ABSTRACT

Title of Thesis: Revival Through Resilience: Small Craft Harbor Design Within a Coastal Urban Community

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Coastal communities along the Mid-Atlantic shoreline are facing difficult decisions moving forward into the 21st Century. The Rockaway Peninsula exemplifies many issues urban coastlines are facing. Environmental degradation, historic urban infill and development, a stagnant economy, rollercoaster historic past, and aging infrastructure, are only a few dilemmas communities along the Rockaway Peninsula are dealing with in the wake of the most current natural disaster that has left many questioning the future development of the area. This thesis explores what roles a Small Craft Harbor (SCH) could function as within an urban setting along the Atlantic coastline. The project will offer suggestions as to how programmatic elements within SCH development along the back bay shoreline of the Rockaway Peninsula, could serve to protect and enhance not only the human communities residing on the peninsula, but ecological systems fighting for survival within the back bay waters of the Jamaica Bay.

REVIVAL THROUGH RESILIENCE: Small Craft Harbor Design Within a Coastal Urban Community

by

Travis Wierengo

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CHAPTER 1: INTRODUCTION

COASTAL URBANIZATION IN THE MIDST OF CLIMATE CHANGE

Coastal communities along the Mid-Atlantic shoreline are facing difficult decisions as they move forward into the 21st Century. Human populations continue to migrate into urban environments along coastal landscapes, where human development located in flood prone low elevated areas, are placed at risk. In 2000, around half the United States population lived in coastal areas; at densities five times greater than those of non-coastal areas; and continues to grow three times faster than areas elsewhere. Along the Atlantic coast alone, almost sixty per cent of the land within a 3.5 feet of sea level, is planned for further development. Add to this equation an average expected Sea Level Rise (SLR) of 1.5 feet by 2070, and the results would more than triple the number of people exposed to coastal flooding. New infrastructure and capital improvements need to seriously consider ways to ameliorate these concerns through resilient building practices. Environmental ecosystems are strained by previous land uses, while financial budgets, both private and at the municipal levels, search for funding in order to support and replace outdated infrastructure in these areas.

The Rockaway Peninsula exemplifies issues many urban coastlines are dealing with as a result of these issues. Historical environmental degradation, urban infill and development, a stagnant economy, and susceptible aging infrastructure in the wake of damage incurred by the most current natural disaster, has significantly depressed prosperity within the area. The devastation delivered by Hurricane Sandy in 2012, opened eyes into the antiquated flood zone maps, and exposed infrastructure residing along the 524 miles of shoreline within the New York City (NYC) limits. The Rockaway peninsula, occupying the only oceanfront land area within NYC, found itself at the frontline of this destruction.

During Hurricane Sandy, peak storm surge reached 10 feet and coincided with high tides, elevating water heights even further. Since 1900, sea levels have risen 1.1 feet in the New York City area. This equates to 1.2 inches per decade, and is nearly twice the observed global rate of sea level rise (SLR) of .7 inches per decade, over a similar timer period. Forty-five percent of this observed SLR is due to land subsidence.[1] Higher sea levels are extremely likely to continue, with an anticipated rise from 12 - 55 inches by 2080.[2] As a result, coastal flooding is very likely to increase in frequency, extent, and water height.

For the Rockaway area in particular, this description provided within NYC's December 2012 Special Initiatives for Rebuilding and Resilience (SIRR) report, illustrates the destructive forces unleashed upon the peninsula by Sandy:

> "Waves struck the Peninsula's coastline, smashing houses, splintering large sections of boardwalk, causing widespread flooding, and washing away or thrusting onto neighborhood streets and properties at least 1.5 million cubic yards of beach sand. The storm surge pushed through Rockaway Inlet, overtopping

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[1] New York City Panel on Climate Change, *Climate Risk Information 2013: Observations, Climate Change Projections, and Maps,*, (C. Rosenzweig and W. Solecki, 2013), NPCC2. 8

[2] NYSERDA ClimAID Team. 2010. Integrated Assessment for Effective Climate Change Adaptation Strategies In New York State. (C. Rosenzweig, W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grabhorn, Eds New York State Energy Research and Development Authority.

bulkheads and seawalls throughout the Bay and bringing significant inundation to many bay-lining neighborhoods. Though the storm brought hardship to many parts of New York, it was particularly devastating for this area. Although rebuilding in South Queens is well underway as of the writing of this report, it is clear that simply restoring what existed in these neighborhoods before Sandy's arrival is not enough. As the climate changes, this area's vulnerabilities will only grow. Most of the destruction brought by Sandy to these neighborhoods was, directly or indirectly, attributable to the huge volumes of water that inundated the area. From the Rockaway Inlet, the surge spread throughout Jamaica Bay, overtopping deteriorated seawalls and bringing floodwaters into neighborhoods from that direction as well. As a result, at these and other points along the Peninsula the "ocean met the bay," with flood heights reaching as high as 10 feet. Bay-facing peninsula neighborhoods were deluged, including Somerville *(Project site location)* and Edgemere. There, low-lying land and soft soil conditions, together with already eroded coastal conditions, allowed Sandy to undermine existing bulkheads, leaving homes virtually

unprotected from the storm's waters."[3]

Outlined by the New York Panel on Climate Change (NCCP2) committee within the *Special Initiative for Rebuilding and Resiliency* report addresses this area's vulnerability to storm surge and rising sea levels by limiting oceanfront and bayside exposures to floodwaters, and facilitating the rebuilding and retrofitting of buildings and infrastructure in a more resilient fashion to protect more efficiently. The plan also builds on the areas natural assets, local economic strengths, and community spirit to encourage reinvestment in its waterfront communities. This is an attempt for the communities to come back stronger after Sandy and become better prepared to confront a future of growing risks.

[3] New York City, Special Initiative for Rebuilding and Resiliency, *A Stronger More Resilient New York*, (PLANYC, 2013), 304.

This attention has created a multitude of recently published documents suggesting new plans, initiatives, and strategies for planners and designers involved in projects located in risky low-lying areas (FIGURE 1). Among these, Mayor Bloomberg convened the second New York City Panel on Climate Change (NPCC2) in January 2013, to provide up-to-date scientific information and analysis on climate risks for use in the Special Initiative for Rebuilding and Resiliency (SIRR).[4]

FIGURE 1. Collection of NYC Plans, Initiative, Strategy Reports (Wierengo)

For this reason, the subject of coastal resilient design defending against SLR and the associated increased risk of frequent flooding was executed to better understand protective design strategies the Rockaways, and other Mid-Atlantic coastal communities could implement when deciding future land development. A quantitative basis for sea level elevations and timeline scenarios were gathered in order for the design to protect against not just existing flooding measurements, but anticipated changes and resulting problems.

SMALL CRAFT HARBORS

Part of thoughtful design includes the ability to look forward in time, and deduce a basic understanding of the potential needs of future populations who will inhabit the landscapes in which a design will live. The challenge not only rests in understanding human needs, but also the environmental and climatic contexts of the future. In 1960, Garrett Eckbo warned "the most important issue that faces all landscape architects, environmental planners, and designers in the twenty-first century will be precisely the integration, perhaps by shotgun, of current economic and political thinking with ecological reality"[5]. This is especially the case for Small Craft Harbors (SCHs), due to their location requirements within the dynamic landscapes along the littoral edges of terra firma and terra infirma.

This report relies upon the definition used by the American Society of Civil Engineers to define a Small Craft Harbor (SCH) as geometrically extending well beyond the bounds of the small body of water in which a boat sits. It includes the waters outside the harbor, the waters inside the harbor, and the landside programming existing along the shoreline[6]. A transition within the developmental uses of SCHs from independent land uses, to amenities within larger mixed use

[5] *Climate Design, Design and Planning for the age of climate change,* AECOM, Publishers Group West, 2010, Print. 12

[6] *Planning and design guidelines for small craft harbors*. 3rd ed. Reston: American Society of Civil Engineers, 2012. 1. Print.

developments during the economic recession the United States economy experienced beginning around 2009, corroborates with additional research, suggesting the number of roles SCH's need to preform as today and in the future, are multiplying in response to increased popularity in water related activities, environmental stresses, limited quantity of appropriate site locations, changing climatic conditions, and the increasing public's desire for access to the water[7].

Questions regarding previous marina development along shorelines have been faced with great skepticism, due to the belief they will result in degradation to the ecology and landscape, become responsible for point source pollution, and eventually become an economic burden in the event of damage and repair, resulted from the harsh climate conditions and frequent storms[8]. Historic precedents provide evidence that an ill-equipped and misguided design of a SCH, could fulfill these negative accusations, but there is also research and data through new marina initiatives to support the contrary.

Over recent years, sets of guiding principles have been layout to aide the development of SCHs, and promote a thriving landscape on multiple levels. Two documents: the 1993 *Guidance for the Coastal Non-point Program* (CNP) issued by the US EPA (updated in 2001), and the 2012 National Parks Service *Clean Marina Guidebook*, have created a new sustainable movement visible within the

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[7] *Planning and design guidelines for small craft harbors*. 3rd ed. Reston: American Society of Civil Engineers, 2012. Print.

[8] "Environmentally Compatable Marinas: The major issues that need to be addressed in designing new and retrofitting existing marinas." *Planning and design guidelines for small craft harbors*. 3rd ed. Reston: American Society of Civil Engineers, 2012. 49-58. Print.

Marina Industry. Statewide *Clean Marina* initiatives promote sustainable design and management practices associated with SCH development. Strategies stated within these documents, suggest local ecology can actually become enhanced by habitat creation; shorelines and erosion issues can boost water quality and inhibit stormwater contamination; while the community is granted access to the water and local natural resources and the local economy can boost tax revenues generated by water related activities[9].

In order to better understand how the development of a SCH on the Rockaway Peninsula could benefit the community and landscape, research was conducted to comprehend existing design principles used in creating this type of land-use. Existing knowledge and guiding principles regarding the layout and configuration of SCH's were identified, and then further analyzed for additional functions a SCH could potentially serve to operate as within an urban coastal environment. These additional functions were in direct response to problems and concerns the Rockaway community has expressed through public meetings including water quality, resiliency against flooding, public access to water, economic and commercial opportunities, and community identity. The author reviewed published initiative plans, citywide planning documents, and minutes/video recordings of meetings involving the Rockaway community's desires, regarding storm resiliency, public access to the bay's waters, and economic incentives in order to gain this knowledge base.

[9] United States, National Parks Service, *Clean Marina Guidebook,* March 2012

PROJECT GOALS AND OBJECTIVES

Goals and objectives for this project are centered on the implementation of a SCH and its associated programming, coupled with resilient design strategies and guiding principles common within the discipline of landscape architecture, in an attempt to provided not only infrastructure that protects the existing coastal community residence, but also establishes integrated systems that promote: (a) connections and access to the water; (b) a thriving commercial opportunities; and (c) aides the revitalization of strained ecological systems in an anthropogenic urban environment. To achieve this outcome, the question this project's research works to provide answers to, is:

1. How coastal resilient design infrastructure function on integrated levels to not only provide reasonable protection to a coastal community, but enhance the character of the landscape and way of living?
2. What potential benefits, in addition to the traditional harboring of pleasure craft, can a Small Craft Harbor provide the residents living along an urbanized coastline?

Research into Small Craft Harbor design and resilient design strategies, reveals many similarities between their infrastructure typologies and application. The objective for the culminating design, is to illustrate one example of how existing research and data available to designers, can encourage designs that efficiently use resources and shorelines to encourage safe and prospering coastal communities for residence who believe the benefits of coastal living outweigh the looming risks associated within this dynamic landscape and climate change hazards.

CHAPTER 2: ROCKAWAY'S HISTORIC CONTEXT

INTRODUCTION

From early development, until present, the Rockaway area has had to contend with its distant location from the rest of the New York City Metropolis, looking to leverage whatever resources were available to its communities, in order to encourage economic prosperity and survival. Many of these efforts revolved around water-related tourism and leisure activities.

After analysis of historic events and development trends, three(3) key takeaways became evident, which could benefit design decisions.

(1) Evidence supports a direct correlation between improved access to the area via public and private transportation corridors, and the prosperity of the area. Advancements in transportation technology did not necessarily always benefit this area, and proved during certain times in history to spell trouble for the peninsula. These historic connections between the Rockaway Peninsula and the rest of the Greater City of New York can provide important information of how certain design and planning decisions today, could affect the future success or demise of the coastal community. Although a complete analysis of the elaborate public transit systems in place today, and the matrix of vehicular highways are beyond the scope of this project, a clear understanding of when, and why these transportation corridors were created, was understood in order to inform how the

project’s design can utilize and connect to these modes of transit, in order to strengthen and promote the use of the site for all New York residence.

(2) The historic context also reveals the dichotomy of building types still present in the area, and the current demographic composition. A comprehensive analysis reveals time periods and reasons for certain architectural types, and informs the design of possible successful building typologies that can become implemented within the design, to enhance the unique character and culture of the Rockaways. Historic housing developments and township incorporations surrounding this projects site, such as the Arverne-by-the-Sea, and the Hammels Public Housing, continue to illustrate and represent the diverse residential communities and cultures that took root around the site during different historic periods. Some of these micro-communities came by choice; others were forced into the area. In either case, the design needs to encourage use by all current residence surrounding the site.

(3) Understanding of how settlements along the peninsula interacted with the surrounding bodies of water proves the unbreakable bond between the culture of the communities and the surrounding waters. The design for this project can understand repercussions of previous land uses that degraded the water quality and inhibited a healthy aquatic ecosystem, and serve to rectify previous land uses and community perceptions towards their aquatic backyards. The efforts of early developers to fill in marsh land along the bayside coastline in

order to expand the available space for building, ultimately placed residence and infrastructures in extremely vulnerable areas. What was once historic wetland shorelines protecting the higher grounds first built on, are now home to residential and commercial property. The natural watershed of the bay has transformed into a ‘sewer-shed’ as a result of urban expansion.

Not only did this historic development compromise the safety of residences, but it also constricted the natural ability for the Jamaica bay waters to flush and filter contaminates. This project along with other developments along the shorelines, need to aide in the recovery and resilience to offset the detrimental decisions that have left the waters crippled. Elements along the shoreline need to promote water quality and resilience against flooding; in essence, act as the original land-use (wetland) once did.

INITIAL SETTLEMENT AND EARLY DEVELOPMENT

The Rockaway area remained inhabited by local Indian tribes who used its back bay estuary to fish and collect the abundant shellfish populations, until the Dutch set up settlements in 1624; later to be taken over by the English in 1664[10]. During these early years of settlement, small patches of elevated land were used for homestead developments, while the marshlands were utilized for cattle and horse grazing. Similar to the Indians, early European settlers used the bay to harvest clams, oysters, mussels, and fish. In 1690, Richard Cornell, an

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[10] Chamber of Commerce of the Rockaways, *“History of the Rockaways”,* Rockaway Review Dec 1948

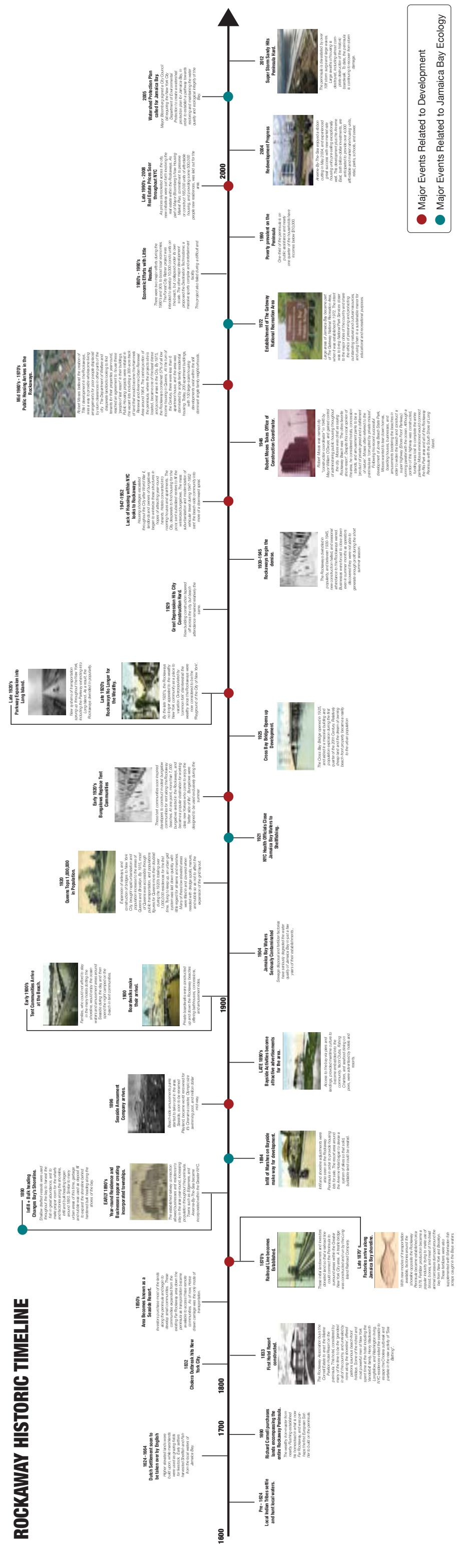
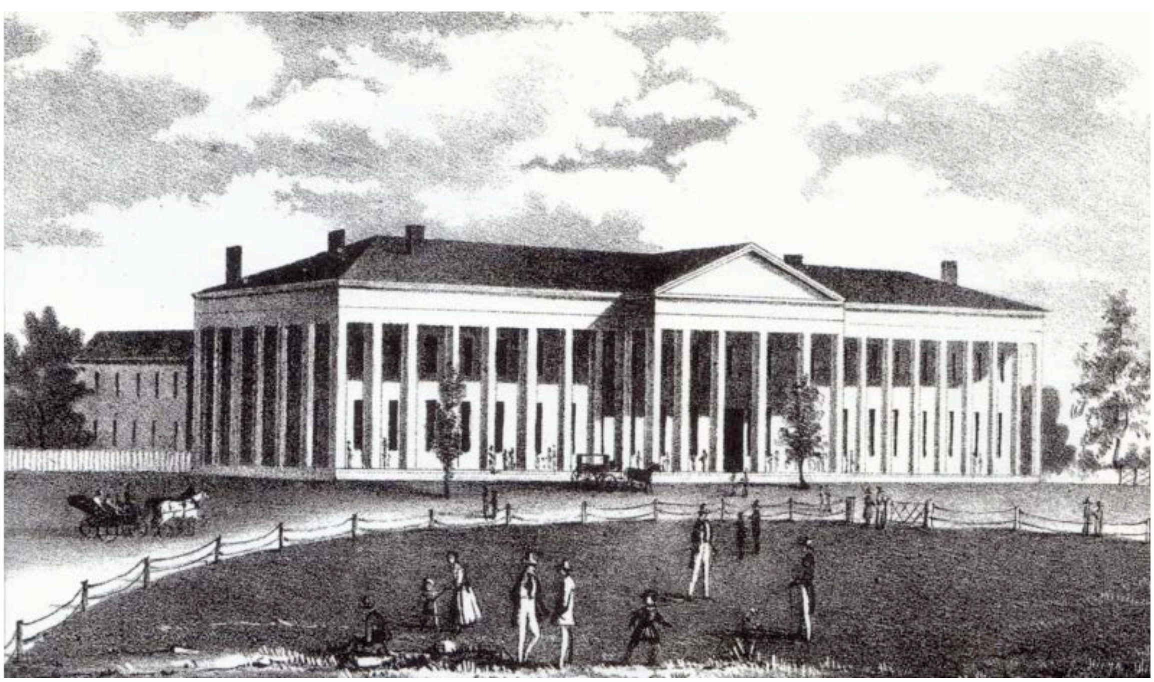


FIGURE 2. Historic Timeline of Development in the Rockaways (Wierengo

ironmaster from nearby Flushing NY, purchased lands encompassing the entire Peninsula, and built possibly the first homestead established on the Peninsula by a European[11].

