013, 58).

Out of the 37 initiatives that comprise Phase One of the Department of City Planning's waterfront protection plan, only three address flooding concerns in my focus area, the Northern Brooklyn Waterfront. Furthermore these three initiatives are located towards the bottom of the list at numbers 23, 25 and 26. Although Northern Brooklyn is included in Phase One, areas that suffered greater damage as a result of Hurricane Sandy and are likely to suffer similar damage in the near future were given clear priority. While Red Hook, Brooklyn suffered serious and widespread damage because of Sandy; areas like Rockaway Beach and Tottenville, Staten Island were clearly devastated to a greater degree. The DCP understands that it can do more, faster and with greatest effect in the city's most vulnerable areas.

I want to turn now to a discussion of those initiatives slated for the Northern Brooklyn Waterfront. A full summary of the 37 initiatives that comprise Phase One is beyond the scope of

this paper, however a fuller discussion of the implications of its geographic priorities is forthcoming. Initiative 25 in Phase One addresses a vital piece of the city's energy and electrical infrastructure, the Farragut Substation located in Vinegar Hill. This large substation, which supplies power to 1.25 million customers in New York, is built directly adjacent to the East River, rendering it extremely vulnerable to any fluctuation in water level (DCP 2013, 58). Although it didn't flood during Hurricane Sandy, it is located in one of the highest flood risk zones. To deal with the threat of flooding damage, the DCP recommends the construction of a floodwall along the substation's perimeter. A floodwall is, a "permanent vertical barrier" that provides "a higher level of surge protection for vulnerable neighborhoods and critical infrastructure" (DCP 2013, 54). In this specific instance, the use of a permanent, singular entity is warranted because of its non-residential character. In many other cases, less obstructive means are called for.

Initiative 26 of the DCP's Phase One deals with the Newtown Creek, the industrial waterway that separates Queens from Brooklyn and is fed by the East River. Issues related to the Newtown Creek were raised in Chapter Four due to the extensive flooding it caused and the extreme pollution of its waters. The Newtown Creek contributed to a phenomenon called "backdoor flooding" because its waters flooded areas further inland to a greater degree than waterfront areas adjacent to the larger East River. The scourge of industry left the banks of the creek barren and unable to repel rising waters, which topped bulkheads and flowed unabatedly into Greenpoint and East Williamsburg. Although the Newtown Creek doesn't support the same level of industrial and commercial activity it once did, it is still an active waterway with numerous heavy industries lining its shores. This fact led the Department of City Planning to its

conclusion about how to protect the areas surrounding it from overflowing waters; a local storm surge barrier.

The Department of City Planning prescribes a local storm surge barrier to protect against flooding while also taking into consideration the activity of the creek. The DCP describes them as, "Large moveable in-water gates that connect with levees or floodwalls on adjacent shores. They are retracted to allow for normal maritime activities during non-storm times and are closed in advance of extreme weather to protect inland areas" (DCP 2013, 56). The implementation of a storm barrier at the mouth of the Newtown Creek is a relatively expensive infrastructural piece in the context of other more "integrated approaches," however the commercial activity of the creek demands such a plan. Outside of the citywide Phase One initiatives, there is a separate but related set of initiatives that apply only to the Brooklyn-Queens waterfront area as isolated by the DCP. Brooklyn-Queens initiative four supports private investments that reduce flood-risk along the Creek until the surge barrier is completed. Furthermore under initiative two, the DCP calls for a feasibility study for a similar type of barrier at the mouth of the Gowanus Canal, which shares many of the same characteristics as the Newtown Creek.

Under the auspices of the citywide Phase One and the eleven initiatives specifically called for along the Brooklyn-Queens waterfront, the neighborhood of Red Hook receives the most attention. Formerly one of the most dangerous, destitute and run-down neighborhoods in the city, suffering from deindustrialization among other urban illnesses, Red Hook has been the site of considerable contemporary development. A fascinating variety of people and businesses now populate the neighborhood; small artisan shops, a Fairway market and an Ikea have recently joined the massive NYCHA Red Hook houses. As Chapter Four discussed, the peninsular shape and unprotected geographic location subjected Red Hook to some of the worst flooding of

anywhere in the city during Hurricane Sandy. Six feet of water filled some streets in the neighborhood, inundating the aged Red Hook houses and causing millions of dollars in property damage. Because of the unique location and diverse array of activities and people the neighborhood supports, the Department of City Planning has taken a markedly different approach to flood resiliency there as opposed to the sites previously mentioned.

An integrated flood protection approach is advocated by the Department of City Planning for implementation in neighborhoods like East Harlem and the Lower East Side in Manhattan and Red Hook, Brooklyn among others. *The idea behind an integrated approach is to protect a given neighborhood from flooding without disrupting its unique built, social and economic character.* According to the DCP, an integrated flood protection system "combines traditional flood walls with landscaping features; benches, park walls, flood-proofed buildings, drainage improvements…"(DCP 2013, 54). As the Department's plans demonstrate, flood protection measures can be utilized for neighborhood improvements beyond their primary stated task. Drainage improvements, landscaping features and park benches to name a few all serve valuable functions in non-storm conditions. Indeed many of the flood protective elements advocated by the DCP are preexisting features of the built environment that if utilized correctly can serve a variety of functions.

Another important element of the integrated approach is deployable floodwalls, which are "useful because in non-storm times, they are invisible and can be put up in time for a storm (DCP 2013, 54). This is another important feature that demonstrates the DCP's understanding of the unique character of the different waterfront neighborhoods in New York. To protect the Farragut Substation, a permanent levee was recommended because it is a piece of infrastructure that doesn't support the daily activities of residents, business owners or tourists. In contrast, Red

Hook is a vibrant, quickly developing residential neighborhood with thousands of homes, restaurants and businesses both small and large. The implementation of a permanent levee or other large infrastructural element would undoubtedly disrupt the flow of daily life in Red Hook. Besides the disruption it would cause in terms of the circulation of pedestrians and vehicles, a steel and concrete behemoth would block waterfront views, break with the primarily low-rise brick building character of the neighborhood and generally intimidate the local populace.

Figure 5.2: SCAPE Oystertechture

"Integration" is at the forefront of the Department of City Planning's efforts to protect vibrant neighborhoods from flooding while at the same time preserving their unique built character. Hurricane Sandy exposed New York City's weaknesses, but it also highlighted many of its strengths. These strengths reside in certain preexisting infrastructure that helped repel advancing floodwaters beyond their intended use value. We cannot forget what makes New York great in our pursuit of protecting it from the inevitabilities of climate change and the strong storms it will cause. Using flood protective elements to strengthen the day-to-day fabric of our city makes sense because it serves a variety of purposes. Therefore I cannot advocate investment in mammoth seawalls because they have no value beyond their intended use and are likely to impinge on scarce and valuable municipal resources.

Highlighting the importance of flood resilient design in New York is the attention it has drawn from architecture and landscape architecture firms from around the world. In this chapter I discuss two separate initiatives that bring together some of the best firms with the best ideas about flood protective design. The first is *Rising Currents* an exhibit and interactive dialogue curated by the Museum of Modern Art at their Queens location, PS1. The Second is the Rebuild By Design competition, funded by the United States Department of Housing and Urban Development (HUD) in the aftermath of Hurricane Sandy. *Rising Currents* was on display in 2009 and shows impressive insight into the realities of climate change and foresight with regard to the events of Hurricane Sandy. The exhibit brought together five different design teams that were each assigned a location around the New York metropolitan area and tasked with developing "soft-infrastructure"(Bergdoll 2011, 13). The stated intention of the five different projects MoMA supported was to, "ameliorate the effects of climate change by mimicking nature and accepting a blurring of the edge between land and water"(Bergdoll 2011, 14).

The areas of the New York metropolitan area addressed were Lower Manhattan, Liberty State Park in Jersey City, Kill Van Kull between Bayonne, New Jersey and Staten Island and the Sunset Park, Bay Ridge and Red Hook neighborhoods of Brooklyn. For the purposes of this paper I address the proposal for Red Hook from the New York based landscape architecture firm SCAPE. Led by Kate Orff, the SCAPE team presented a set of initiatives aimed at widespread and innovative wildlife conservation. 150 years ago before industrialization poisoned the waters surrounding New York, the Bay Ridge flats off the coast of Brooklyn were ripe with high quality oysters. With this history in mind, Orff writes, "Engaging issues of water quality, encroaching tides, and community based development, the team proposes to nurture the already active revitalization of a long-lost natural oyster reef in phased process…"(Bergdoll 2011, 90).