Development around Jamaica Bay's shorelines began to expand in the mid 1800's. In 1833, the Rockaway Association purchased most of Cornell's homestead to construct an ocean front resort called the Marine Pavilion in what is now Far Rockaway. This hotel, considered by many of the time to be the 'grandest in all of the country, and unrivaled by none along the shoreline', offered patrons luxurious beachfront holidays. Some of the richest and most powerful men of New York spent time at the hotel including the Vanderbilt family, Henry Wadsworth Longfellow, and Washington Irving. These men traveled to the hotel to partake in the featured new activity of 'sea-bathing', and as refuge from the citywide outbreak of Cholera.



[11] Chamber of Commerce of the Rockaways, *"History of the Rockaways",* Rockaway Review Dec 1948

FIGURE 3. Marine Pavilion (Seyfried + Asadorian)

RISE OF A SEASIDE RESORT

By 1850, the area of Far Rockaway had become known as a seaside resort, and a village of hotels developed. Development moved down the peninsula slowly from its origins located in the Far Rockaway area. By the late 1850's most of the land on the peninsula was purchased in large tracks by investors. Many of the existing neighborhoods still bear these original entrepreneur's names. Transportation, from the very onset of development, has been a determining factor regarding development and economic prosperity to the peninsula. At the time, the only mode of transportation to the beach was by horse and horse-drawn carriage. This changed during the late 1870's and early 1880's, when a railroad line to the Rockaways became established.

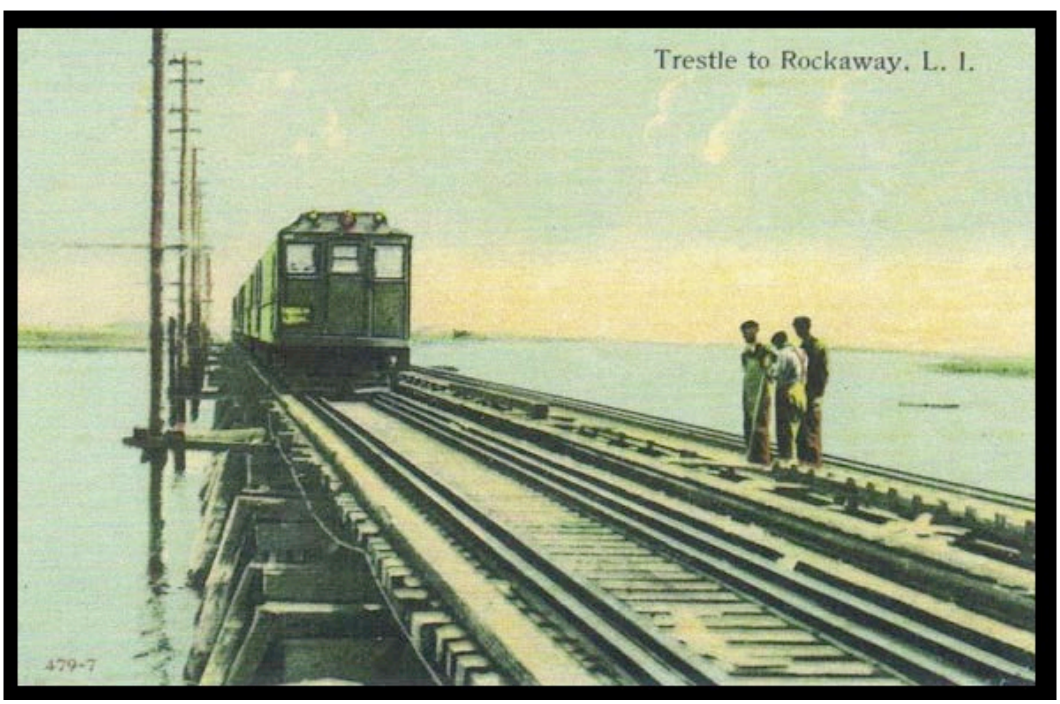


FIGURE 4. Train Bridge Still Exists Today And Runs Through The Site

Influential landowners donated land so the rail line could continue the length of the peninsula transporting visitors to the many villages developing along the coast[12]. Reliable new transportation allowed areas such as Edgemere to establish their first hotels and businesses in the 1890's. Transportation also allowed permanent settlements to become established and year-round residents to take up homes.

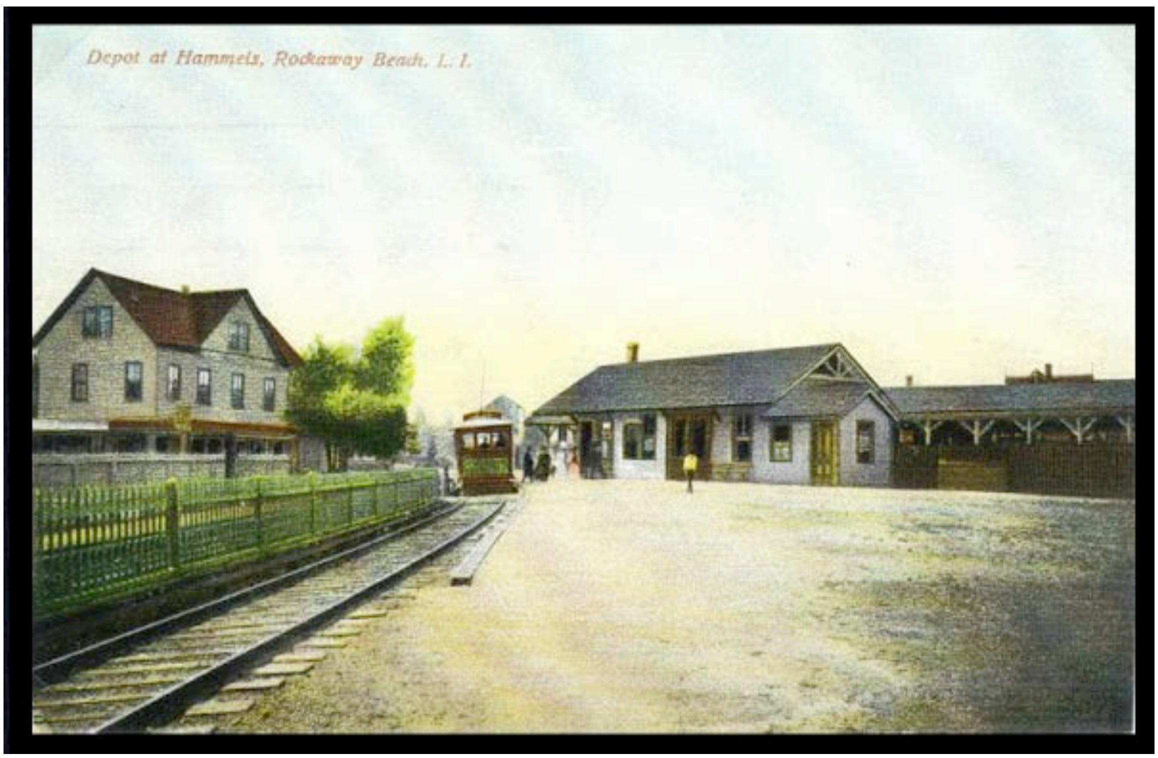


FIGURE 5. Hammels Train Depot Once Located In Projects Site

The Edgemere Hotel was erected in 1894, and was followed by the first development of Arverne-By-The-Sea in 1895. Railroad access increased land

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[12] NOTE: The peninsula at this time, did not reach much further past where the Marine Parkway Bridge exists today. The areas of Fort Tilden, and Breezy Point were groups of sandbars loosely connected through shallow waters. The peninsula has grown since this time by approximately 5 miles to the West due to infill, longshore drift, and engineered jetties and groins protecting the beaches from erosion.

values and business expanded rapidly allowing the areas of Far Rockaway, Edgemere, and Arverne-By-The-Sea to become incorporated within the City of Greater New York.

Beachside amusements parks started to take root in the area including the Seaside Amusement Company in 1896; later becoming Rockaway's Playland. Playland became world renowned for it's Cinerama coaster, Olympic size swimming pool, and million dollar mid-way.[13] Hotels advertised other recreational and leisure amenities in order to attract visitors.

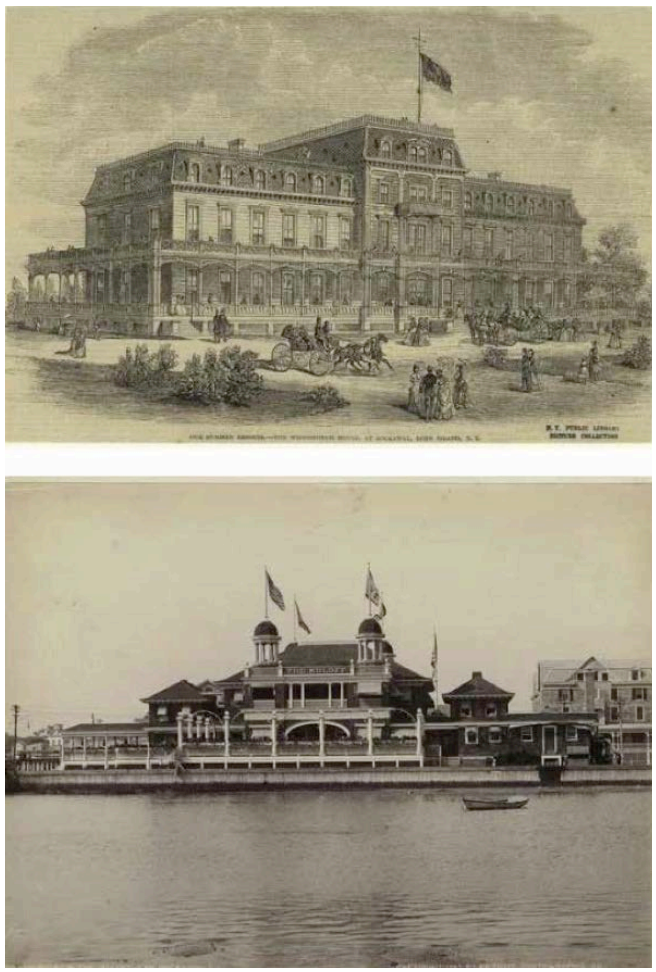

FIGURE 6. Early Hotel Architecture's Grand Appearance

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[13] *NOTE: Playland remained in business until 1985, when it could no longer compete with major regional theme parks.*

FIGURE 7. Playland Amusement Park

Arverne Hotel, circa 1901

FIGURE 8. Arverne Hotel, Circa 1901

The Arverne Hotel advertised a 'specially-constructed plank road' (pier), where a clubhouse was erected in the waters of Jamaica Bay. Here, fish dinners were served, and harbored 'two yachts 110 feet long, three yachts 70 feet long, and four 52 feet long, beside a score of cat-boats and row-boats….with competent men in attendance to await the pleasure of fishing-parties'.

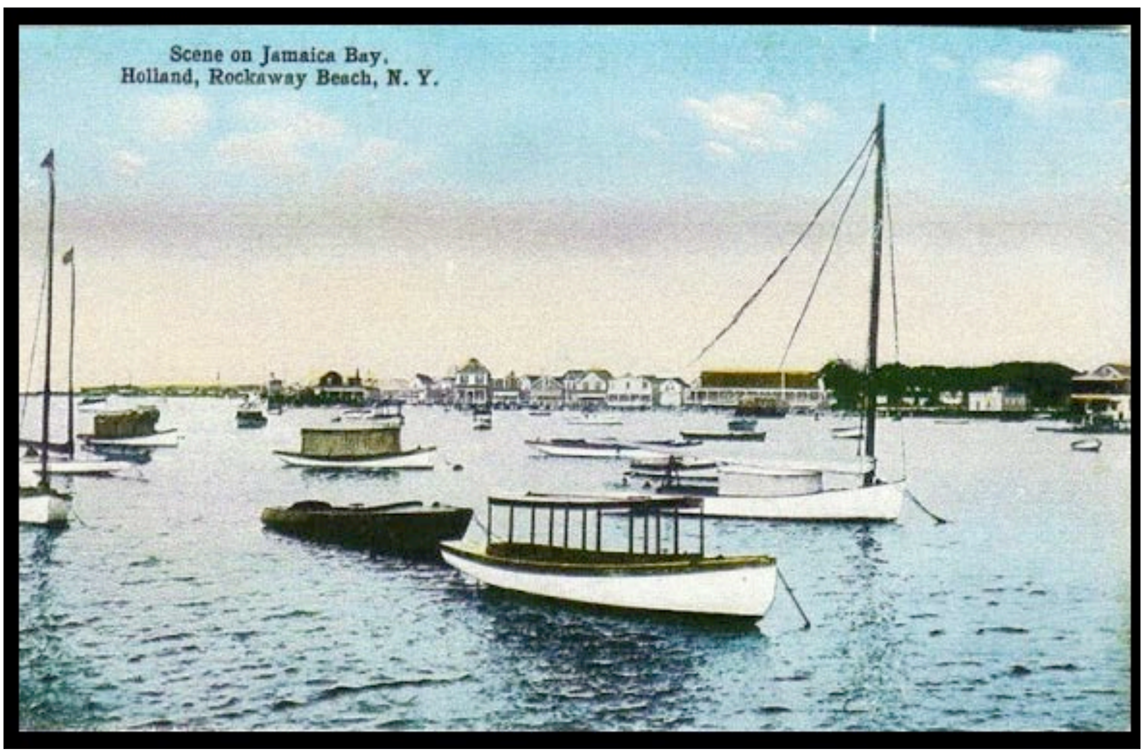

FIGURE 9.   Arverne Clubhouse In Jamaica Bay

water born activities even in the early development years of the area.

FIGURE 10. Jamaica Bay Yacht Club

This early development along the Jamaica Bay illustrates the allure of water born activities even in the early development years of the area. Access to the bay via piers and landings, provided maritime culture to become embedded into the community.

TRANSFORMATION OF JAMAICA BAY

During the middle to late 1800's, marked significant change to Jamaica Bay and it's shorelines. With new modes of transportation available, factories around the shoreline opposite the Rockaway Peninsula became established circa 1878. Fertilizer production became a popular industry trying to make use of blood, bones, and meat of the dead animal carcasses dumped around the bay from New York and Brooklyn. These fertilizers were also supplemented with Menhaden fish scraps caught in the Bays waters.

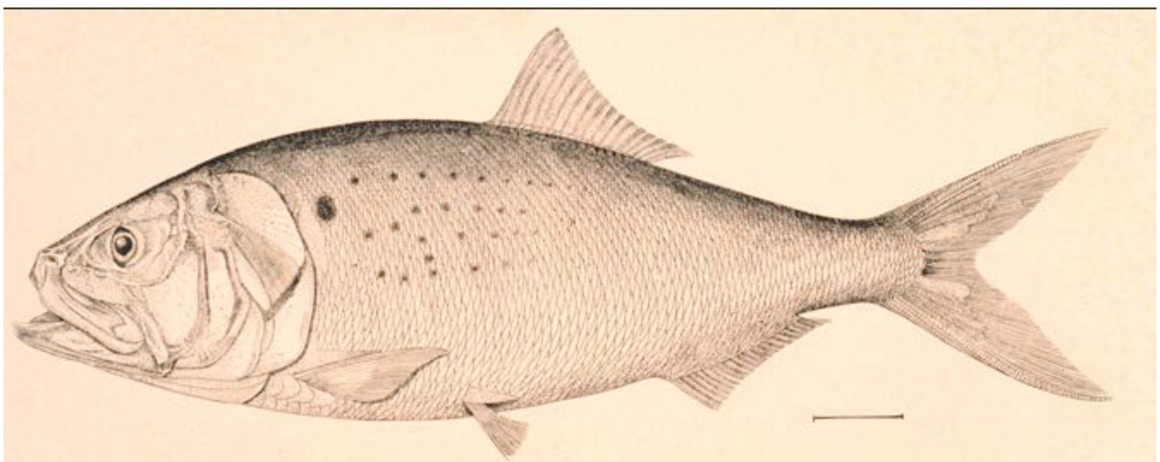

FIGURE 11. Menhaden Fished In Bay For Use As Fertilizer

Shallow drafted vessels were used throughout the bay to harvest the fish in great abundance, and to make proper room for the wharfs and factories along the shoreline, infill and bulk heading began around 1890. Similar to many urban areas of this time, garbage and rubble was used as deposit fill to expand the shoreline behind hardened bulk heading along the shores of the bay. It was the beginning of human manipulation within the bay that has affected the water flushing quality of the bay, and changed the dynamic interface between the water and shoreline.

FIGURE 12. Historic + Existing Shorelines Of Jamaica Bay

Farming was the main land use for the surrounding watershed of Jamaica Bay, prior to mass transportation advancements during the early 20th Century. Expansion of railways, and construction of bridges to New York City, brought rapid urbanization and population increase to the areas of Queens and Brooklyn. By 1915, most of Queens was accessible through public transportation, and populations figures for Queens more than doubled during the 1920's totaling over 1,000,000 residences for the first time. Trying to keep up, an urban grid system was laid down quickly, with little regard for streams and marshes. Many of these low elevated areas were filled in and covered when needed with dredge spoils, manure, and rubble so as not to affect the expansion of the grid layout.

Infill and shoreline adjustments were also seen on the Rockaway Peninsula in order to provide housing lots for sale. The resort area around the Arverne Hotel began to devise a system of dykes creating solid buildable land could be created; as evident in the account published in 1894 by Leslie's Illustrated Weekly:

> *"White sand from the beach is being spread to the depth of a foot or more over hundreds of acres of meadow land fronting on Jamaica Bay. Ditches are being dug and the dykes built up. In a few months the sand and loam will be turned over to a depth of sixteen inches by plows, and then the lawns will appear and choicest building lots be ready, dry and rich, for villas."*

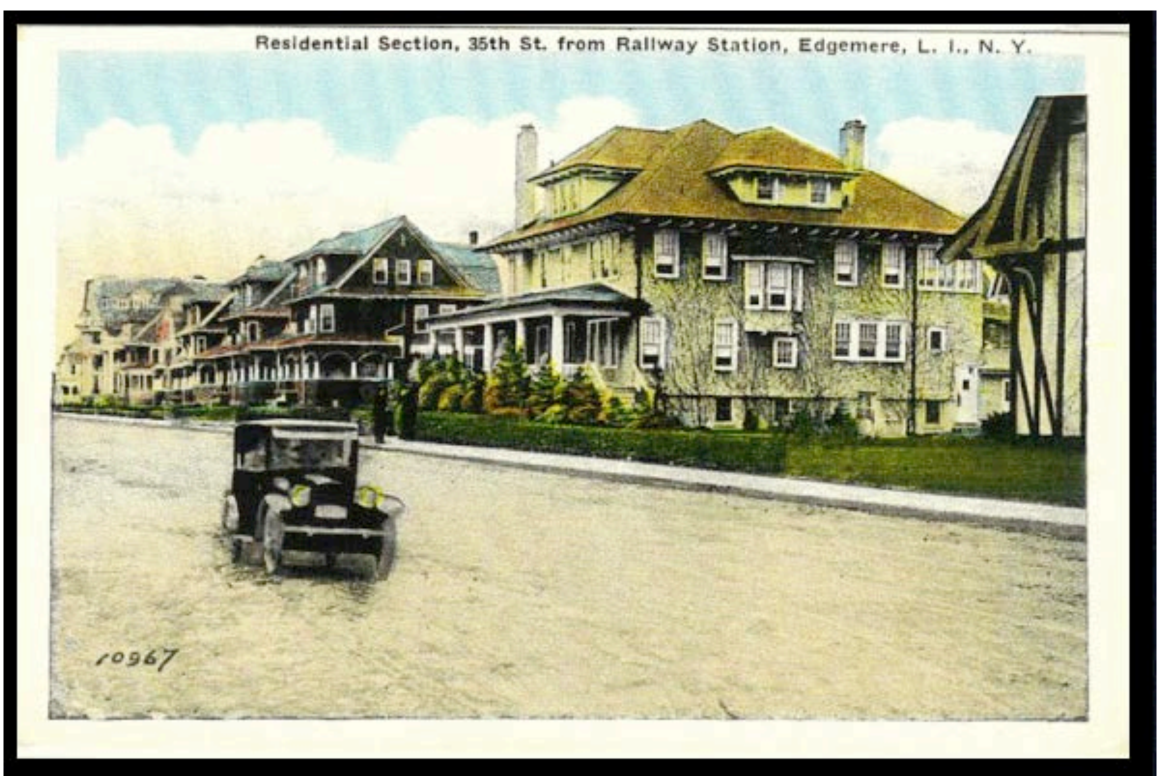

FIGURE 13. In-filled Wetlands Provided Additional Housing Opportunities

It is interesting to note the two conflicting uses of the bay at this time. Even though great efforts were made creating new areas for residential construction along the shoreline, and businesses were advertising fishing expeditions and sailing charters, the waters were also becoming extremely contaminated due to factory use and effluent discharge. Arverne Hotel, the very same establishment advertising their clubhouse, and rich lots for purchase along the bay, also boasted their sophisticated system of wastewater management: "…all the water used in the place is drawn from artesian wells, and the hotel sewage is pumped to Jamaica Bay, and discharged four miles from the hotel." These written accounts of the use of the bay indicate the long history of these waters taking a 'backseat' to the waters of the Atlantic and beachside attractions. By 1904, the waters of Jamaica Bay had become seriously contaminated, and continued their digression to the point New York Health Officials closed the shell fishing industry in 1921.