SCAPE's plan takes into account numerous benefits that could be gleaned from the revitalization of oyster reefs in New York waters. An inexpensive and simple wood and rope structure would nurture oysters in a "clean and revitalized Gowanus Canal" (Bergdoll 2011, 90). Considering the Gowanus Canal's status as a superfund site, it is implausible to think of it a viable location for Oyster growth. Orff however has extreme faith in the abilities of these small creatures to purify water; one oyster can filter up to 50 gallons of water per day (Orff 2010). Furthermore these Oyster farms are constructed in a way that attenuates wave impact, protecting the areas surrounding the Gowanus canal that were flooded during Sandy. Waterfront parks and walkways, demonstrating a multiplicity of benefits for the public good in Red Hook and beyond, will complement the construction of Oyster farm infrastructure. Although a markedly different approach to flood resilient design, employing a number of ecological elements the Department of City Planning doesn't recommend for Red Hook, both plans intend to protect the city while at the same time contributing to the community in non-storm times.

The Rebuild by Design competition, funded by HUD, was initiated in the aftermath of Hurricane Sandy. The competition includes entries from a prestigious international array of design teams like Rem Koolhaas's OMA from Rotterdam, Netherlands and Interboro Partners from Brooklyn, headed by Tobias Armborst. The scope of the designs for this competition extends far beyond the reaches of New York City into New Jersey and Long Island. Out of the ongoing projects, the Northern Brooklyn waterfront receives relatively little attention. Considering the massive Federal Investment, it is unsurprising that the design teams are focusing on areas that were inundated by Hurricane Sandy to the greatest degree. Although the Northern Brooklyn waterfront suffered significant damage from Sandy and stands to be inundated in the

future, it was spared relative to parts of Staten Island, Southern Brooklyn and the Jersey Shore. The one part of my focus area that is mentioned is Red Hook.

One team that has taken on the task of addressing Red Hook is HR&A Advisors, Inc along with Cooper, Robertson & Partners. In their assessment of Red Hook's flood vulnerabilities, they highlight an industrial past that left the shoreline vulnerable to flooding. They reference the initiatives planned for implementation by the Department of City Planning as part of their integrated approach, noting however that they will take time and that Sandy uncovered other unaddressed vulnerabilities. These vulnerabilities include "gaps in commercial corridors; exposure of Red Hook Houses public housing complexes; and a lack of connectivity between Red Hook and the rest of the City"(RBD, 2013). They advocate a variety of measures that can be implemented in the short term to protect Red Hook until some of the larger, public initiatives are completed. These included, "flood protection for existing stores and buildings along Van Brunt Street…development of new public housing to relocate ground flood tenants to high elevations in new structures"(RBD 2013). The design team hopes to create better connections between Red Hook and adjacent neighborhoods, a link that is severed by the Hugh L. Carey (Brooklyn-Battery) Tunnel.

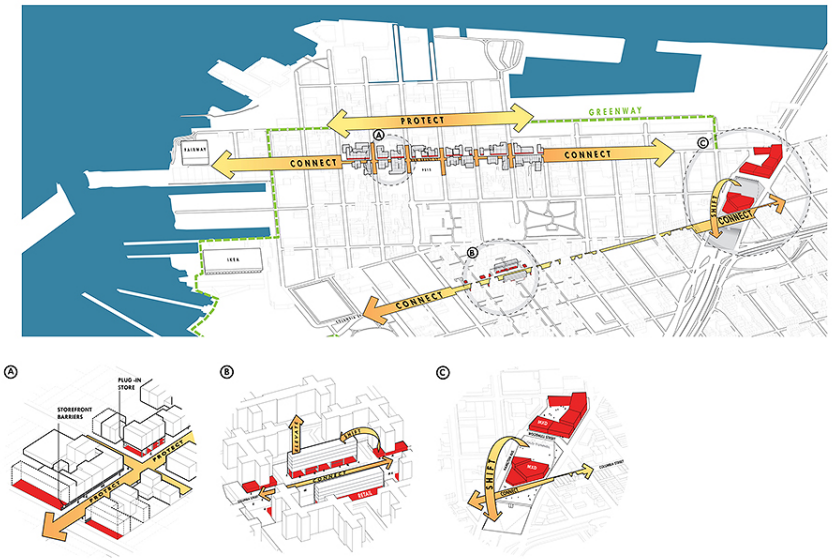

Figure 5.3: HR&A Red Hook Plan

Recognition of the shortcomings of the Department of City Planning's initiatives for Red Hook demonstrates the importance of public-