THE HEYDAY OF ROCKAWAY BEACH

During the late 1800's and early 1900's in America, seaside vacationing became extremely popular. The early part of the 20th Century saw many vacation communities constructed along the oceanfronts of Brooklyn and Queens. The Rockaways were (and still continue to be), New York City's only oceanfront community. Private boardwalks were constructed up and down the Rockaway beaches offering bathhouses, concessions, and amusement rides.

BATHING SCENE AT ROCKAWAY'S SEASIDE IN 1906

FIGURE 14. The New Activity Of Sea Bathing Brought People In Droves To Beach

FIGURE 15. Private Boardwalks Sprung Up Providing Concessions

Families, who could not afford to stay in the many hotels dotting the shoreline, would enjoy the ocean waters and amusement areas around Seaside during the day, and then spend the night camped on the beach in tent communities.

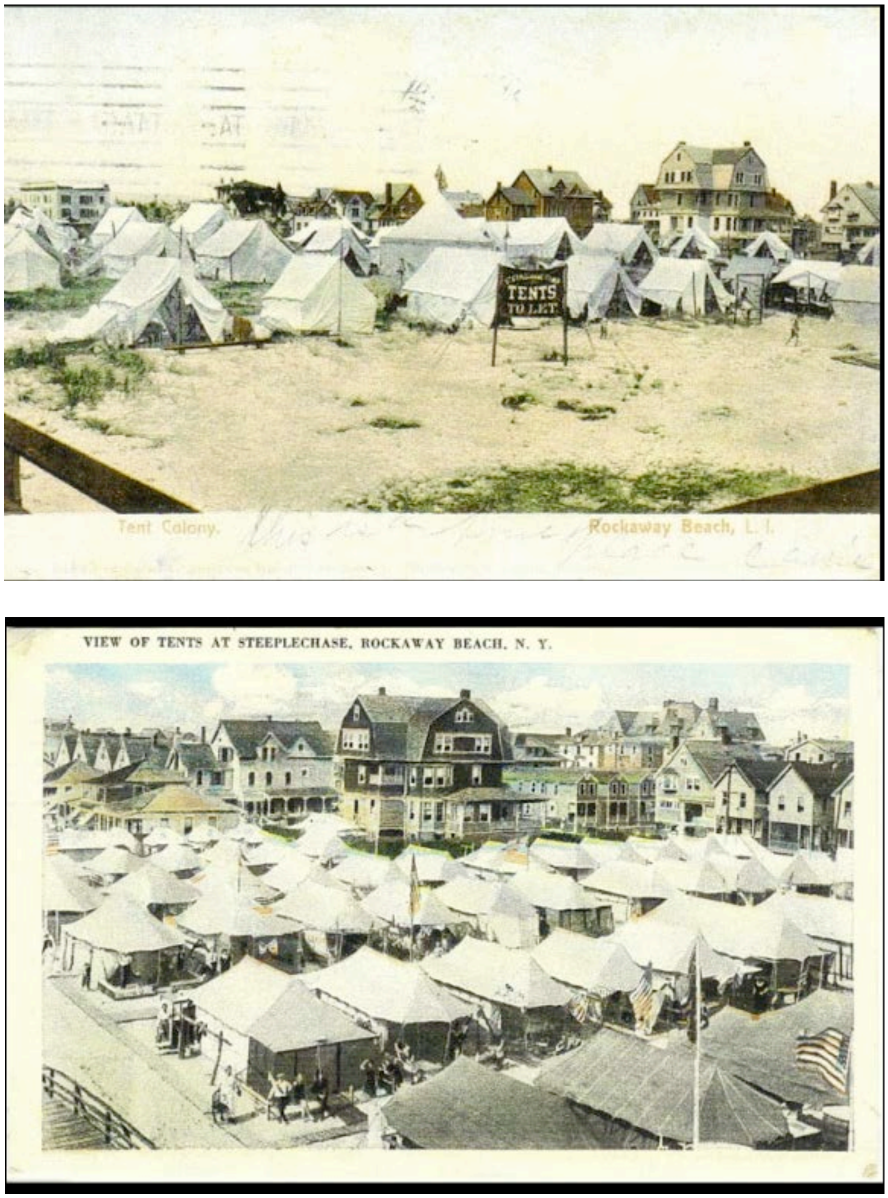

FIGURE 16. Tent Communities Provided Accommodations For All Social Levels

These tent communities soon inspired developers to construct modest bungalow communities for rent along the Rockaway beaches. At one point, more than 7,000 bungalows existed in the Rockaways, and became a popular destination for working class new Yorkers who come to enjoy the ‘better side of life’.

Bungalows were designed to be used exclusively during the summer months. Architect Henry Hohauser and builder Isaac Zaret constructed the Wavecrest Bungalows between 1921-1925. Vernacular in design and constructed of local materials such as locust wood, brick and cedar shingles, their architectural details included hip roofs, exposed rafters, porches, and small brick chimneys. Most measured approximately 20’x30’ on 25’x50’ lots, and were one-and-a-half stories[14]. Some bungalows were even erected on long piers extending out into the calmer waters of Jamaica Bay[15]. This form of architecture is an integral part the culture and history during a prosperous time, and can be used as inspiration for the sites architectural design to strengthen and celebrate the history of the site.

[14] NYC Historic Districts Council, “Far Rockaway Beachside Bungalows, Queens”, March 14, 2014, <http://www.6tocelebrate.org/neighborhood-items/far-rockaway-beachside-bungalows-brooklyn/>
[15] NOTE: This image depicts bungalows adjacent to the site and still visible today.

FIGURE 17. Bungalows Of Rockaway (Library Of Congress)

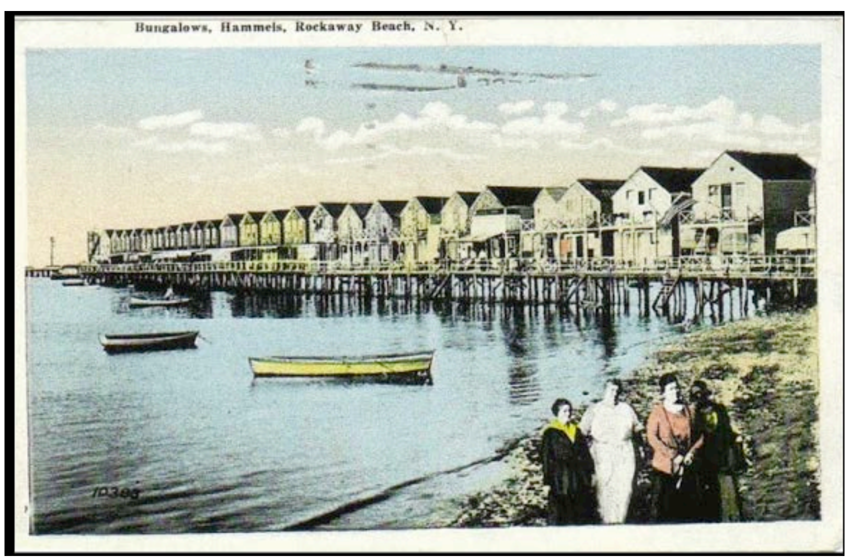

FIGURE 18. Bungalows Build On Piers Still In Existence Along Project Site

By the late 1920's, the Rockaways no longer appealed to the wealthy New York community as a place to vacation. Overpopulated by 'common folk' disinterested the wealthy since the Rockaways were now considered to be the 'Playground of the City of New York'.

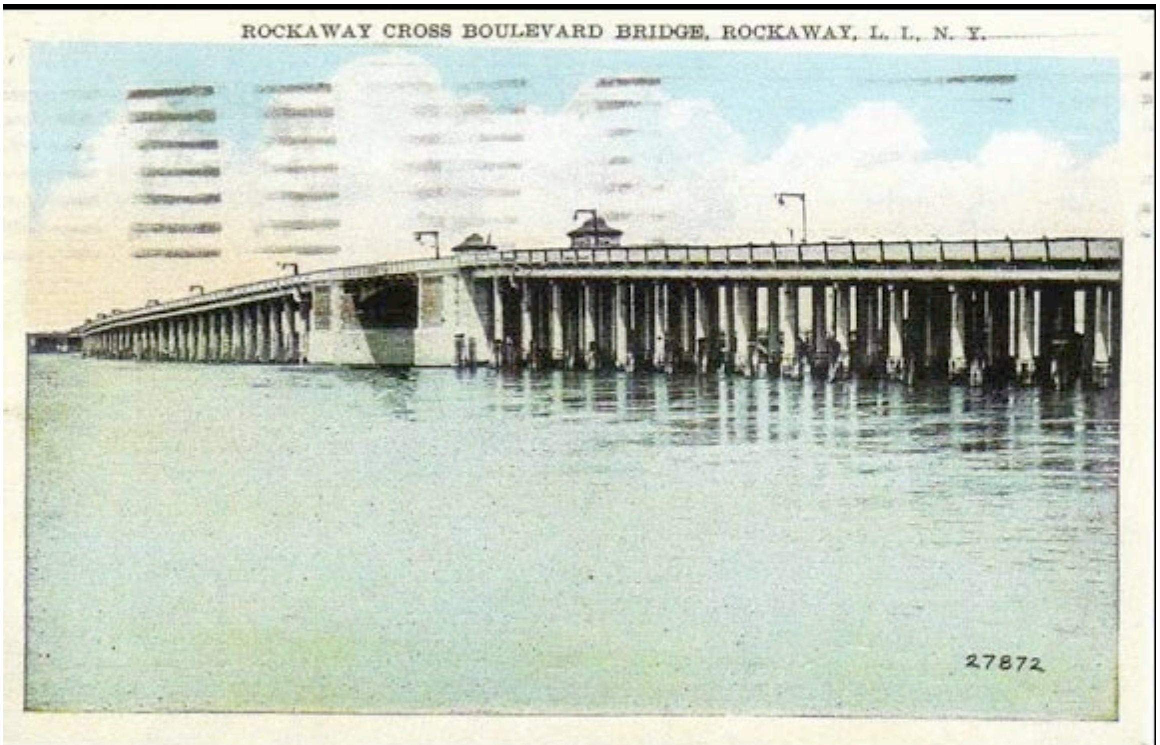

FIGURE 19. Cross Bay Boulevard Provided Additional Access To Peninsula

The Cross Bay Bridge opened in 1925, and aided in a massive building and population explosion during the first quarter of the 20th Century. Relatively cheap land and the dream of owning beachfront property became a reality to the urban population. Land developers bought up land similar to what was experienced in Coney Island a few decades prior. It was the 'golden years' of development along the Rockaways. Unfortunately, this development occurred on many filled wetlands and placed residence in areas prone to frequent flooding. Rising sea levels have only increased the frequency of flooding within these low-lying back bay communities. Because the site is situated along this shoreline and surrounded by residences at risk from flooding and changing sea levels, the site design should encourage measures to protect the neighborhoods abutting the site.

CHANGING TIMES FOR THE ROCKAWAYS

The site design for this project needs to understand the reasons why there are such distinct communities in such close proximity to the site. Many of these unique cultural establishments can be explained by analyzing previous development movements in response to issues and developments facing other parts of New York City. During the Great Depression, new building construction tapered off across the city, but beach attendance remained relatively the same. New systems of transportation sprung up throughout the New York, including the Parkway extending into Long Island. As a result, the Rockaways dwindled in popularity, and between 1930-1945, new construction halted, and seasonal attendance to the Rockaways waned. Businesses were forced to close down even in summer months as operators discovered they were not able to generate enough profit during the short summer season. As the attraction decreased for the beachside community, and housing shortages escalated throughout the City after World War II, landlords and owners of bungalows began to winterize these structures in hopes of attracting year-round tenants. Hotels converted into rooming houses and apartments. The City, desperate to find housing for the poor, sent subsidized renters to fill the winterized bungalows. The mass suburbanization and modernization of vehicular travel during 1947-1952 sent the beachside community into more of a downward spiral.

Around this time, Robert Moses was named city "construction coordinator" in 1946 by Mayor William O'Dwyer, and gained control of administering public housing throughout the city. Through newsprints, radio recordings, and public speeches, Moses was cited as saying Rockaway Beach was ‘The cities favorite shore resort’. Despite this vocal opinion of the area, he considered hotels, concession stands, and amusement parks to be a ‘product of private greed and a defilement of nature’. Moses often referred to the peninsula as ‘corrupted by private misuse’. Following his recent successful development of Jones Beach State Park, Moses wanted to tear down homes, boarding houses, businesses, and amusements bordering the beaches in order to widen the beach and construct a super highway (Shore Front Parkway) running parallel with the ocean. Although a portion of this highway was constructed, funding was lost to complete the entire parkway Moses envisioned would connect the Riis Park area and all of the Rockaway Peninsula with the South Shore of Long Island.

FIGURE 20. High-rise Public Housing And Parkway Replaced Houses, Businesses, And Boardwalks As Part Of Moses Plan (Wierengo)

In addition to the development of the highway, Moses and the City also rejected residences' requests to reconstruct, improve and modernize their present establishments. Sticking to his present agenda, Moses would not "support the construction of hotels, rooming houses, beach clubs, yacht clubs, concessions or anything of that nature", even though large swaths of land lay vacant. To prevent improvements to existing structures, work permits for new construction were denied in order to 'keep the beachfront open for public enjoyment'.

FIGURE 21. One Of Many Urban Housing Projects In A Barren Landscape Proposed By Moses + Fought By Local Residence

Robert Moses believed the creation of Title I development in the Rockaways, was a way to provide wholesome living arrangements for poor people displaced by slum clearances in other parts of the city.[16] When the tourism left the area, it took with it jobs, stores, and tax income. The city took notice and thought the area was an ideal relocation site for the families on the ADC (Aide to Dependent Children) program. Participants of this program were absent a 'bread winner' in the family. The remote location of the Rockaways from the city and ports, and lack of employment opportunities, was of no importance. The Department of Welfare and desperate landlords looking to find tenants for their properties year-round, reached an agreement to house these 'people of last resort' in their buildings. Unfortunately, these buildings were

[16] Kaplan, Lawrence, and Carol P. Kaplan. *Between ocean and city: the transformation of Rockaway, New York*. New York: Columbia University Press, 2003. Print.

designed to be inhabited during summer months only, and riddled with safety and health code violations. Because updates and improvements to accommodate year round tenants would prove costly to the landlords, part of the agreement between the Department of Welfare and landlords, suspended all building violations. Landlords didn't have to worry about fines and liens on their buildings due to plumbing, fire, and sanitation infractions[17].

Despite criticism against low income housing by such critics as Jane Jacobs and Nathan Glazer's comment "Public housing is the graveyard of good intentions", Public Housing projects were initiated in the vacant lots including a 300-acre track of land that would become the Hammels Renewal and Arverne Urban Renewal Area around 1964.

FIGURE 22. Hammels Housing Project Adjacent To Site Still Exists Today

[17] Kaplan, Lawrence, and Carol P. Kaplan. *Between ocean and city: the transformation of Rockaway, New York*. New York: Columbia University Press, 2003. Print.

The central portion of the peninsula, where the projects site is located, became one of the least dense, and poorest areas in the City. By 1975, the Rockaways contained 57% of all low income housing in Queens. At the turn of the Century, the area was dominated by single family residential housing, with less than 6 apartment buildings existing. Today, 200 apartment buildings, with 100 large-scale housing developments exist, mixed in between the still dominant single family neighborhoods.

This time period explains existing housing structures surrounding the site, including the Hammels Public Housing project. It also explains the obvious lack of commercial enterprise and resort type amenities. Although the area could serve as an attractive destination for New York Residence to spend money of tourism based activities, the transformative time period of Mose's power, continues to plague the area's economic health, and communities ability to provide recreational amenities to its residence. The projects design and programming has the opportunity to re-introduce recreational and commercial services once common to the area, and support the revival and recognition of the Rockaways, as a viable tourist and economic destination.

RECENT DEVELOPMENT AND HISTORY

By 1990, one third of the peninsula was on public assistance and nearly one quarter of the households had incomes below $10,000. There were two major efforts during the 1980's and 90's to boost local economies. The Forest City Ratner project was intended to develop 10,000 condo units on the beach, but collapsed under its own scale. The other major development proposed the Destination Technodome; a massive sports complex and entertainment facility. This project also failed during a difficult and stagnant real estate market across the city.

FIGURE 23 Vacant Lots Still Common Along Rockaways Landscape

As prices skyrocketed across the city during the late 1990's through 2008, new initiatives were set forth involving the real estate within the Rockaways. As part of Mayor Bloomberg's New Housing Market Plan, commitment to preserve or construct 165,000 units of affordable housing, and providing some 500,000 people new residences, was laid out for the area. Arverne-By-The-Sea enjoyed a ribbon cutting in May 2004, and experienced great success with new market rate housing units pre-selling exceptionally well. This development plus the Arverne East, both billion-dollar investments, are anticipated to provide over

4,000 affordable and market rate housing units, retail, parks, schools, and sewer. To date, development on Arverne East has not broken ground, but Arverne-By-The-Sea continues to expand and develop land.

FIGURE 24. Arverne-By-The-Sea One Of Many New Developments Built

GATEWAY NATIONAL RECREATION AREA + ENVIRONMENTAL REVIVAL

Large areas of Jamaica Bay became part of The Gateway National Recreation Area, when it was established in 1972. The intent was to bring National Park Services closer to the major cities of the country and share the ethics of preserving and protecting outstanding natural and cultural resources, and using them in a sustainable manor for educational and recreational purposes. The 26,000 acres welcomes almost 10 million visitors annually.

On July 20, 2005, Mayor Bloomberg signed a City Council bill requiring the New York City Department of Environmental Protection to create a watershed protection plan for Jamaica Bay, in order to establish a pathway towards restoring and maintaining the water quality and ecological integrity of the Bay. This began the current movement through various agencies and non-profit organizations to remediate and restore vital ecological systems that have become degraded to a point of collapse within the Jamaica Bay waterways.