private partnerships in the interest of achieving flood protection goals. Although some of the plans suggested by HR&A Advisors, Inc won't be completed in the short term, like the construction of new public housing buildings, others like flood protection for Van Brunt Street are certainly feasible. The combination of public and private short and long-term goals is undoubtedly the best way to achieve goals of protecting a neighborhood like Red Hook from flooding while preserving its unique built and social character. BIG TEAM, another design team that is participating in the Rebuild by Design program also recognizes the vulnerabilities of Red Hook and offers some generalized solutions for its protection. They call for the need to "retrofit existing buildings, harden and diversify critical infrastructure and revitalize commerce"(RBD 2013). These goals would be achieved through the implementation of a Resilient Community District (RCD) strategy that would deeply engage local residents. The RCD would further the design team's goals of creating "spectacular public waterfront parks…substantial new affordable housing and…enhanced transit connections to job centers of Downtown Brooklyn and Lower Manhattan…"(RBD 2013).

Public initiatives from the Department of City Planning and private design team efforts demonstrate a commitment to the waterfront in terms of flood protection and preservation of existing communities. New York can be protected from flooding without inundating the city with a disruption of another kind, giant floodwalls and levees. Analysis of these plans also shows that a discussion of Northern Brooklyn in the context of flood protection for the whole city is of importance, but not the priority. The Northern Brooklyn waterfront experienced significant damage but was relatively unscathed when considering areas like Far Rockaway, Breezy Point and Coney Island. Indeed over the next decade many of the flood protection initiatives advocated by the DCP, SCAPE, BIG TEAM and HR&A will be implemented, but those for the most

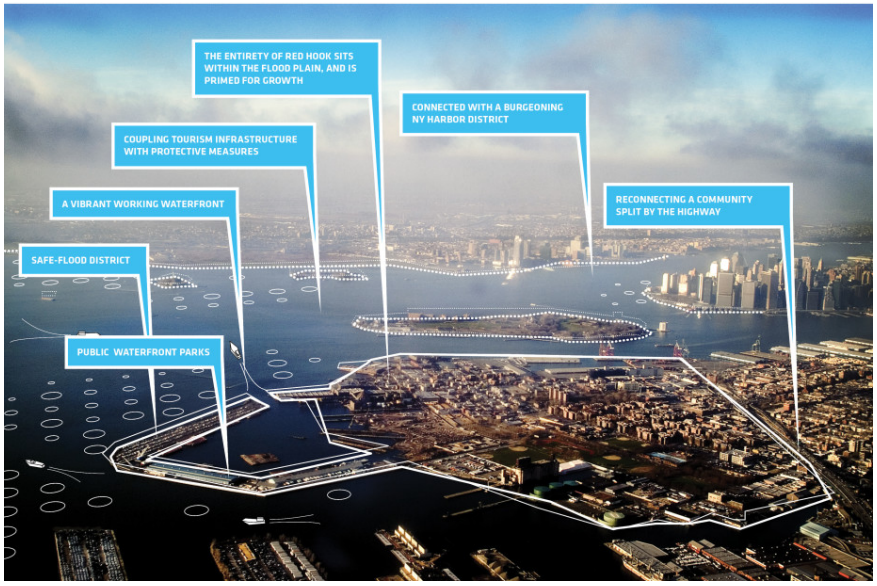

Figure 5.4: BIG TEAM Red Hook Plan

vulnerable areas unsurprisingly get priority. As the DCP writes early in *A Stronger, More Resilient New York*, there simply is not enough money to do everything the Department wants to immediately, and because of this some areas must be prioritized. Other areas are certainly not forgotten, but short-term climate change realities force our hand in consideration of which neighborhoods will receive aid first.

CHAPTER 6: CONCLUSION

Perhaps one of the best lessons we can learn from the research presented in this thesis is that often times New York City has protected itself from flooding without necessarily realizing it was doing so. Consider Battery Park City or Northern Williamsburg where thousands of people were spared from the worst of Sandy's wrath because of built elements located right in harm's way. Indeed waterfront esplanades, parks and modern buildings built closer and closer to the water are a theoretical hazard. However a few positive examples from Hurricane Sandy prove that flood protection and everyday built improvement inherently go hand in hand. Hurricane Sandy has provided us with an opportunity, to not only protect New York from the inevitability of extreme weather but to improve the social and built character of our city along the way. *Flood resilient design is not a one sided discussion about concrete walls and massive floodgates, it is a conversation about how a park bench or waterfront park can stop waves and serve vital recreational purposes too.*