CHAPTER 3: RESILIENT COASTAL DESIGN

RESILIENCE BY NATURE

Canadian ecologist C.S Hollings, one of the pioneers of resilience theory, suggests resilience is 'the ability of a system to absorb disruptions without tipping over to a new kind of order: one that can be disastrous for the organisms involved'. Hollings also makes an important distinction between the kind of resilience that we humans often try to achieve, what he calls "engineered resilience", and the kind of resilience seen in natural systems, which he refers to as "ecological resilience." Hollings suggests "ecological resilience" is typically able to cope with far more complex and unpredictable kinds of events (FIGURE 25).[18] Coastal resilient design attempts to protect our engineered infrastructure (referring to the technical solutions that aide the flow and movement of society[19]), from risks associated with natural hazards common in dynamic coastal landscapes. Victor Olgyay wrote in 1963: "creatures must, if they cannot physiologically adapt to changes in the natural environment, prepare what defense they can."[20] If we were to combine Olgyay and Hollings ideals of resiliency with those attributed to biomimicry (the imitation of the models, systems, and elements of nature for the purpose of solving complex human

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[18] C.S Hollings, "Resilience and stability of ecological systems". *Annual Review of Ecology and Systematics*. 1973 Vol 4 :1-23.
[19] Droege, Peter, and Joe Brown. "Revolution of practice." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 13. Print.
[20] Droege, Peter, and Joe Brown. "Revolution of practive." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 13. Print.

problems), it can be suggested that resilient design should look towards nature to find solutions.

RESILENT TYPES OF ENGINEERING

FIGURE 25. Resilient Types of Engineering (Wierengo)

Coastal communities within an urban context, also need to consider design incorporating ecology within the heavily anthropogenic environments of cities. For the first time in history, the world's cities will have to adapt to the environmental limitations of a de-naturalized world we have created. Cities of the futures, have the potential to integrate systems of technologically advanced human civilization, with nature, thus pairing urban vibrancy and convenience, with a sustainable lifestyle and an authentic experience of nature[21]. A new creative phase in the evolution of the cities through a more sophisticated form of

[21] Droege, Peter, and Stephen Engblom,Claire Bonham-Carter. "The era of the ecological metropolis." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 190. Print.

eco-engineering, is transforming urban areas from a machine, into an organism[22].

If communities choose to continue to inhabit the coastal areas prone to storm surge and rising water levels, they must protect themselves and resist harm caused by the sea. A resilient city is not one that is shielded from climate change all of the time, but one that is protected by effective defenses and adapted to mitigate most climate impacts, while able to recover quickly after a major storm event.[23]

FIGURE 26. Mid-Atlantic Resilient Coastal Ecological Engineering (Wierengo)

For resilient design, why not learn from forms found in nature that naturally protect landscapes such as dunes, wetlands and reefs? These natural green infrastructure precedents act and preform much the same way our engineered infrastructure do, but work on integrated levels and perform multiple tasks such as providing crucial habitats for wildlife, and in some cases, sequester carbon in

[22] Droege, Peter, and Joe Brown. "Revolution of practive." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 13. Print.
[23] New York City, Special Initiative for Rebuilding and Resiliency, *A Stronger More Resilient New York*, (PLANYC, 2013), 8.

the atmosphere.[24] Nature wastes nothing, and makes much from little.[25] No longer can urban designs have the luxury of design solely based on perfect geometry and artistic flare, without regard to functionality and ecology. Resilient design moving into the 21st Century should simultaneously create environmental, economic, social, and aesthetic value through an integrated system, where functionality compliments aesthetic value without increasing costs[26].

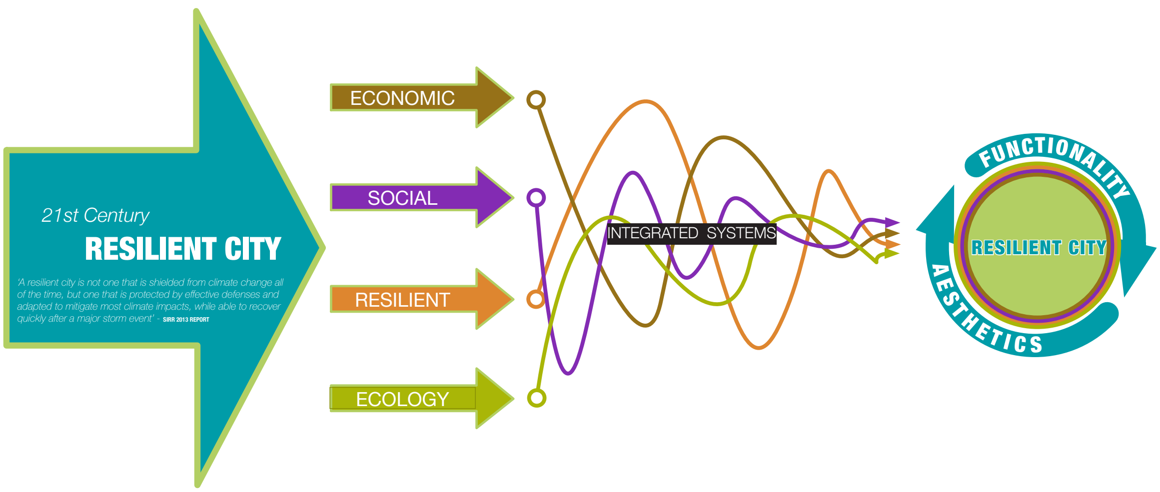

FIGURE 27. Integrated Systems Within a 21st Century City (Wierengo)

These integrated principles within the context of a SCH, suggest the potential to work with this vision of urban futures by providing an inlet into an honest interaction between urban residence and an aquatic natural experience. SCH's can also provide multiple functions vital to our survival and continued

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[24] Droege, Peter, and Richard Weller. "Flux." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 26-31. Print.
[25] Droege, Peter, and Ichsani Wheeler. "The story of apples and fish: designing for urban productivity." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 38-45. Print.
[26] Droege, Peter, and Richard Weller. "Flux." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 26-31. Print.

colonization along coastal areas by creating a place of attraction, economic activity, and social inclusion, while defending the community against rising sea levels and storm surge flooding.

COASTAL RESILIENT DESIGN + CLIMATE CHANGE RISKS

Fundamental to designing resilient landscapes for climate change is acknowledging how design parameters are changing[27]. Addressing flood risk based on current conditions has immediate, short-term benefits to communities, but does not adequately account for increasing flood risk resulting from SLR[28]. Along the Atlantic coast alone, almost sixty per cent of the land that is within a meter of sea level is planned for further development[29]. As climate conditions and sea levels continue to rise, coastal design must adapt to natural and anthropogenic forces[30]. Humans have long been attracted to coastal areas as a source of food, water, natural resources, and employment. In 2000, around half the United States population lives in coastal areas, at densities five times greater than those of non-coastal areas, and continues to grow three times faster than

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[27] Droege, Peter, and James Rosenwax, Celeste Morgan, Dr. Courtney Henderson. "Design and natural systems: design with nature." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 68. Print.

[28] United States, National Science and Technology Council, The National Global Change Research Plan 2012-2021, (National Coordination Office, 2012) *http://www.globalchange.gov/what-we-do/assessment/coastal-resilience-resources*

[29] U.S. Army Engineer Institute for Water Resources, "*Response to Climate Change", Jan 14 2013, <www.corpsclimate.us>*

[30] Droege, Peter, and ken Appel, Christopher Benosky, Dr. David Gallacher. "Changing climates and the world's rivers and wetlands." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 88-97. Print.

areas elsewhere[31]. Urbanization and an average SLR of 1.5 feet could more than triple the number of people exposed to coastal flooding by 2070[32].

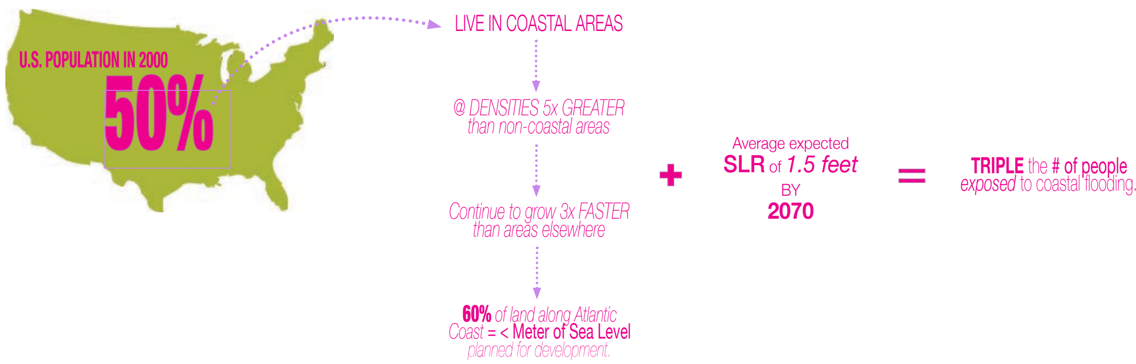

FIGURE 28. Increased Urban Coastal Area = Higher Risk of Damage (Wierengo)

The concept of resilience coastal design upends old ideas about "sustainability". Instead of embracing stasis, resilience emphasizes volatility, flexibility, and de-centralization. Change, from a resilience perspective, has the potential to create opportunity for development, novelty, and innovation. As Hollings himself once put it, there is "no sacred balance" in nature… "That is a very dangerous idea."[33] Examples of natural fluctuation are ever present within the coastal environment including the weather, tides, currents, and sedimentary drifts. As with any good design solution, context and place must direct and inspire. In the context of coastal natural systems, a designer's response to climate change is not necessarily through new technology. Cues from the

[31] *United States EPA 2008, About Estuaries, United States EPA, http://www.epa.gov/nep/about1.htm*
[32] Droege, Peter, and Vivian Lee. "Coastal Design and planning: areas of transition." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 98-107. Print.
[33] C.S Hollings, "Resilience and stability of ecological systems". Annual Review of Ecology and Systematics. 1973 Vol 4 :1-23.

natural context can inspire solutions and green technologies already existing in nature[34].

The Rockaway peninsula is a barrier island, and therefore by nature, acts as a protector against storm surge and wave energy through it's many defensive green infrastructure elements. Wind-swept sands create dune lines that mitigate wave energy, while the back bay harbors marine wetlands and marshlands that serve to mitigate flooding associated with severe storms. Unfortunately, the protection is for the mainland, and not for the island itself. Infrastructure and buildings located on the island, must endure naturally unstable and shifting landscapes common to the barrier islands of the Atlantic coast.

If the decision is made to continue to build within these unstable landscapes, protective measures and strategies area needed in order to provide safe conditions against natural hazards. Because of the diversity of geography and unique building typologies found within coastal urban areas, there is not one single approach to climate resilience and managing risk. Each waterfront faces specific types and levels of risk with different opportunities and constraints. Given the Rockaway area's coastal exposure, the most significant climate change-related risk is flooding from coastal storms, which is likely to be exacerbated by projected sea level rise. For the Rockaway area, and most of the New England and Mid-Atlantic coastlines, Hurricanes and Nor'easters pose the greatest risk associated with coastal damage. Hurricanes strike the region very infrequently during the months between July and October, and generally produce large storm

[34] Droege, Peter, and James Rosenwax, Celeste Morgan, Dr. Courtney Henderson. "Design and natural systems: design with nature." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 68. Print.

surge and wind damage during their short durational period. Nor'easters on the other hand, occur during the winter months, and although they generally produce smaller surges with weaker winds, are able to produce great deals of damage due to their long temporal durations.[35] Although dune systems can mitigate mechanical damage from wave action and flooding sourced from the ocean during short durational storms lasting less than one complete tidal period, longer durations storm systems, such as Nor'easters and seasonal fronts, hydraulically swell the bays with surge, so most flooding of homes is actually sourced from the bay and not the ocean. This is also the area where many SCHs are located due to the protective nature of back bays from long fetched wave action. Tidal marshes are able to withstand these natural inundated periods, but human infrastructure placed on artificially filled land where these marshes naturally exist, does fare as well. These back bay areas are home to many aging resident communities build prior to FEMA flood zone mapping and required flood-proofing construction codes, resulting in serious danger for the residence and increased economic damage.

COASTAL RESILIENT STRATEGIES + HAZARDS

There are a variety of potential strategies, to adapt waterfront areas to become more resilient in the face of increasing coastal hazards. Suggested by the New York City Panel for Climate Change (NPCC2), strategies can be broken up into two (2) categories based on their scale. One group of strategies involve

[35] New York City Panel on Climate Change, *Climate Risk Information 2013: Observations, Climate Change Projections, and Maps,,* (C. Rosenzweig and W. Solecki, 2013), NPCC2. 13

protecting a single building lot (Site Strategy), while the other group is on a larger scale, and works to protect entire stretches of coastline (Reach Strategy).

Hazard types are also divided into two groups determined by their durational period. Event hazards, as the name suggests, are those associated with a sudden event, which result in storm surge, wave action, and erosion. Gradual hazards are those that slowly present themselves over time. All strategies, no matter which category they reside in, must be designed to endure hazards from both hazard groups, and should be analyzed for: (a) the hazards addressed, (b) applicability, (c) costs, (d) potential co-benefits, and any other considerations to the site[36].

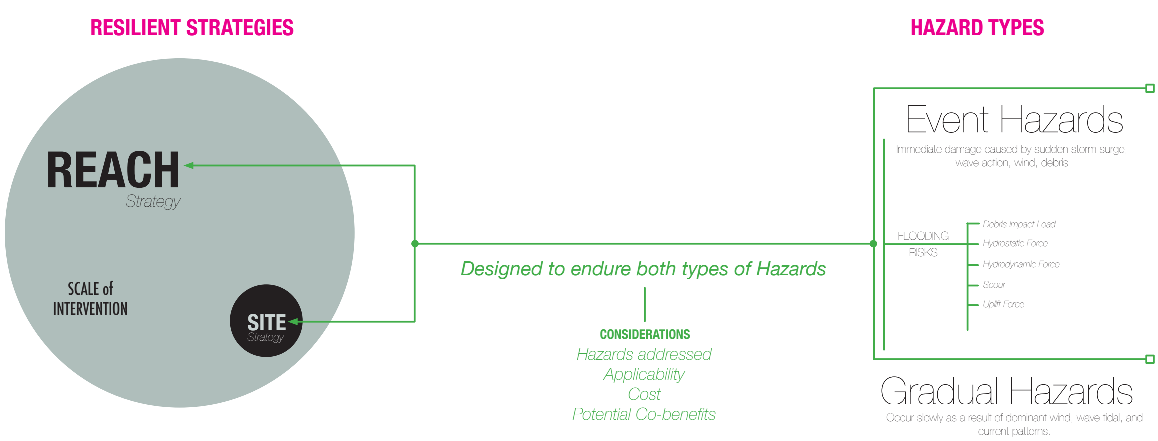

FIGURE 29. Types of Coastal Resilient Strategies + Hazards

EVENT-BASED AND GRADUAL HAZARDS

Storm surge is a rise in coastal water level associated with a hurricane or other strong coastal storm. This surge is exacerbated in the Rockaways

[36] The City of New York Department of Planning, *Coastal Climate Resilience Urban Waterfront Adaptive Strategies, (Department of City Planning 2013), 2-4*

because of the right angle formed by Long Island and New Jersey. This coastal angular form is called the New York Bight, and acts to funnel storm surge into the New York Harbor. A bight is a geography term indicating a curve, or recess in a coastline, river, or other geographical feature[37]. Along the ocean, storm surge can produce large crashing waves due to its unlimited fetch. This creates an additional hazard and may lead to sudden erosion. The back bay, on the other hand, has limited fetch and thus is not as susceptible to wave energy, but is more likely to incur flooding during a long durational storm.

FIGURE 30. Hazards Associated With Backbay Flooding (Wierengo)

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[37] The New Oxford Dictionary, "Bight", <http://www.oxforddictionaries.com/us/definition/american_english/bight>

According to the New York City Panel on Climate Change, sea level rise is very likely to result in increased frequency of coastal flooding. Risk associated with flooding can be classified into the following categories:[38]

1. **Debris Impact Load:** The impact from flotsam materials and objects carried by floodwaters. Debris may include tree trunks, fuel tanks, piers, building elements, boats, and barges.

2. **Hydrostatic Force:** The force due to standing or slowly moving water created when flood levels are unequal on different sides of a structure. This can cause vertical buoyancy and flotation of structures.

3. **Hydrodynamic Force:** The force from floodwaters moving at high velocity which exert frontal impact forces while creating drag along the sides and suction on the downstream side. High-velocity flows can destroy solid walls and dislodge inadequate foundations.

4. **Scour:** Erosion created from water and wave action across unstable ground, combined with turbulence with foundation elements. Scour can impact a structure's lateral stability.

5. **Uplift Force:** The force generated by waves beneath elevated structure such as a dock or pier lifting from pilings and beams.

Gradual hazards, compared to event-based, occur slowly as a result of dominant wind, wave, tidal, and current patterns. Slow erosion to shorelines, undermining of structural foundations, and continually reshape the landscape and shoreline.

[38] The City of New York Department of Planning*, Coastal Climate Resilience Urban Waterfront Adaptive Strategies, (Department of City Planning 2013), 10*

SITE STRATEGIES

FEMA issued the first Flood Insurance Rate Maps for New York City in 1983, resulting in building code requirements for those within the designated flood zones[39]. Unfortunately, eighty-four per cent of the nearly 90,000 buildings in the area inundated by Hurricane Sandy in NYC, were build before such standards were required.[40] Retrofitting existing buildings with new flood strategies can be extremely expensive, and therefore many of the peninsulas residences are susceptible to severe damage if strategies only remain at the site scale.

For new construction, the methods of site resilience can either prevent damage to the building, by trying to keep flood waters out of the building or site, avoid flood waters through elevation, or to allow water into the site but flow beneath the structure (FIGURE 31). Implementing resilient methods on the site scale can have great implications on the character of a street or neighborhood. Consideration of the impact of a given strategy on the public realm, from the perspective of a person walking down the street, should be considered to ensure an active street life that supports the neighborhoods livability, economic vitality, and safety.[41]

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[39] The City of New York Department of Planning*, Coastal Climate Resilience Urban Waterfront Adaptive Strategies, (Department of City Planning 2013), 10-11*

[40] New York City, Special Initiative for Rebuilding and Resiliency, *A Stronger More Resilient New York*, (PLANYC, 2013), 10-12.