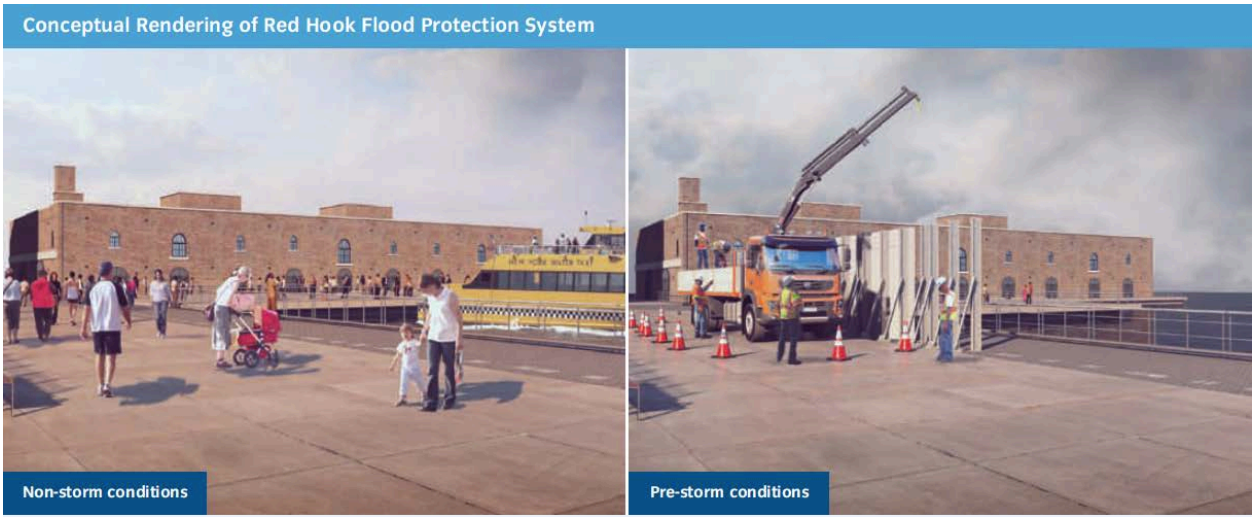

Figure 6.1: Integrated Flood Protection

The second chapter of this thesis paper provided a historical precedent for a contemporary discussion of modern waterfront development and extreme weather vulnerability. Perhaps the most important legacy of four centuries of commercial and industrial development

along the waterfront is the hardened edges they created to serve their needs. Wetlands and marshes that formed an important part of New York's aqueous ecology were filled in and therefore compromised in their ability to protect the shoreline. The storm surges and waves from Hurricane Sandy reached the New York waterfront at full strength because there were no natural or artificial elements standing in the way. When confronted with a hardened edge, like those that ring much of Manhattan and Brooklyn, the water easily topped bulkheads and flowed freely into the streets, basements and subway stations of the city.

Early in this thesis I try to understand the history of the New York waterfront and why development since the early 19th Century rendered the city so vulnerable to extreme weather like Hurricane Sandy. An interrogation of waterfront history, which centered on industrialization, deindustrialization and hardening edges, also elicited some exciting revelations about the strengths of New York's vast coastline. One of those strengths is Battery Park City, the late 20th Century residential and business development that escaped Sandy relatively unscathed. Battery Park City demonstrated the protective power of esplanades and parkland, proving that building close to the water doesn't necessarily have to be a risky endeavor. Turning now towards Chapter 3 and contemporary development particularly in Brooklyn, developments on the waterfront there also proved to be resilient in the face of the storm.

Along the Northern Brooklyn waterfront, the Williamsburg Edge development and numerous others that have sprung up in recent years appear to be located directly in harm's way. However, compared with other waterfront parts of Brooklyn, the Williamsburg neighborhood fared particularly well in no small part because of the density of development along its shore. Waterfront esplanades that were constructed in connection with residential developments actually broke the powerful waves of the East River during the storm, turning a potential liability

into a surprising strength. In the context of the large scale and lucrative development that has occurred along the waterfront in recent years, the flooding from Hurricane Sandy could have served a deadly blow. Instead, design considerations for leisure activity proved to be important flood prevention elements that now serve as an example for future developments about how their investment can be protected. Hurricane Sandy doesn't mean we have to retreat from the water, it just highlights the need for thoughtful waterfront design that puts flood protection at the forefront of developmental considerations.

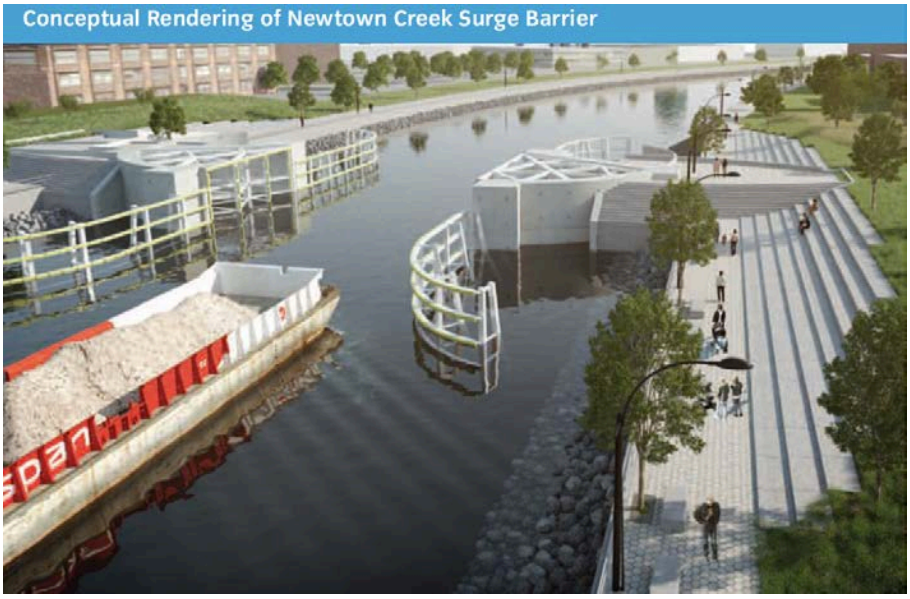

Figure 6.2: Newtown Creek Rendering

The extent to which New Yorkers have embraced the parks, kayak clubs and other waterfront activities of the 21st Century pays homage their love of the waterfront. For the better part of the second half of the 20th Century, the waterfront was an assemblage of crumbling infrastructure, toxic waste sites and chain-link fences. Highways were built and proposed where chess tables, flowerbeds and bike paths should have been. Today and for the past decade, New York has been making significant strides towards the creation of the leisure waterfront New Yorkers want and deserve. Complicating this renewed waterfront rapport is the realities of climate change, made painfully apparent by Hurricane Sandy. New Yorkers want to keep utilizing all the waterfront has to offer, which makes efforts to fortify the shore in unobtrusive ways so important.

Hurricane Sandy caused unprecedented damage throughout the New York City area. Not only did 43 New Yorkers perish in the floods and fires, but also hundreds of thousands of others suffered from infrastructural failure, property damage and from a feeling of insecurity in their homes and places of work. When Hurricane Sandy flooded 51 square miles of New York, killed power to all of Lower Manhattan and caused $19 billion in damage in the city alone, an utter lack of preparedness was revealed. Author May Joseph, a resident of Greenwich Village in Manhattan who suffered personal hardship as a result of the storm had harsh words for New York and the way it handles disaster. She writes, "New York…is inexcusably behind the times when it comes to being prepared for climate change. For a city of its scale and import, it has little to offer the world, regarding how cities can improve their infrastructure. Instead, New York is an example of environmental hubris"(Joseph 2013, 205-6). This is one of the most damning assessments of the city; one that cuts to the core of everything New York thinks it is and aspires to be.

Joseph comments elsewhere in her book, "Hurricane Sandy marks a major turning point in New York City's history, equivalent in seismic shift to the impact that 9/11 wrought upon the city" (Joseph 2013, 2). Indeed the way New Yorkers think has been fundamentally altered by the deadly and damaging impact of Hurricane Sandy. Everything that is built or invested in must be done so with careful consideration of the inevitabilities of future extreme weather events. All indications from climate scientists, insurance calculations and damage projections point to an increase in the extent of damage future storms will cause. Swiss Re estimates that $1.7 billion in damage today will be $4.4 billion by the year 2050 as a result of rising sea levels and increased storm frequency (DCP 2013, 35). According to the Department of City Planning, one dollar invested in flood prevention today will see a four-dollar return. On both a personal level, as

Joseph provides, and a statistical level offered by Swiss Re and the DCP, there is incredible impetus for investing in thoughtful and effective flood resilience measures now.