[41] The City of New York Department of Planning*, Coastal Climate Resilience Urban Waterfront Adaptive Strategies, (Department of City Planning 2013), 4*

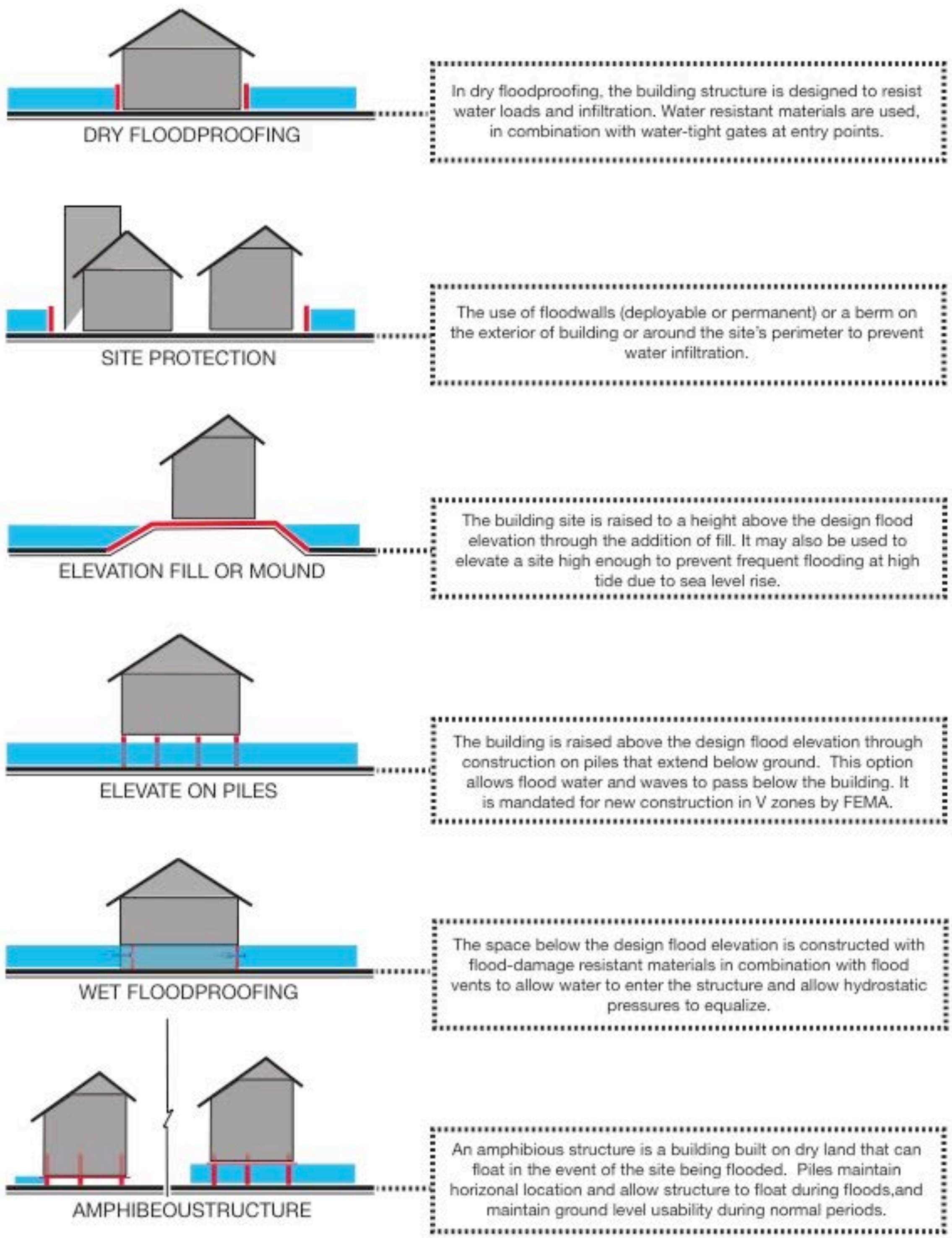

FIGURE 31. Site Strategy Typologies (Wierengo)
(Data Source NYCPLANNING Urban Waterfront Adaptive Strategies)

REACH STRATEGIES

This group of strategies encompasses larger scale approaches to resilience, and includes interventions at the upland, shoreline, and water areas. Upland strategies do not involve direct impact on the water or the shoreline, but involve changes to areas inland of the shoreline. Shoreline strategies armor or reinforce the shoreline to protect from erosion, block storm surge, or attenuate waves. In-water strategies primarily deployed seaward of the shoreline and act to protect upland areas from erosion and wave forces by attenuating waves, or reduce storm surge. (FIGURE 32)

The objective of all reach strategies, is to stabilize large stretches of shoreline against erosion, mitigate wave forces, block flooding of upland neighborhoods, and remove development from vulnerable areas. To be fully effective, reach strategies require consistent application across property lines. Because of the scale, and cooperation required by many individual sites and landowners, many of the reach strategies are organized and maintained by a public agency, and should take place within the larger context of integrated coastal zone management.[42]. This is a more practical approach in high density coastal areas, and the encouragement of open space, due to its adaptability towards evolving coastal environmental conditions caused by climate change, offers an opportunity to shape a more interactive coastal region between humankind and nature; thus creating more diverse habitats and recreational

[42] The City of New York Department of Planning*, Coastal Climate Resilience Urban Waterfront Adaptive Strategies, (Department of City Planning 2013), 10*

programs.[43] The appropriateness of a reach strategy depends on the specific coastal environment, and the design must consider the shoreline composition, sediment transport, wave force, and water depth in order to minimize any negative impacts on tidal wetlands and water quality.

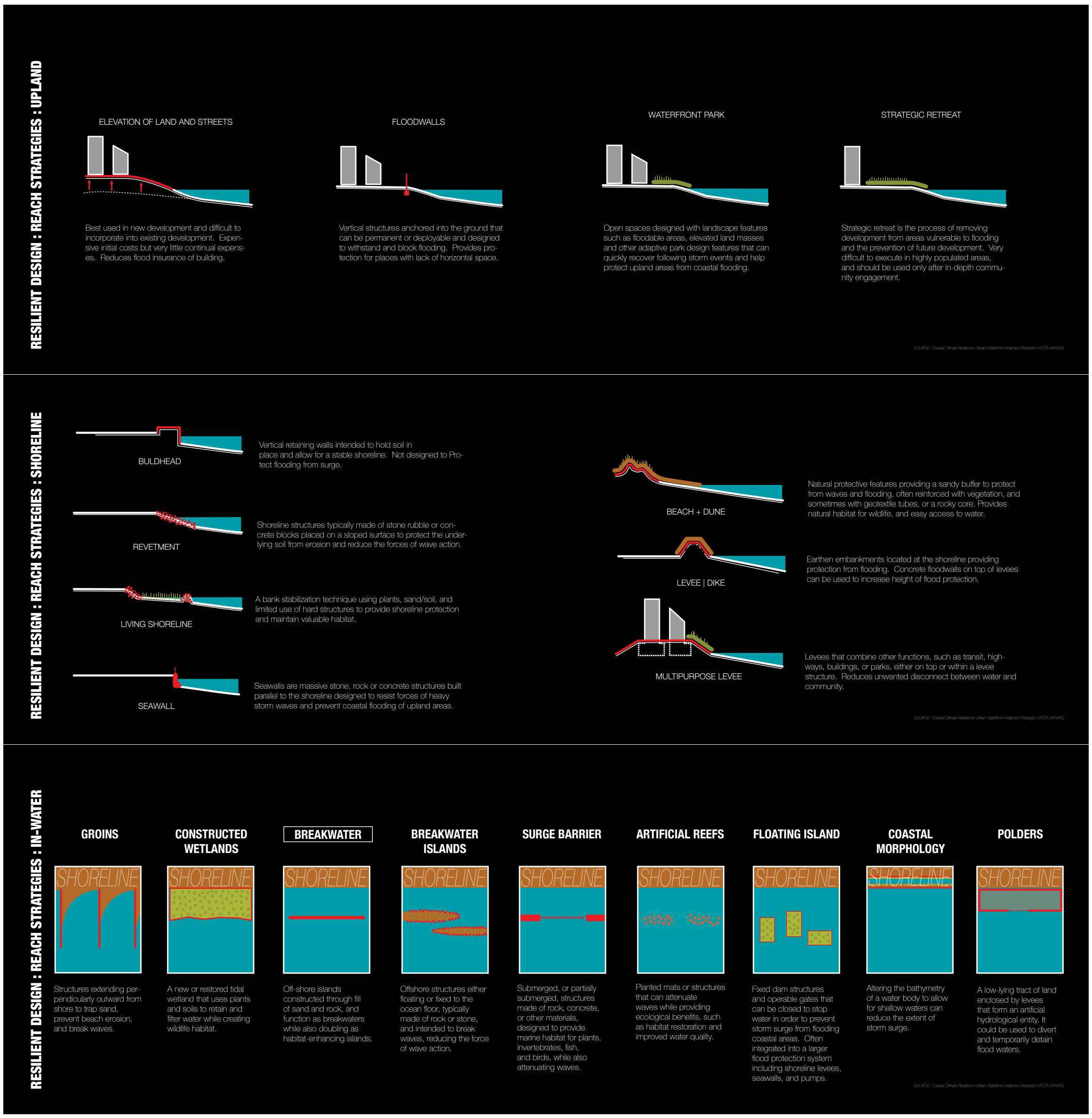

FIGURE 32. Reach Strategy Typology (Wierengo)

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[43] Droege, Peter, and Vivian Lee. "Coastal Design and planning: areas of transition." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 98-107. Print.

CHAPTER 4: SMALL CRAFT HARBOR DESIGN

CURRENT STATE OF THE MARINE INDUSTRY

Aging infrastructure and economic difficulties has placed many existing harbors in need of substantial capital improvements to provide a safe environment for public and private use. Recent storm events have increased the number of facilities whose infrastructure is no long able to sufficiently protect vessels or human use. Sixty percent of existing marina stocks are located within saltwater environments, and seventy-five percent are twenty-five years or older[44]. The medium age for these marinas is forty years-old, and with the expected life cycle of many marina infrastructure lasting on twenty-five years, these figures indicate a large number of todays existing marina stock is outdated and should either be replaced or renovated to meet current regulatory initiatives working towards more sustainable coastal landscapes.

Damage incurred by recent storm related events, also burden already tight economic situations and stressed budgets. Environmental regulations and laws are changing with the need and desire to protect ecological systems in peril as a result of previous land uses and activities.

Marinas are also facing pressure by land developers looking to capitalize on prime real estate values associated with waterfront property. Many sites

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[44] *Peter D Anzo, "Marinas are still good investments in todays volatile economy" Marina Dock Age, November 2009, 26-28*

previously used as marinas, have been redeveloped as market rate housing and office space. In order to empower SCH developments today with the ability to fulfill all the needs of current demands, and continue to be of service to future populations in an efficient way, the author suggests, based on a review of literature, design elements within a SCH should serve to function on multiple levels. This provides maximum results through minimal materials. The reduction of material and infrastructure should minimize the risk of damages caused by storm events, and lower operating costs associated with general maintenance and upkeep.

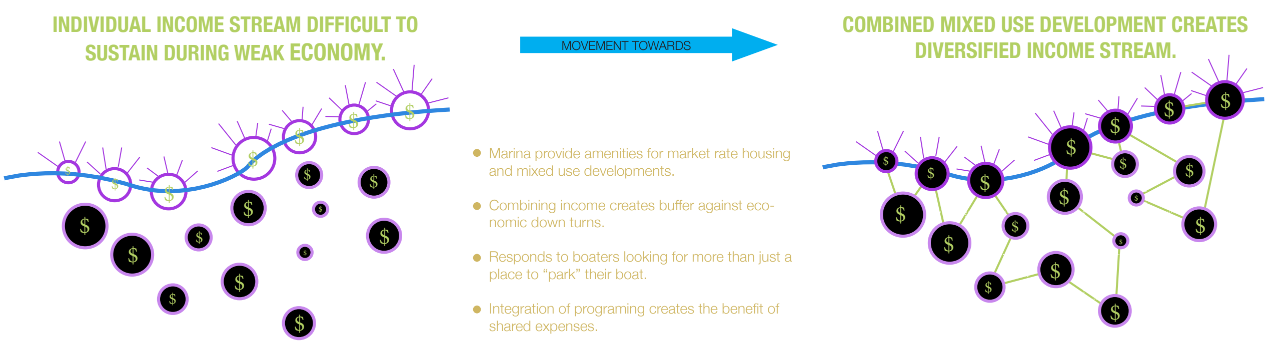

FIGURE 33. Marina Use Transition into Mixed Used Development (Wierengo)

SCH development provides an opportunity to act as a powerful tool in the redevelopment of urban blighted waterfronts. The research gathered in this document, and the goal of the site design portion of the project, is to demonstrate how the development of a thoughtfully designed SCH, can fulfill the needs of both public and private entities concerned with usage of their urban waterfront. According to the US Census Bureau in 1999, there were 8,200 marinas in the United States. That number has remained virtually unchanged to date. Between

1992 and 1997, marinas enjoyed an expansion period when their numbers increased twenty-six percent. Recent property tax increases on waterfront property, mounting pressure from environmental groups, and the costs of waterfront property, have had a tremendous impact on stopping all but a few new marina developments in the United States.[45] Demand, on the other hand, has surpassed supply. According to the National Marine Manufacturing Association's (NMMA) 2012 Economic Report, the total economic impact of recreational boating reached $121.5 billion dollars in 2012, and total boat registrations to the USCG, totaled 12,182,157. This equates to around 1 boat for every 9.4 households in the United States (approximately 1:14 in New York). 34.8% of the US population participated in boating related activities in 2012, and 238 million adults in the US spent roughly $40.7 billion in services and docking fees that same year. Retail sales figures show that 2,750,000 power and sailboats were sold between the years of 2000-2008[46]. For comparative purposes only, if only one-third of these new boat sales needed slips versus being trailered or kept at ones residence, it leaves approximately one million vessels in need of storage (actually 916,667). By dividing that number by the existing 8,200 marinas registered storage facilities, the result is that each existing marina would need to add space to accommodate approximately 100 more boats per marina[47].

[45] National Marine Manufactures Association, *2011 Recreational Boating Statistical Abstract, 2011, IV-V*
[46] National Marine Manufactures Association, *2011 Recreational Boating Statistical Abstract, 2011, IV-V*
[47] *Peter D Anzo, "Marinas are still good investments in todays volatile economy" Marina Dock Age, November 2009, 26-28*

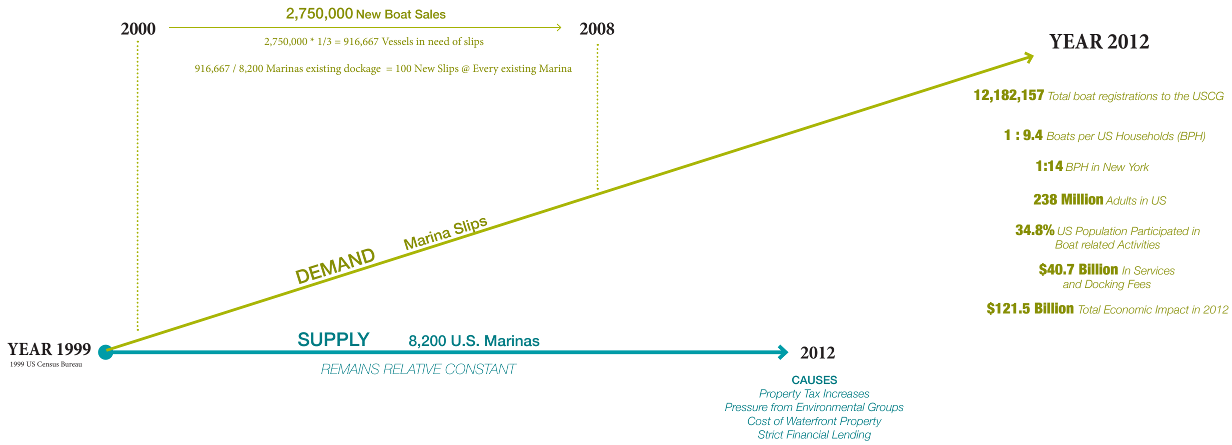

FIGURE 34. Marina Industry Supply + Demand (Wierengo)

Combining an undersupplied existing infrastructure (many facilities in need of capital improvements), and market trends indicating a continual growth in demand for marina based facilities, there suggests the possibility of increasing the supply of marina facilities through the redevelopment of urban waterfronts to act as sustainable SCHs. New technologies in material options and BMP’s set forth in national and statewide clean marina initiative plans, provide a solid set of guidelines designers are able to incorporate into the SCH design, so that it will not only provide options to the boating public, but aide in communities need to access and utilize their waterfront efficiently and effectively both today, and in the future. Innovative solutions based off these guiding principles, and principles commonly practiced in the landscape architecture discipline, could potentially develop SCH design into even more sustainable developments.

CLEAN MARINA MOVEMENT

Each marina is site specific and the environmental approaches, controls, and features appropriate for one facility may or may not be appropriate for another[48]. Creating a clean marina goes well beyond initial design and construction methods. In addition to the design configuration of the harbor, providing a clean marina includes management and personnel desires to make everyday conscience sustainable efforts. The author believes the design team responsible for the development of a SCH, has the ability to make these daily decisions easier and more efficient to execute. It is therefore recommended (if possible) to spend time with the future management team of the harbor early in the development process, so daily workflows are in concert with the design placement and configuration of programs. If this is not possible, speaking with SCH management teams, and local marine business professionals should provide valuable substitute information[49].

BENEFITS OF A CLEAN MARINA

ECOLOGICAL

Habitat Creation

Shoreline Stabilization

Water Quality Improvement

Stormwater Management

SOCIAL

Access to Natural Resources

Real Estate Appreciation

Taxable Revenue from Marine Activities

FIGURE 35. Benefits of a Clean Marina (Wierengo)

[48] *Daniel S Natchez "Environmentally compatable marinas: The major issues that need to be addressed designing new and retrofitting existing marinas", Marinas, Parks and Recreation Developments (American Society of Civil Engineeres, 1994) pg 51*

[49] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 3-4. Print.

Clean Marina initiatives are becoming commonplace, as research suggests positive economic, social, and environmental attributes connected with marinas practicing BMP's illustrated within national and statewide clean marina programs. While *Clean Marina* Programs vary from state to state, all programs offer information, guidance, and technical assistance to marina operators, local governments, and recreational boaters on BMPs to prevent or reduce pollution[50].

The 1993 guidance for the *Coastal Nonpoint Program* (CNP) issued by the US EPA (updated in 2001), specifies 15 management measures for marinas grouped under two broad categories; the first group of seven (7) is of most help to SCH designers[51]. In 2012, the National Parks Service also introduced the *Clean Marina Guidebook* to help encourage the enjoyment and responsible use of park facilities related to marine activities.

Both of these documents have been used to form unique plans for harbors and marinas within different states. Although each state's plan may slightly differ from one another, review of literature has concluded there are similar focus areas highlighted in most state's *Clean Marina* plans. Based on comparing the Mid-Atlantic states individual clean marina programs, seven (7) critical areas are commonly targeted within the SCH design: FIGURE 36 (1) marina flushing, water

[50] *Clean Marina Guidebook* . 2007. Reprint. Denver: National Parks Service Commercial Services, 2012. Print.
[51] *Coastal Nonpoint Pollution Control Program*. Washington DC: US Environmental Protections Agency, 1993. Print.

quality assessment, habitat assessment, shoreline stabilization, storm water runoff management, fueling station design, and sewage facility installation[52].