While this thesis goes to great lengths to the assess the damage and shortcomings of New York when faced with extreme weather events like Hurricane Sandy, it is also mindful of the city's incredible strengths that the storm exposed as well. Those strengths include the parts of the waterfront like Battery Park City that managed to survive the storm due to superior design and higher elevations. Those strengths also include the built elements of the Brooklyn waterfront that repelled floodwaters and protected inland areas beyond their intended use. Beyond the level of infrastructure however lies perhaps the city's greatest strength in the face of extreme tragedy, New Yorkers' sense of community, civic pride and dedication to the city. While Joseph was angry and dismayed by New York's lack of preparation to deal with Hurricane Sandy, she was also overwhelmed by the kindness of fellow New Yorkers. She admits being struck by the "extraordinary social cohesiveness of friends and strangers from across New York who…offered solace in the desolate underworld of disaster" (Joseph 2013, 210).

It is this sense of community that excites Alexandros Washburn, former head of design for the Department of City Planning and a resident of Red Hook. In his neighborhood, one of the hardest hit, a makeshift pizzeria was set up on the street. Neighbors helped each other in the aftermath of the storm in inspiring ways in Red Hook and elsewhere. Writing about the Red Hook Houses, journalists Cara Buckley and Michael Wilson painted an unpleasant picture of living conditions in public housing after the storm. More importantly however is the numerous neighborly acts they reported on as well. They write, "The residents cooked for each other, eager to not waste food that was thawing fast…there was an impromptu outdoor barbecue for 25 people, with hamburgers, frankfurters and ribs sizzling on grills" (Buckley, Wilson 2012, 2). Eric

Klinenberg, professor of Sociology at New York University found when studying heatwaves in Chicago, “networks of social cohesion are vital to surviving extreme events…”(Washburn 2013, 185). As these few example show, this was certainly the case in New York after Sandy.

Washburn writes in his book, “Much of the recovery effort since the flood has been focused on just getting back to where we were. And where we were was unprotected…We have to change”(Washburn 2013, 199). However we can’t respond by walling ourselves in. Flood resilient design in New York has to take into account the unique built and social character of the city that makes it worth saving. We can build massive, unsightly floodgates and propagate a city as fortress mentality, but likely at the cost of the neighborhood atmosphere and community tightness New York fosters. For this reason, this thesis advocates flood resilient design plans that are integrated into the existing built and social fabric of the city. Beyond integration and continuation, flood resilient design can be harnessed to improve the city during non-storm conditions.

Figure 6.3 Relief Efforts in Far Rockaway

The Northern Brooklyn waterfront is a microcosm for the larger conversation regarding flood resilient design in the whole city. There we see a combination of hi-tech strategies, like the floodgate at the mouth of the Newtown Creek and more local, lo-tech elements like improved

parks in Red Hook. A closer look at Red Hook shows a concerted effort to protect the neighborhood in ways that improve living conditions both in normal and extreme weather conditions. A Rebuild by Design proposal by the firm HR&A suggests improving transit corridors between geographically isolated Red Hook and the rest of Brooklyn. Better connections could prove vital in an extreme weather situation because residents could evacuate safely if needed and rescue workers and supplies could reach the neighborhood faster. Better connections with the rest of Brooklyn would also markedly improve the lives of Red Hook residents and business owners the majority of the time when extreme weather is not an imminent concern.

Washburn writes in regard to resiliency and sustainability efforts in Singapore, "Projects engineered to make the city more sustainable are designed also to make the city more livable" (Washburn 2013, 194). *Therein lies perhaps the most important goal planners, architects and government officials should hope to achieve when contemplating how to protect the city from flooding, resilient designs that benefit the city in extreme and normal conditions.* Hurricane Sandy was both an incredible tragedy and an incredible opportunity, but only if New York improves rather than just returns to where it was. If we look only to protect the city from flooding, we risk damaging the built environment, neighborhoods and communities that are the city's greatest strength. Therefore we are compelled to build and design flood resilient measures that improve the lives of residents and business owners on a quotidian basis.

REFERENCES CITED

Ambrose, Nicole, Jason Crowley, and Ward Dennis. "Overall History - Brooklyn/Queens Waterfront." *Overall History - Brooklyn/Queens Waterfront*. Historic Preservation Program at Columbia University GSAPP, n.d. Web. 23 Feb. 2014.

Bagli, Charles V. "Plan to Redevelop Brooklyn Sugar Factory Hits Snag: De Blasio."*The New York Times*. N.p., 27 Feb. 2014. Web. 6 Apr. 2014.

Baker, Kevin. "City of Water." *The New York Times*. N.p., 12 Oct. 2013. Web.

Bergdoll, Barry. *Rising Currents: Projects for New York's Waterfront*. New York: Museum of Modern Art, 2011. Print.

Bone, Kevin, Mary Beth. Betts, and Stanley Greenberg. *The New York Waterfront: Evolution and Building Culture of the Port and Harbor*. New York: Monacelli, 1997. Print.

Buckley, Cara, and Michael Wilson. "In New York's Public Housing, Fear Creeps In With the Dark." *The New York Times*. N.p., 2 Nov. 2012. Web.

Buttenwieser, Ann L. *Manhattan, Water-bound: Planning and Developing Manhattan's Waterfront from the Seventeenth Century to the Present*. New York: New York UP, 1987. Print.

Cope, Nick. *Assessing the Red Hook Flooding*. 2012. New York. *Brownstoner*. Web. 25 Mar. 2014. <http://www.brownstoner.com/blog/2012/10/assessing-the-red-hook-flooding/>.

Dunlap, David W. "A Modern Flood Barrier Aims to Protect Verizon's Landmark Building." *The New York Times*. N.p., 30 Oct. 2013. Web.

Flegenheimer, Matt. "For Subway Riders, Fallout From Hurricane May Last Years." *The New York Times*. N.p., 28 Oct. 2013. Web.

Fountain, Henry. "Natural Allies for the Next Sandy." *The New York Times*. N.p., 28 Oct. 2013. Web.

Gastil, Raymond. *Beyond the Edge: New York's New Waterfront*. New York, NY: Princeton Architectural, 2002. Print.

Gill, John Freeman. "In Canarsie, a Coalition of the Tried and True." *The New York Times*. N.p. 8 Oct. 2013. Web.

Godfrey, Brian J. 2001. "Redeveloping the Manhattan Waterfront." *From the Hudson to the Hamptons: Snapshots of the New York Metropolitan Area,* pp. 49- 60, edited by I.M. Miyares, M. Pavlovskaya, and G.A. Pope. New York: Association of American Geographers.

Godfrey, Brian J. “Waterfronts of New York State.” *New York State Encyclopedia,* ed. Peter Eisenstadt and Laura-Eve Moss, Syracuse University Press, 2005, 1670-1672

Higgins, Andrew. "Lessons for U.S. From a Flood-Prone Land." *The New York Times*. N.p., 14 Nov. 2012. Web.

Joseph, May. *Fluid New York: Cosmopolitan Urbanism and the Green Imagination*. Durham: Duke UP, 2013. Print.

Louie, Elaine. "Three Feet High and Rising." *The New York Times*. N.p., 30 Oct. 2013. Web. "Rebuild by Design: Innovating Together to Create a Resilient Region."

New York City Department of City Planning. *A Stronger, More Resilient New York*. NYC Special Initiative for Rebuilding and Resiliency, 11 June 2013. Web.

New York City. *PlaNYC 2030*. By Michael Bloomberg. N.p., 31 Dec. 2013. Web. 23 Feb. 2014.

Orff, Kate. Reviving New York's Rivers - with Oysters Dec. 2010. *Kate Orff: Reviving New York's Rivers*. Web. 06 Apr. 2014. <http://www.ted.com/talks/kate_orff_oysters_as_architecture?language=en>.

Rebuild by Design: Innovating Together to Create a Resilient Region. Department of Housing and Urban Development, n.d. Web. 23 Feb. 2014.

Schuerman, Matthew. "Bloomberg's Waterfront Development Comes Under Scrutiny from Sandy's Impact." *WNYC.org*. N.p., 5 Dec. 2012. Web. 23 Feb. 2014.

Schuerman, Matthew. "New York, the Vertical City, Kept Rising Under Bloomberg."*WNYC.org*. N.p., 8 July 2013. Web. 23 Feb. 2014.

Sullivan, Robert. "Could New York City Subways Survive Another Hurricane?" *The New York Times*. N.p., 23 Oct. 2013. Web.

Washburn, Alexandros. *Nature of Urban Design: A New York Perspective on Resilience*. Washington: Island, 2013. Print.

Yee, Vivian. "At Brooklyn’s Domino Sugar Site, Waning Opposition to Prospect of Luxury Towers." *The New York Times*. N.p., 16 Oct. 2013. Web.