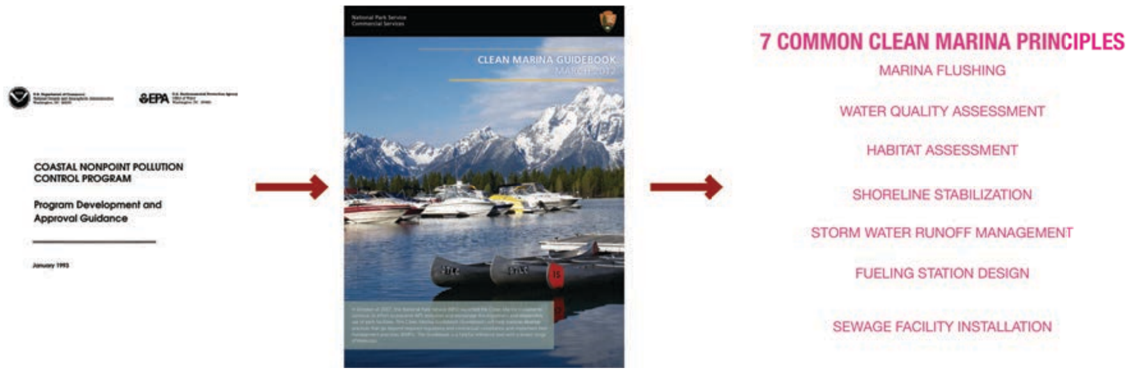

FIGURE 36. Common Clean Marina Principles (Wierengo)

RISK ASSESSMENT AND DESIGN APPROACH

In addition to the design of a SCH abiding by regulatory and sustainable initiatives, it is extremely important to determine the threshold of risk the clients and stakeholders are willing to accept from the beginning of the design process. The design of a small craft harbor differs from other design approaches, in regards to risk and the design process. Literature review suggests the design approach for projects located in marine environments, should (a) identify the probability of a *design event* occurring during the *design lifetime*; and (b) to what extent the event will affect the infrastructure within the period of concern. The design lifetime could be thought of as the duration of the financial debt term, or the lifespan of the docks and materials before they need to be replaced[53]. The *design event* becomes certain forces exerted onto the landscape and

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[52] *US Department of Commerce NOAA "Clean and Coastal Resource Management" Sept 17, 2010, <http://coastalmanagement.noaa.gov/initiatives/management_m.html#3>*

[53] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 91. Print.

infrastructure from a climatic storm event. There are no national building codes that apply directly to SCH design. Locations are each unique and have different strengths and risks husbanded to the *loci.* It is common for designs to take into consideration storm events for the 50 yr., 100yr, and 500yr marks depending on the geographic region. For example, the great lakes region generally uses the 20-year event, much different from areas prone to hurricane events where 100-year benchmarks are used. Acceptable risk can be interpreted many ways including terms of financial loss, life safety, preservation of irreplaceable value. Regardless of the interpretation: design criteria requires:

1. Defining the intensity of the load or event the small craft harbor must accommodate
2. Determining how likely that event is to occur
3. Estimate chance that event will occur within a given time period[54]

With current research suggesting climatic conditions and sea levels are changing, it is important to not only design around the risks associated with a certain level of criteria based on historic levels, but to anticipate an escalation of these figures in the future. Determining ways in which the design of the SCH can not only provide protection and resiliency against damage incurred within the harbor, but also provide protection for neighboring sites vulnerable to storm related damage should be encouraged. SCH design should not only provide

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[54] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 90. Print.

residence and visitors access to water-related activities, but also protect the residence and community from water-related damage. Storm surge flood protection should be incorporated within the design to serve as the first line of defense for the community. How these elements of protection are incorporated within the overall aesthetics of the design of a SCH, is up to the designer. There are examples of storm surge protection concealed within a design and not openly apparent, while other designs purposely expose and advertise the measures taken to protect the community.

FIGURE 37. Protective Functioning of a Small Craft Harbor (Wierengo)

PUBLIC PRIVATE PARTNERSHIPS AND SCH DEVELOPMENT

Risks associated with SCH development have made private equity scarce and pushed dependence towards the municipality. Harbors have become increasingly large-scale civic facilities and less real estate amenities[55]. This produces wide spread public benefits that warrant public funding coupled with the fact that such projects often fuel private investment in housing, retail shops,

[55] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 80. Print.

hotels and other economic development drivers within the community. Financially, the public sector provides security for financial debt obligations, while private equity brings expertise in the development, construction, and operations[56]. Design must appease both equity and the public use. This can generally be accomplished through pubic access and enhanced usage along waterfronts, while private entities receive the benefits of elevated real estate prices adjoining the harbor. In many cases, revenue created by upland commercial development can offset the costs incurred for capital infrastructure improvements along the waterside[57].

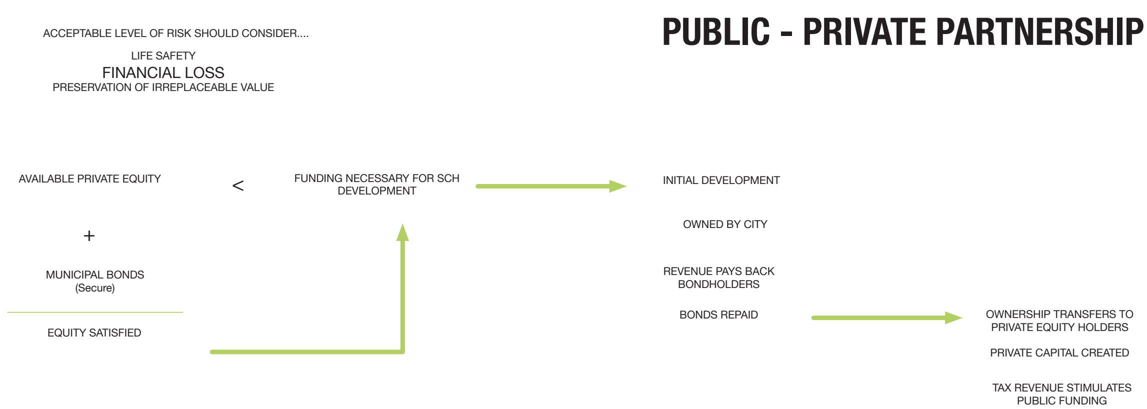

FIGURE 38. Public – Private Partnership Funded Development (Wierengo)

[56] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 81. Print.
[57] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 3-4. Print.82-83

STAKEHOLDER INVOLVEMENT

Local boating clubs, public and private organizations whose activities around the site may benefit or become hindered from waterfront development, should be taken into consideration from the very beginning of the design process. For example, if the community is comprised mostly of fisherman, close proximity to fishing grounds would be a significant advantage. Likewise, in a sailing dominate market; sufficient water depth and constant winds would be sought after. It is suggested to consider the needs and desires of three (3) general categories of stakeholders through the stages of SCH development[58]:

STAKEHOLDERS	GENERAL NEEDS
1. Boat owners and users of the slips	Functional needs of boats, cultural + social needs.
2. The General Public	Sustainable waterfront development with both visual and physical access to the water.
3. Developer and Marina Owner (Private or Public)	require efficient and profitable operation

FIGURE__ Small Craft Harbor Stakeholders + *Needs (Wierengo)*

SMALL CRAFT HARBOR CONFIGURATION + DESIGN

Providing appropriate protection against winds, waves, and water depths are paramount to the overall design of a SCH. With large amounts of waterfront shorelines already developed, finding areas with naturally protected waters is difficult. It is extremely expensive to create new calm water conditions, and for

[58] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 3-5. Print.

this reason, the harbor design team should make every attempt to arrive at the most efficient layout possible. A balance should be achieved between the boaters desire for convenient moorings, and the objective of maximizing boat slip revenue. This is especially important if the marina portion of the harbor is expected to financially stand-alone. In either case, the overarching challenge within the design, revolves around providing an outcome both attractive aesthetically, and cost-effective in spite of the many constraints common to this kind of development (FIGURE 39).

These design requirements form the basis for the design, and have been installed, tested and adapted, as the marine market and vessels have changed over the years. Common programmatic elements and suggested design guidelines most marina designers today follow are illustrated in (FIGURE 47). For practical purposes, there appears little reason to challenge their effectiveness within a design. Although functionality and efficiency are the primary result of these guidelines, the connection and integration of the harbor into the community should also be of concern for the designer. Occupation of a community's waterfront by a SCH is often beneficial to the local residence as long as proper circulation and access systems are in place that do not overburden the local infrastructure, and can overcome common constraints that plague many urban waterfronts.[59]

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[59] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 2. Print.

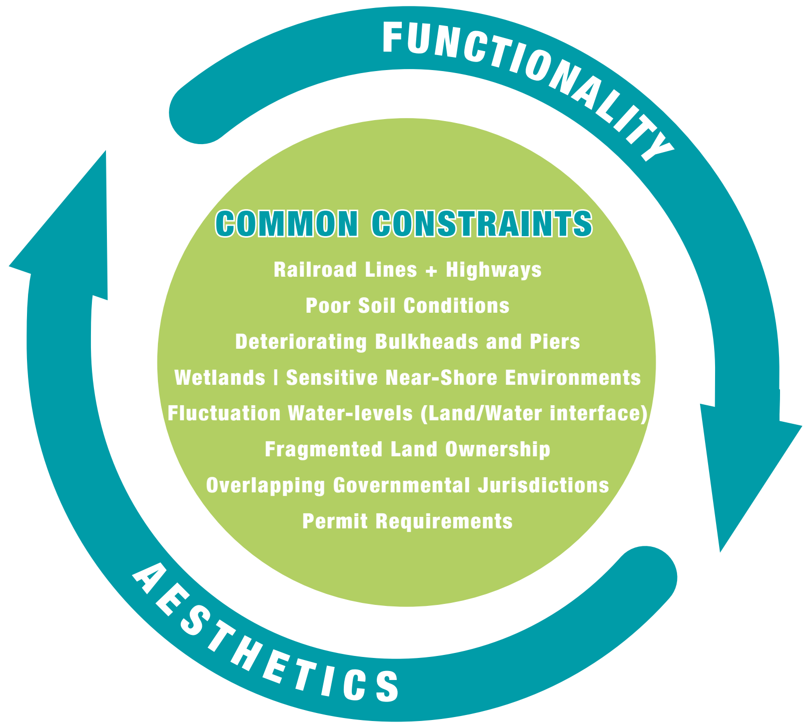

FIGURE 39. Common Constraints Of SCH Design (Wierengo)

PROGRAMMATIC ELEMENTS

Programmatic elements commonly associated with SCHs, can be broken into two categories for analysis and suitability studies: landside and waterside. The most dynamic and pivotal area within the design often occurs along the shoreline, where both categories of programs merge. The programming of this area should take into consideration both groups of programs and the way in which circulation between the spaces will function. The shoreline areas also entertain the most interaction between different stakeholders groups. Marina slip patrons need access and security for their vessels and supplies, while the public desire unobstructed access to the waterfront both physically and visually.

Developers and marina operators also need secure access to the water for vessel launching and retrieving activity, fueling, and general maintenance. All three of these activities require specific design elements in order to provide a safe, efficient, and enjoyable experience.

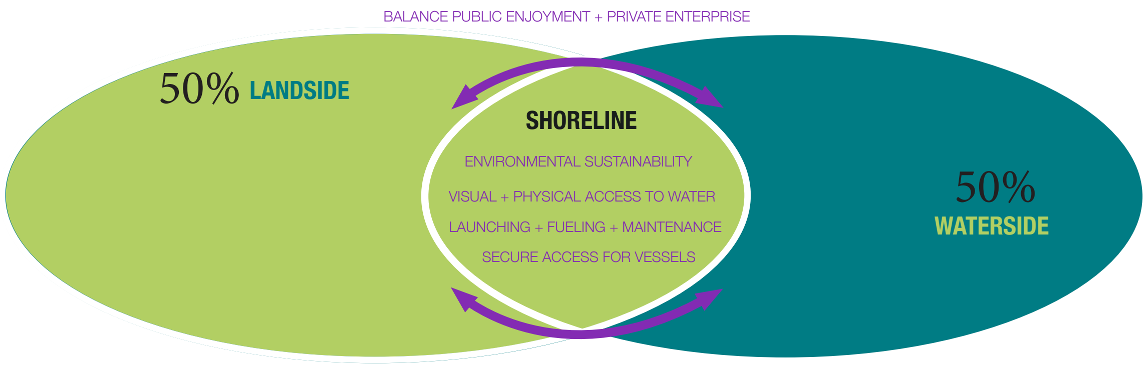

FIGURE 40. SCH Programming Categories (Wierengo)

Landside Programs

Land-based facilities generally comprise of 50% of the entire SCH infrastructure, and need to balance public enjoyment and private enterprise. This is extremely important because many SCH projects become developed under a public/private partnership entity. These facilities need to meet the broader needs of the surrounding community and promote environmental sustainability, provide visual and physical access to the water, maximize economic revenue potential, and minimize installation and operating costs[60]. Programs and design elements located on the landside areas of the site can further be broken down into four (4) sub-groups based on their primary user groups and general access (FIGURE

[60] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 285-286. Print.

FIGURE 41. Landside Programming (4) Common Use Groups (Wierengo)

Waterside Programs

Common programs within the waterside areas of the site can also be broken down into two sub-categories: inner-harbor structures, and protective outer structures. The protective outer structures include breakwaters and attenuators designed to act as protective barriers from wave energy and currents that pose risks to harbored vessel. Determining which structure to use, depends upon site conditions and budgets. FIGURE 43 illustrates advantages and disadvantages of both types of outer-structures.

Many people perceive marinas to provide services at the expense of the environment. What many regulators and the public fail to remember is that the in-water portions of boating structures can provide beneficial environmental habitats. The undersides of docks, piles and shoreline stabilization structures provide additional habitat substrates where marine organisms attach themselves

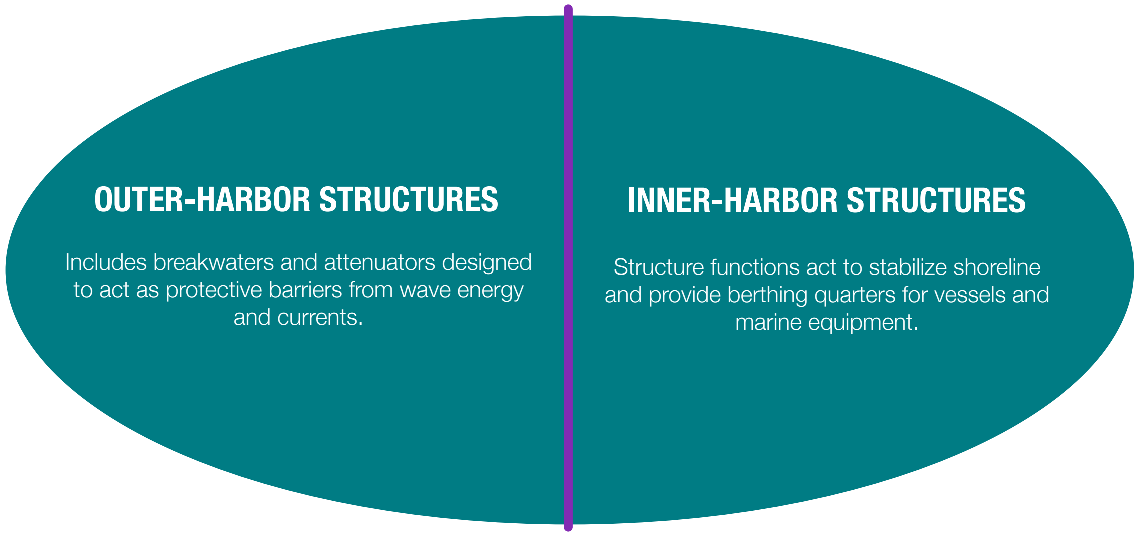

FIGURE 42. Waterside Programming Dual Zones (Wierengo)

and thrive[61]. Joe Brown, landscape Architect and CEO of AECOm's Design + Planning practice states "nature works. It can work with us, and it can work for us as long as we make room for it and design built systems that cooperate with it. It's time to think of natural systems as green infrastructure."[62] Thinking of the underwater structures with this approach, an opportunistic functioning on an ecological level is born. This is also an example of multi-usefulness of structures and materials to provide multiple services.

The material selection used in this area of the marina can serve to benefit or detract from the environmental quality of the area. Creosote and copper-based preservatives used to preserve wood, should be carefully examined in order to realize the toxic leaching which may occur into the waters. Studies

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[61] *Daniel S Natchez "Environmentally compatible marinas: The major issues that need to be addressed designing new and retrofitting existing marinas", Marinas, Parks and Recreation Developments (American Society of Civil Engineers, 1994) pg 51*
[62] Droege, Peter, and Joe Brown. "Revolution of practice." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 13. Print.

clearly show that in reasonably well-flushing areas, the contribution of dissolved copper from timber dock structures to the aquatic environment is so small it is undetectable,[63] but the wood preservative industry does caution that large scale marina projects should take into consideration the expediential affect with large amounts of timber in an enclosed environment. This data suggests even more importance in understanding and designing SCH to positively flush and filter the water in order to create healthy water conditions.

Inner-harbor structures include fixed and floating dock structures, wet slips, recreational piers, and mooring fields. Fixed and floating docks come with distinct design consideration for both systems use within a SCH as illustrated in (FIGURE 46). No matter what structures are decided upon, the waterside structures have a close working relationship between each other and create an entirely different circulation system crucial to the efficiency and success of the marina related operations. These are the building blocks of the SCH and define the water/land interface creating links between humans, vessels, and water. These structures also create the basis of revenue generation[64]. Common criteria in determining the most appropriate shoreline or 'edge' treatment and materials are illustrated in (FIGURE 45).

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[63] Dr. Kenneth M. Brooks "*The affects of dissolved copper on salmon and the environmental affects associate with the use of wood preservatives in aquatic environments*"; The Environmental Impacts of Boating; Dec. 2004

[64] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 191. Print.

BREAKWATER STRUCTURES

Effectively block 90% of wave action
Can be fixed to bottom or floating
Can be composed of various materials
Continuous or Discontinuous

ATTENUATING STRUCTURES

Only reduce wave agitation to some acceptable level
Mostly floating structures at least 1/2 water depth
Can be composed of various materials
Used when fixed breakwaters not feasible
Should be used only in protected coastal locations
Should be used in water depths less than 30 feet

RUBBLE STRUCTURE CONSTRUCTED OF PILED ROCK OR ITS EQUIVALENT

Earthened mound covered with armor.
Trapezoidal cross section with a 2H:1V typical slope
considered an attractive nuisance from a liability factor

SLENDER CANTILEVER WALL STRUCTURE

Affixed to bottom by piles and not penetrating more than 80% of water depth
Least amount of footprint + preferred by many regulators
limited to environments with wave < 6-10ft

GRAVITY CONTAINMENT STRUCTURE

Vertical faced + held in place by it's own weight
Interlocked to construct coffer wall or bin
Good choice in locations with minimal wave action
allows fish movement + flushing to occur

BREAKWATERS and ATTENUATORS

NOTES:

A. *Fixed structures* do not move relative to the wave.
Floating structures dynamically respond to the hydrraulics of the site.

B. In general design, the concern is how the waves will effect the structure. In this case, it is also imortant to know how the structure will affect the wave.

C. The water depth is the single largest factor in determining the cost and usage of harbor protective structures. Water depth based on associated depths during the design event and includue storm surge and tides.

BREAKWATERS:	ATTENUATORS
-Effectively block 90% of wave action -Can be fixed to bottom or floating -Can be composed of various materials (solid or porous) -Continuous or discontinuous (Vertically or Horizontally)	-Only reduce wave agitation to some acceptable level -Mostly floating devices and at least 1/2 water depth. -Can be composed of various materials (solid or porous) -Continuous or discontinuous (Vertically or Horizontally) -Used when physical, economic, or regulatory conditions preclude opportunity to construc a fixed barrier. -should be used in only the most protected coastl environments with water depths of less than 30ft.

BREAKWATER TYPES:	DESCRIPTION
Rubble structure constructed of piled rock or its equivalent:	- earthened built mound covered with aromor to protect against erosion. -Trapizoidal cross section with a 2H:1V typical slope. - Core must be built up to height of static stormwater level. -Rough armored water runup is 1/2-1/3 that of smooth armored structures. -Armor stone exterior material should have a diameter at least 1/3 wave height. -If public access permitable, crest width must be wide enough to allow for splash zone. -Considered an attractive nuisance from a liablity factor and must consider risk. -12ft is typical mimimun crest width to allow land based machines to drive out during construction.
Slender Cantilever wall structure	-affixed to bottom by piles and not penetrating more than 80% water depth -Least amount of footprint, so preferred by many regulators. -Limited to environments where waves of 6-10ft or less can occur.
Gravity Containment structure	-vertically faced cloesd cell -Held in place by its own weight. -Structural panels or sheets interlocked to construct coffer wall or bin -Offers greatest utility to land and water area but causes the most harsh water basin conditions (reflection) -Materials include steel sheets, timber crib, and standalone bin wall. -Pannel walls good choice in locations with minimal wave action -allow fish movement and flushing to occur through open bottom.

Information adapted from ASCE

FIGURE 43. Outer-Harbor Structures (Wierengo)

EDGE TREATMENT MATERIAL CONSIDERATIONS
material physical properties and strength
durability
adaptability
cost
availability
handling/constructablity
maintenence requirements
environmental imact
interaction of treatment with boats and humans

SHORELINE STABALIZATION CONSIDERATIONS

1. Erosion control requirements
2. Typical and storm wave and water levels
3. Amount of wave reflection or dissipation required
4. Stormwater|drainage requirements
5. Upland and waterside spactial limitations
6. Aesthetics
7. Environmental concerns and regulations

FIGURE 44. Edge Treatment And Shoreline Stabilization Considerations (Wierengo) (Data Source ASCE)

COMPARISON OF TYPICAL SHORELINE PROTECTION ALTERNATIVES

Alternative	**Function**	**Storm Protection**	**Footprint Impact**	**Relative Construction Cost**
Do nothing	Preserve Existing Conditions	None- natural erosion	No Change	0
Beach	"Soft" aesthetic, dissipate wave energy	Low-Moderate	Wide	$
Vegetated or geotextile bank protection	Maintain slope, maximize aesthetics and biologically	Low-Moderate	Moderate to Wide	$
Sloped revetment	Stabilize shore and dissipate wave energy	Moderate - High	Moderate	$$
Bulkhead | Wall	Retain upland and relect waves	High	Minimal	$$$
Gunite | Shotcrete	Stabilize slope and retain upland	Moderate - High	Minimal to Moderate	$$$

BEACHES: This is an economical and effective wave atttenuator that provides recreation and aesthetics to a design. It is important to consider the space needed for slope underwaer and littoral drift of sediment. If the beach will offer swimming, it is extremely important to seperate tswimming spacce from vessel traffic.

VEGETATED BANKS: These are less costly than hard-structures and provide/create habitat enhancement and mitigation. It is mportant to understand seasonal water level changes with respect to vegetation species used. Resistence to erosion is more limited compared to hard-edges, but may be offset by use within a hybrid treatment solution.

REVETMENTS: These stabilize shoreline while maximizing wave dissipation by releasing hydrostatic water pressure through the structure. These treatments are reccomended anythime spatial planning permits. Habitat creation can be incorporated via plant material introduced between armor spacing (biorevetments). Costs are lower than bulkheading and typically designed for the 25-50-year design event.

BULKHEADS: Provide maximum upland protection from waves, and retain backfill. allowing development to occur immediately ajacent to structure. Water depths are also preserved within close proximity to shoreline. These are the most costly, and reflect 90% of wave action.
Common materials:
Steel: sheet piles interlock (lifespan: 50yrs)
Concrete: Sheet piles and can be prefabricated or poured in place (lifespan: 30yrs)
Timber: Easy to handle and cost effective, but preservatives need and not envirmentally sound. (lifespan: <30yrs)
Composite: Replacement option for timber

GUNITE SLOPES: These are dry mixture of sement and aggregat that is sprayed and primarily used to protect eroding bluffs. Aesthetically, the y are sprayed over steel mesh material and can match surround geologic features in appearance.

FIGURE 45. Comparison Of Typical Shoreline Protections (Wierengo)

FIXED AND FLOATING DOCK CONSIDERATIONS

Factors to consider when choosing a dock type:

1. Environmental

Water Depths <20ft = Fixed or Floating docks
Water Depths >20ft = Floating docks
Notes: -catenary, chain, winchtype systems are used to anchor floating docks.
-If the tidal range fluxuated more than 3' within a normal cycle, floating docks are reccomended.
(access to boat and proper mooring line scope become difficult and dangerous when fixed docks are used in high range tidal areas)

2. Materials

-Timber: Southern Pine and Douglas Fir has to be treated and bans due to environmental concerns over chemical leeching require piles to be wrapped.
-Concrete: Applied in the construction of fixed piers in harsh environments. Can be used as piles in areas where bedrock is not found, but should not be used in cold areas where freeze/thaw occurs.
-Steel: Used in the substructure of fixed piers and floating docks, and as piles where fixed and float ing docks are used in deeper waters.
-Composite and Plastic Materials (Fiberglass-reinforced polymer (FRP): very corrosion resistant and used for decking and grating due to its high scratch resistance, and color retention against UV fading.
-Stone: Used in fix pier construction only. cost effective if quary is nearby. requires a hard substrate such as bedrock to be used within design and popular in early 20th Century construction of wharfs.

FIXED PIERS

PROS: Used if tidal ranges are less than 3ft and in low tidal estuarine environments. Fixed piers are better suited to withstand higher wave heights and long periods. They are cost efficive, have long usefull lifespans, and better accommodating of larger vessels.

CONS: During large storm events, fixed piers may become submerged, prohibitting access to vessels and causing electrical utilities to corrode or shore-circut.

FLOATING DOCKS

PROS: Rose in popularity in the 1970s and provide long lifespans (20-30yrs for timber and aluminum, 30-40yrs for concrete pntoon). Most systems are provided by regional or international based companies that provide design, manufacturing, and installation under warrantee for the complete system. Flotation is provided by open or closed cell polystyrene. Floats are ancored to bottom up to depths of 40ft.

CONS: Although both systems reduce light penetration to aquatic vegetation, floating docks gnerate more reduction. Incorporation of grated decking is possible to allow light to penetrate.

FIGURE 46. Fixed + Floating Dock Considerations (Wierengo)

Shoreline Interface

Riprap can provide a meaningful habitat, especially when a filter fabric is used to prevent erosion and sediment migration into the water basin. If the area is not conducive to the use of riprap due to the diagonal slope needed to secure riprap, vegetated planted buffer strips between the shoreline interface (usually vertical seawalls and bulk heading) and the remainder of the upland facilities should be used. Many marinas have found that such aesthetical approaches have allowed price increases that neighboring facilities were not able to sustain[65].

Outdoor Service Areas

Controlled areas designed to collect and contain all waste for the servicing of boats should be designated for such activities as the sanding, scraping, painting and even the washing of the boats[66]. Bluestone surfaces can sustain the loads needed for the weights of the larger boats, as well as the travel-lifts and cranes, while providing a pervious surface for stormwater infiltration. Vegetative screening also provides containment of air-blown particles to stay within the area. These buffers can also enhance the aesthetics of the site, by masking more industrial and private areas from the public.

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[65] Daniel S Natchez "Environmentally compatible marinas: The major issues that need to be addressed designing new and retrofitting existing marinas", Marinas, Parks and Recreation Developments (American Society of Civil Engineers, 1994) pg 55

[66] Daniel S Natchez "Environmentally compatible marinas: The major issues that need to be addressed designing new and retrofitting existing marinas", Marinas, Parks and Recreation Developments (American Society of Civil Engineers, 1994) pg 56

GENERAL HARBOR CONFIGUATION DESIGN GUIDELINES

Design Element	Optimal Location within Harbor	General Design Notes and Guidelines
Interior Channel		- 5x beam of average size boat +10% number of boats using the space
Berth Widths		
double		- 2x beam of wider vessel served + clearance for environmnetal conditions
single		- beam of widest vessel served + clearance for environmental conditions
Large vessels	Close to harbor entrance	- allow more maneuvering space, water depth, and reduction of interference with smaller vessels
Fuel and Sewer Pump-outs	Close to Harbor Entrance	- Should be well protected from waves to avoid spill-overs
Transiet Piers	Near Marina Office (also close to entrance if possible)	- efficeint conection and wayfinding between harbor master office should be encouraged
Launch + Haulout Facilities	Quiet waters away from activity near fuel dock	- Protection from wind, and close to holding piers for dry docked vesssels -ability to accomodate at least 3 vessels at one time within water space.
Head Piers		- should be kept to less than 600ft in length to make slips close to restrooms, trash receptacles, parking, and the marina office. - Minimum width 8ft (to allow cleats, power pedestals)
Mooring Fields		- If not sufficient space for full swing moorings,bow and stern balls should be used.
Dinghy Landing + Storage Area	Close to mooring Field Close to Dock office	- Appropriate Signage should be applied to landing platform
Harbor Entrance	Oriented not more than 10 -15% deviation from dominate wind direction Not parralel to shoreline As far as possible away from shoreline	- Straight approach 3-5x length of largest vessel accomadation - Entrance to harbors of <300 vessels = 6B (B= beam of largest vessel) -Wave absorbers should be used to minimize wave reflection off entrance breakwaters. - Entrance is the most restricted and highest risk area in the SCH. - Must be narrow enough to prevent wave penetration into harbor. -Optimal entrance depths 13-16ft minimum BUT at least 3ft below largest anticipated vessels keel at lowest water level + 10% draft of largest vessel for sheltered waters. (30% for entrances with 3ft waves present and 50% for areas with >3ft waves anticipated)
Vehicular Circulation	Directs user groups to specific areas	-tour/shuttle buses should be planned for.
Parking	trailer parking located by boat ramps Public parking close to public space Slip tenant parking close to Head Piers	-seperate parking for truck and trailer parking - .5:1 or 1:1 ratio for parking:wets lips (.5 in urban areas) -Additional parking for retail and restaraunts needed -Trailer parking minimum 20 spots per boat ramp lane.
Pedestrian and Bycycle	begin loops close to parking lots	
Waterfront Promenade		-benches, seatwalls, lighting, railing, and decorative features common. -Provide controlled access to berthing areas and other harbor facilities. -Consider use for emergency vehicle access -Typical widths: 6ft pedestrian only, 10ft with bycycles, 20ft with restaraunts, golf carts, vending carts.
Waterway Circulation	Transit dockage close to retail	-easy access to commercial and retail areas should be providd for vessel docking to enjoy land based facilities.
Lighting		-important to provide safety, but not distract marine navigation
Launching Boat Ramps	Away from wave action and winds	-Trench drains used at launch sites to collect sheet flow from entering water before treatment. -Washdown areas need to bontain contaminates that should be treated.
Storage Yards	Clear circulation path to launching sites	-Do not need to be paved, but must support boat and transport vehicle loads
Harbor Administration Faciluty	Adjacent to waterside access Centrally located	-Clear visibility into harbor waters -Act as main hub of operations for the harbor
Commercial Facilities	Access to waterside and public areas	-Restaraunts, bars, supply store, vending / concessions, boat sales, rentals
Fish Cleaning Station	Close to boat ramps and wet slips	-multiple stations with water access
Public Fishing Piers Docks	away from boat traffic and channels	- minimize interference with props, mooring balls and structures
Public recreational areas	away from harbor operations and equip.	-suggested activities include: picnic and grilling, horseshoes, bocce, rock wall, sand volley abll, playground, festival park area, dog park.
Dry Stacked Marina	Clear of overhead obstructions	-access to parking lots for boat owners should have strongconnection

FIGURE 47. General Harbor Configuration Design Guidelines (Wierengo)

CHAPTER 5: *SITE SELECTION* + *CONTEXT* + *ANALYSIS*

SITE SELECTION: BARRIER ISLAND WITHIN AN URBAN CONTEXT

The design site is located along the back-bay shoreline of Rockaway, NY. This decision was based on the current context and conditions of the area. The entire peninsula makes up the Community 14 District within Queens County, one of the 5 boroughs of New York City. As of 2012, Queens County had a population of over 2.2 million people. Neighboring Brooklyn has over 2.5 million residents. This indicates close to five million NYC residents are within 15 miles of the peninsula. The Greater NYC Metropolitan area just reached 19 million people and continues to grow. This concentration of residents within such a small area, and within close proximity to water, provides a wonderful opportunity to create a design exploring my research subjects (FIGURE 48).

Not only are harsh urban conditions generating problems for the community, but also due to the shape of the Atlantic coastline, it is positioned in an extremely vulnerable locations to storm surge flooding and damage. The New York Bight extends from Cape May NJ, to the tip of Long Island, and acts to funnel storm surge water towards its center; which happens to be the location of the Rockaway Peninsula (FIGURE 49).

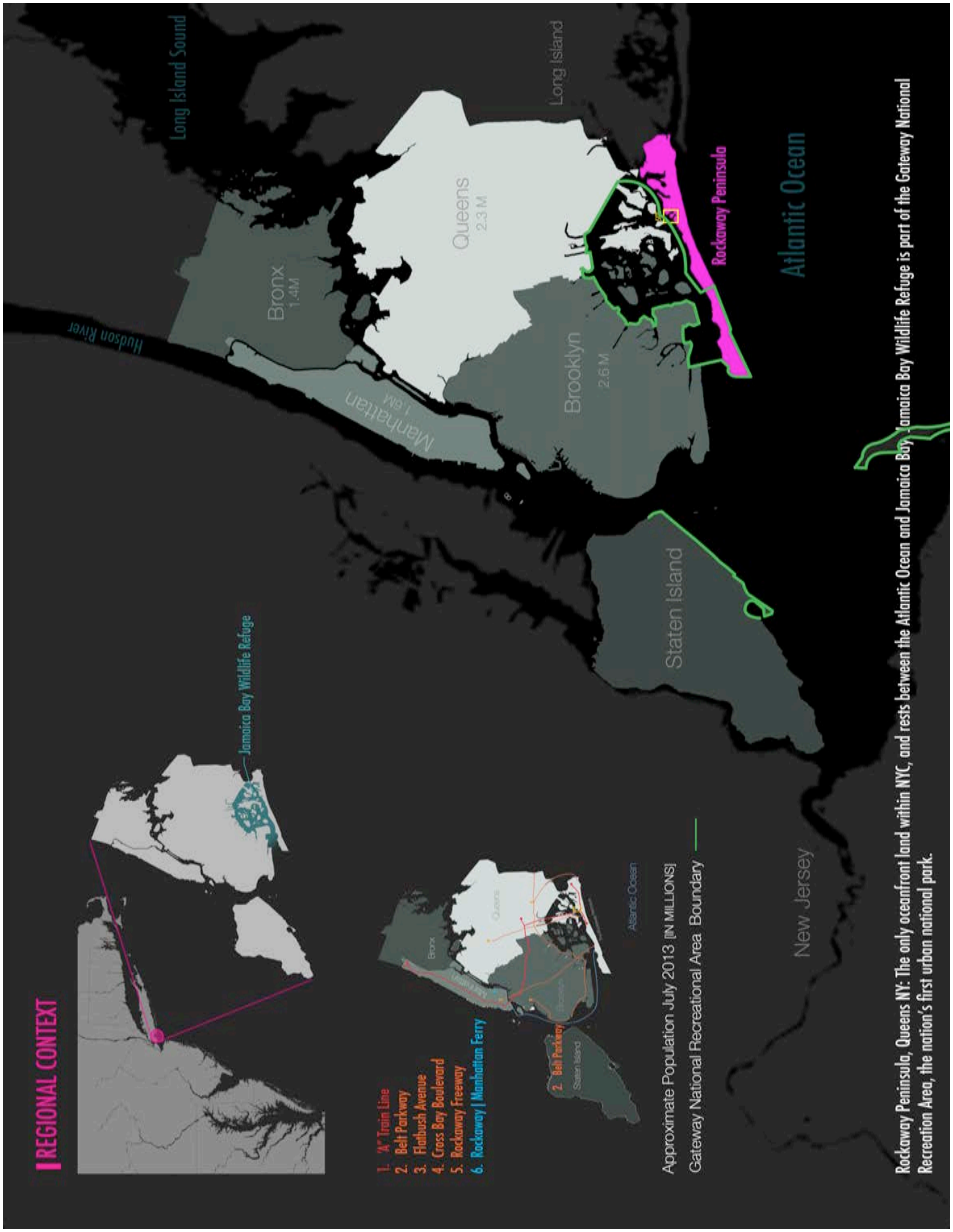

FIGURE 48. Rockaway Regional Context (Wierengo)

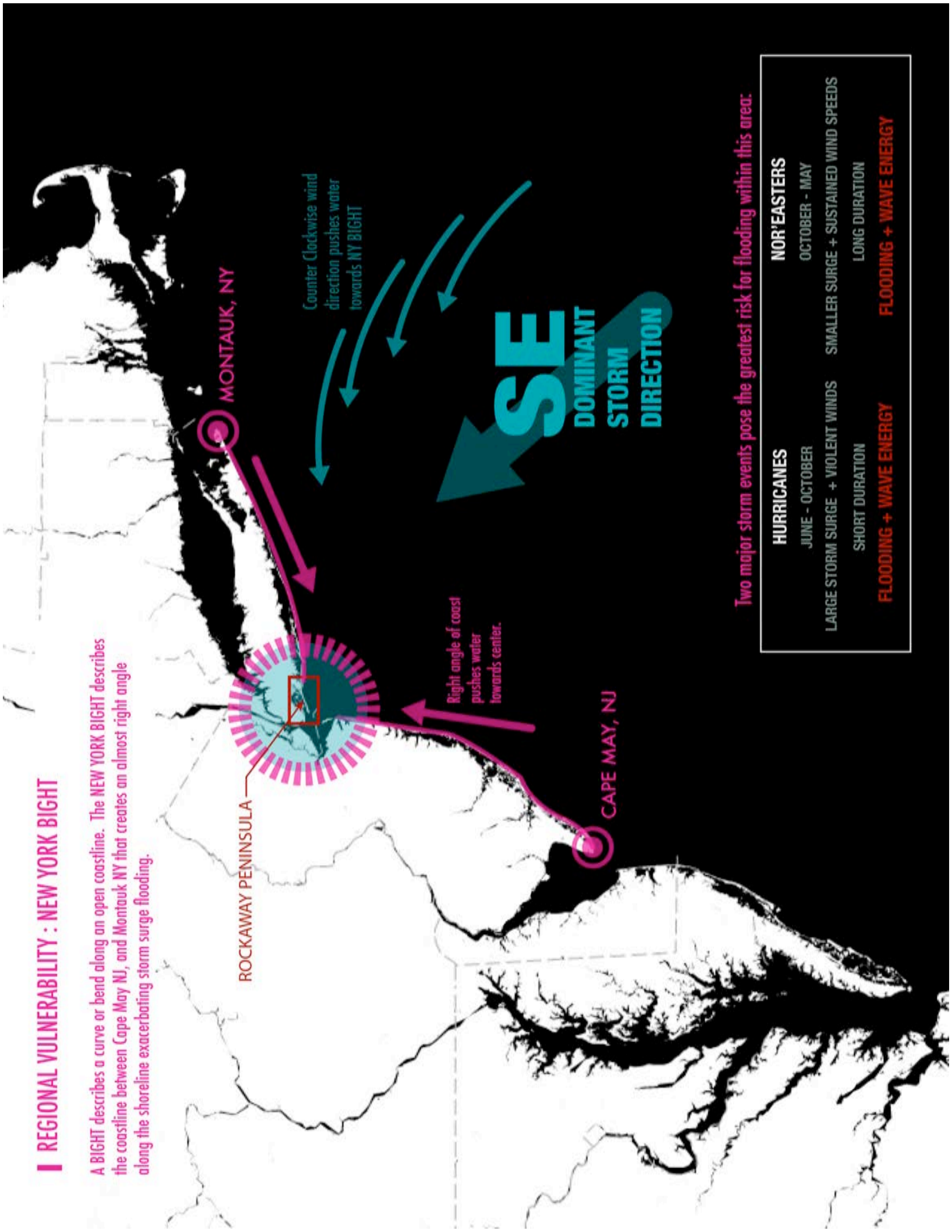

FIGURE 49. New York Bight + Rockaway Location (Wierengo)

Climate change poses to create additional significant risks to New York City's communities and infrastructure. On October 29th, 2012, Hurricane Sandy flooded nearly 50 square miles of NYC, and caused tremendous damage in the city. It was the most destructive storm in the regions history, and has focused attention on the effects extreme climate events have on New York City[67]. During hurricane Sandy, peak storm surge reached 10 feet and coincided with high tides, elevating water heights even further.

Outlined by the NCCP2 committee within the *Special Initiative for Rebuilding and Resiliency* report, addresses this area's vulnerability to storm surge and rising sea levels by limiting oceanfront and bayside exposures to floodwaters, and facilitating the rebuilding and retrofitting of buildings and infrastructure in a more resilient fashion to protect more efficiently. The plan also builds on the areas natural assets, local economic strengths, and community spirit to encourage reinvestment in its waterfront communities. This is an attempt for the communities to come back stronger after Sandy and become better prepared to confront a future of growing risks.[68]

The Jamaica Bay separates this relatively narrow barrier peninsula, from the mainland; a body of water that encompasses 13,000 acres, (20 square miles). Within this body of water, thousands of tidal islands, varying in size,

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[67] New York City, Special Initiative for Rebuilding and Resiliency, *A Stronger More Resilient New York*, (PLANYC, 2013), 5.

[68] New York City, Special Initiative for Rebuilding and Resiliency, *A Stronger More Resilient New York*, (PLANYC, 2013).

make up a jigsaw puzzle of salt marsh islands and tidal wetlands teaming with wildlife[69]. In fact this area is one of the most important resting grounds along the Atlantic Flyway, a migratory route used by millions of birds annually[70].

The waters of Jamaica Bay are part of the United States Department of Interior's only "Wildlife Refuge" and part of the larger Gateway National Recreation Area; the country's largest urban wildlife refuge that has been deemed the "crown jewel" of New York City's ecological resources. The areas proximity to natural aquatic environmental areas, confronted with poor water quality, proved even more advantageous.

Stormwater nutrient contaminations, and increased annual wetland loss, are two of the most important issues regarding the bay's health. Surrounding New York City's largest wetland, the 91,000-acre sewer-shed has been severely altered through anthropogenic actions and is nearly completely paved over, built up and industrialized. Less than 1% of the original freshwater wetlands remain and the 2.2 million people living in this sewer-shed, contribute to the almost 300 million gallons of treated effluent wastewater entering the bay each day. Nitrogen by volume is the largest contributing contaminating with almost 40,000 gallons a day. 92% of the Nitrogen originates from four (4) wastewater plants, and subway pump stations located along the bay's shoreline. This has left the ecological health of the bay unable to cope, and in serious distress[71].

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[69] *Soil Survey of Gateway National Recreation Area, New York and New Jersey*. New York City: US Dept. of Agriculture, US Dept.of Interior, 2001. Print.
[70] New York City Audubon, "Jamaica Bay Project", Jan 2014, <http://www.nycaudubon.org/jamaica-bay-project>
[71] *Soil Survey of Gateway National Recreation Area, New York and New Jersey*. New York City: US Dept. of Agriculture, US Dept.of Interior, 2001. Print.

Four (4) sites along the back-bay shoreline were selected and analyzed. An 81 acre site located along the central portion of the peninsula chosen most appropriate.

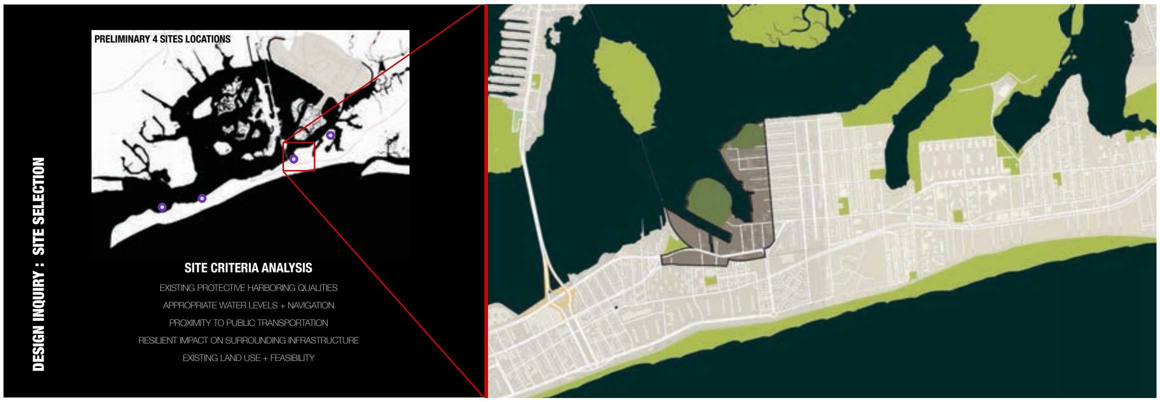

FIGURE 50. Preliminary Site Locations (Wierengo)

SITE INVENTORY + ANALYSIS

Research indicates it is crucial to conduct proper analysis of existing systems both waterside, and landside when determining the appropriateness of a potential site for the development of a SCH. Joe Brown, AECOM's chief executive of planning design+ development, suggests:

> "The only way we can make a real difference in our impact on the global environment and climate is through a holistic approach to policy, planning, engineering, and design, wherein all work collaboratively toward the common goal. That goal must be the functional integration of built and natural environments. Build environments should be viewed as the extension of natural environments, allowing natural systems to function and working with these systems in high-performance buildings and landscapes.

At the same time, we must not lose sight of our goals of economic productivity and social equity"[72].

When addressing the analysis and preliminary research needed for a SCH, the thought process illustrated in this quote provides incentive to look for solutions that connect the natural and built systems into a cohesive and unified space; where built and natural infrastructure blend seamlessly together.

Proper zoning, compatibility with existing land uses, good vehicular and pedestrian access, good access to navigable waters, and safe mooring at a reasonable cost, are also factors that greatly determine if a particular location is suitable[73].

The peninsula is a narrow strip of land nearly 11 miles in length, and varying in widths ranging from the widest dimensions measuring almost a mile wide, to extremely narrow areas barely 3/10ths of a mile. The site location exemplifies the peninsula's dimensions by providing both one of the widest areas, and one of the narrowest within the site (FIGURE 51). This is due to the two (2) water channels cutting into the site. At the narrowest point within the site, there is approximately 2,000 feet of land between the high tide lines of Jamaica Bay, and those of the Atlantic Ocean. The widest point of the site is 9/10ths of a mile between the high tide lines. The close proximity to both shorelines provides an opportunity to connect activities and programs occurring ocean-side, with those occurring within the site (situated along the bayside coastline). This could potentially strengthen the community identity as a water-oriented destination to

[72] Droege, Peter, and Joe Brown. "Revolution of practice." *Climate design: design and planning for the age of climate change*. Pt. Reyes Station, CA: ORO Editions ;, 2010. 12. Print.
[73] *Planning and Design Guidelines for Small Craft Harbors*. third ed. Reston: American Society of Civil Engineers, 2012. 13. Print.

live and visit, and community discussions have suggested and request opportunities to strengthen the connection between the beach and bay.

Disadvantages of such a narrow strip of land, could be revealed during intense storm events where rise water levels could rise to a point where they breach the peninsula and cause an inlet to occur. This poses significant threat and potential destruction. The area on site that is furthest from the Atlantic high tide line, has the least likely chance of a breach occurring, but is also much further away from beach activities to provide a strong connection.

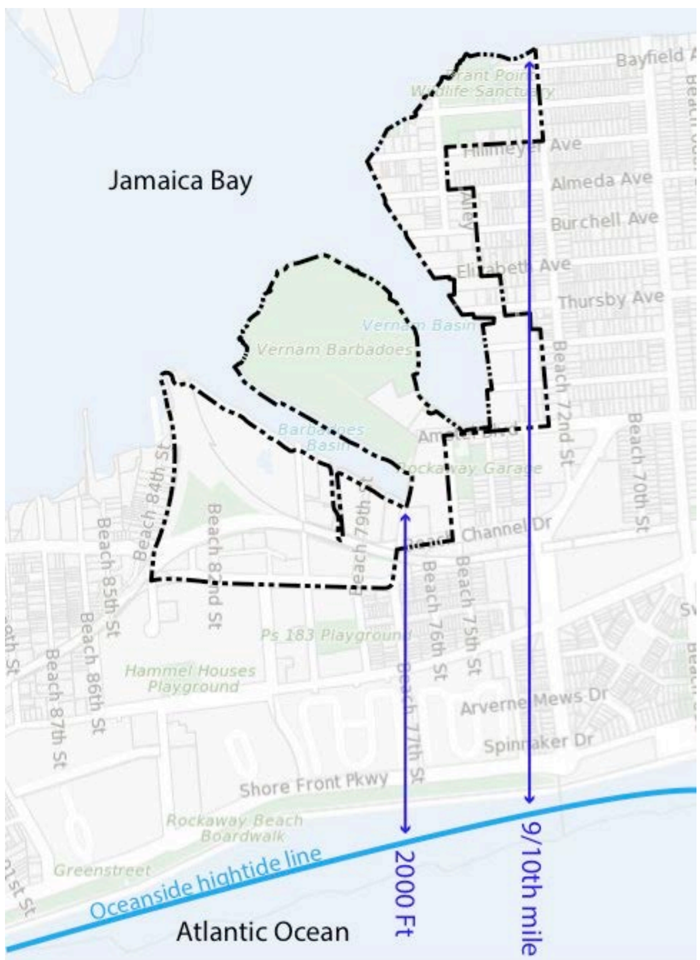

FIGURE 51. Distance Between Tide Lines (Wierengo + Propertyshark)

The barrier island that comprises the 'Rockaways', divides the Atlantic Ocean and the marine estuary of Jamaica Bay. The Rockaway Peninsula is part of a chain of barrier islands that stretch along the coastal Mid-Atlantic seaboard. These islands were created by the longshore transport of sediment (mostly deposited by glacial melt) and moved by wave actions and water currents[74]. The main direction of wave action for this area is from the southeast, indicated by the two large sand spits that dominate the central coastal area of the New York Bight; Sandy Point on the New Jersey coast, and Breezy Point, NY (located on tip of the Rockaway Peninsula).

Similar to most barrier islands located within the Atlantic Coastal Plain province (ACP), natural areas are comprised of Eolian and Marine washed sands along the coastal shorelines, but the majority of exposed surfaces, such as those within the site, have become 'anthropogenic soils' caused by human manipulation through activities such as dredging, hydraulic fill, coal ash, and broken down concrete rubble (FIGURE 52). Many of these locations had their soils compacted over time due to development, or use as a dump deposit location and have lost their permeability; thus creating greater runoff. For these areas, erosion is mostly due to stormwater runoff displacement of sediment. Unregulated deposits along the waters edge that occurred in previous years, have also increased contaminates leeching into the soil and eventually stormwater runoff. Many soils with contaminates have not been properly capped

[74] *Soil Survey of Gateway National Recreation Area, New York and New Jersey*. New York City: US Dept. of Agriculture, US Dept.of Interior, 2001. Print.

and sealed throughout the peninsula causing a slow leak into the neighboring water bodies directly affecting the quality. Soils making up the marshes that reside within the Jamaica Bay estuary, and alongside the ‘back bay’ shoreline of the Rockaways consist of organic deposits underlain by glacial outwash.

Areas that have retained natural soils made of mostly sand, coarse rock and broken shells, have very quick drainage capacities that allow quick movement of water, creating low moisture holding capacity. Because of the low moisture holding capacity, plant material is sparser in these areas, resulting in erosion occurring not from stormwater runoff, but from strong prevailing winds. Plant selection for the site should be chosen based on their minimal watering needs, and ability to stabilize sediments.

FIGURE 52. Anthropogenic Soils Dominate Site (Wierengo)

Shoreline soils are dotted with remnants of concrete rubble, stone riprap, rusted metal fragments, and sandy silt deposits. There are certain areas that are more natural in appearance and exhibit tidal mudflats with sandy embankments and broken pieces of marsh that are still in existence (FIGURE 53).

FIGURE 53. Degraded Shoreline at Low Tide Within Site (Wierengo)

There are many constraints within the site regarding stormwater infiltration, due to existing soil conditions. In their compacted states, the soils are not expected to infiltrate at the desired levels to contain stormwater runoff with the site. Based on current land uses, there is a high probability of some contamination residing on site within the sub layers of soil, although exact determination of their presence cannot be positively identified within the scope of this project. Opportunities exist in ameliorating past degradation of the soils and nearby waterways by containing and treating stormwater as it enters the site before being released into the open water of the bay.

FIGURE 54.   Existing Shoreline Stabilization Methods (Wierengo)

Shoreline remediation and cleanup will also aide in filtering contamination that is already residing within the open water and soils along the edge. Debris haphazardly is thrown between washed out areas between aging bulk heading, while rusting boats, and heavy machinery litter natural shorelines. Other areas, see dilapidated infrastructure falling into the water (FIGURE 55).

FIGURE 55.   Existing Site Shoreline Stabilization on Site (Wierengo)

TOPOGRAPHY

The topographic reliefs of the landscape within the Atlantic Coastal Plain are relatively flat with slight undulations.[75] Elevations on the peninsula range from sea level to ten feet, and the entire peninsula is within the Coastal Zone Boundary and susceptible to flooding and storm surge associated with tropical storms and large winter events.

Because the site is extremely flat except for a small portion of land within the peninsula, storm surge resiliency must be fully integrated within the design. Natural shorelines have a slight gradual slope into the water, and this gradual decline continues below the waters surface. There is a wetland present on site, but is littered with invasive plant species and trash *FIGURE___ Existing Wetland on Site).* Using this information, an opportunity can arise if programmed to act as a stormwater filter and restrict building around this depressed area.

FIGURE 56. Existing Wetland on Site (Wierengo)

[75] *Soil Survey of Gateway National Recreation Area, New York and New Jersey*. New York City: US Dept. of Agriculture, US Dept.of Interior, 2001. Print.

The flat terrain of the site provides strong areas for structures, parking, and play space without extensive grading, but can also act as a possible weakness because there is not a strong hierarchy of view-sheds created by the topography. Site lines will be affected by vegetative and structural programming and may provide division of the site. The flat area is also a concern based on its elevation. The majority of the site is only five feet above sea level, and has a significant chance of water inundation during a storm event. Structures and plant material must be able to withstand saltwater inundation. Structures should also have the ability to withstand debris carried through storm surge that may crash against its foundations. Opportunities to strengthen views and protect structures exist if the design incorporates strategies to elevation structures above storm surge water lines. This could protect the structures from storm surge and floating debris, and create elevated vantage points.

JAMAICA BAY

The Rockaway Peninsula divides the waters of the Atlantic Ocean, from the calmer waters of Jamaica Bay. This body of water encompasses 13,000 acres, (20 square miles) and has been deemed the "crown jewel of New York City's ecological resources."[76]

The waters of Jamaica Bay are part of the United States Department of Interior's only "Wildlife Refuge" and part of the larger Gateway National Recreation Area; the country's largest urban wildlife refuge covering over 26,000

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[76] *American Littoral Society, "Protecting Jamaica Bay", Jan 2014, <http://www.littoralsociety.org/index.php/component/content/article/17-special-places/jamaica-bay/10-jamaica-bay>*

FIGURE 57. Jamaica Bay Estuary (Wierengo)

acres of land and water across New York and New Jersey.

Within the body of water that makes up the bay, thousands of tidal islands, varying in size, make up a jigsaw puzzle of salt marsh islands and tidal wetlands that became established on post-glacial outwash plains at the terminus of the many creeks and steams of long island.[77] These islands are teaming with wildlife and are the last reminder of what once covered most of New York City's coastal landscape.

Surrounding New York City's largest wetland, the landscape and watershed is nearly completely paved over, built up and industrialized. Human populations surrounding this body water are estimated to be 5 Million. The

[77] *Soil Survey of Gateway National Recreation Area, New York and New Jersey*. New York City: US Dept. of Agriculture, US Dept.of Interior, 2001. Print.

Jamaica Bay watershed includes portions of Brooklyn, Queens and Nassau County, and has been severely altered through anthropogenic actions that have left the ecological health of the bay unable to cope (FIGURE 58). On going efforts around the watershed are working to benefit the ecology and public awareness of the fragile nature of the back bay. The site design has the opportunity to contribute towards these efforts.

There are large areas along the perimeter of the Bay that are designated wildlife and park open space. Most of these areas are along the north and northeastern edge opposite the Rockaway Peninsula. Areas designated parkland and open spaces within the peninsula are primarily on the western edge and away from the majority of residences.

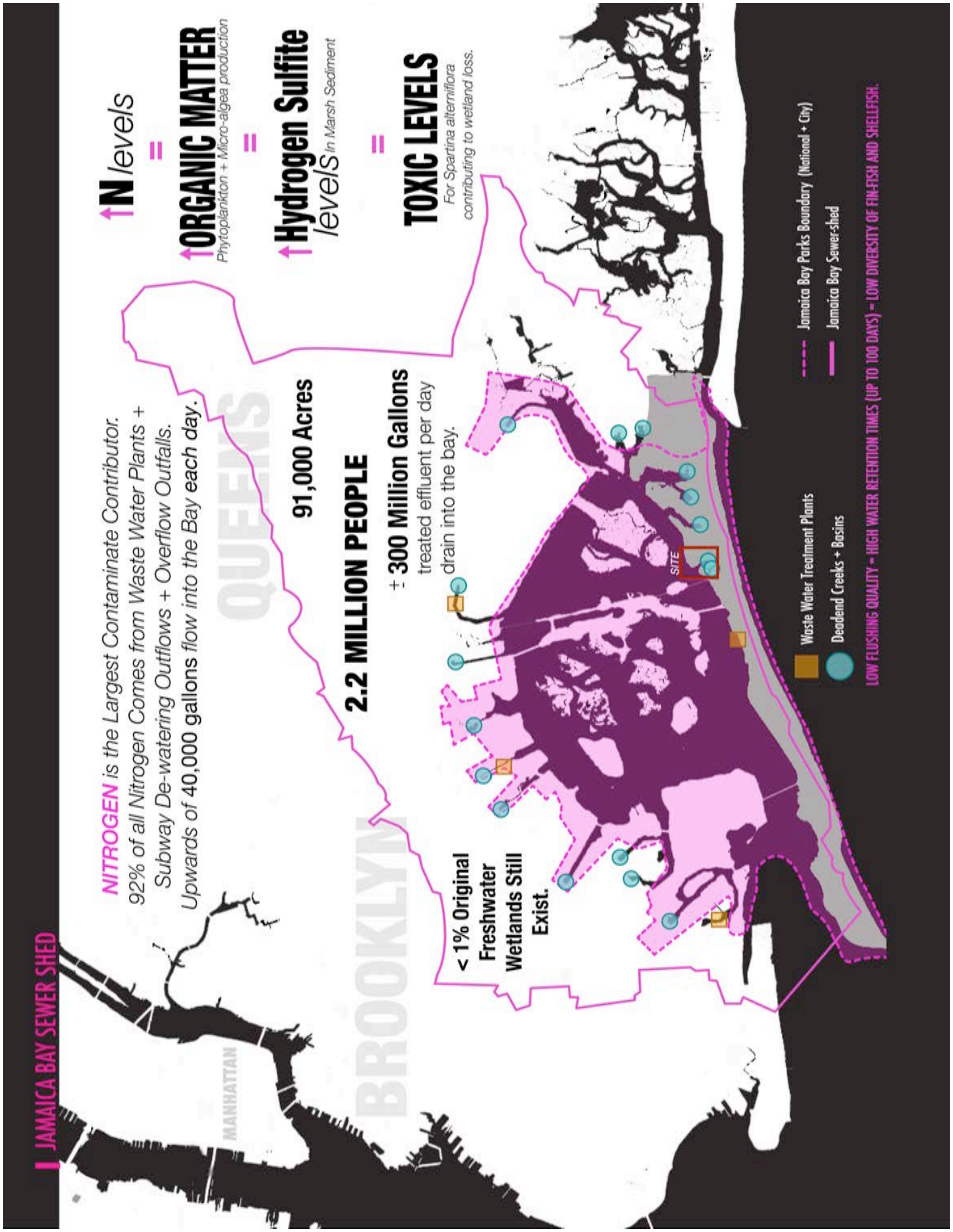

FIGURE 58. Jamaica Bay Sewer-shed + Contamination (Wierengo)

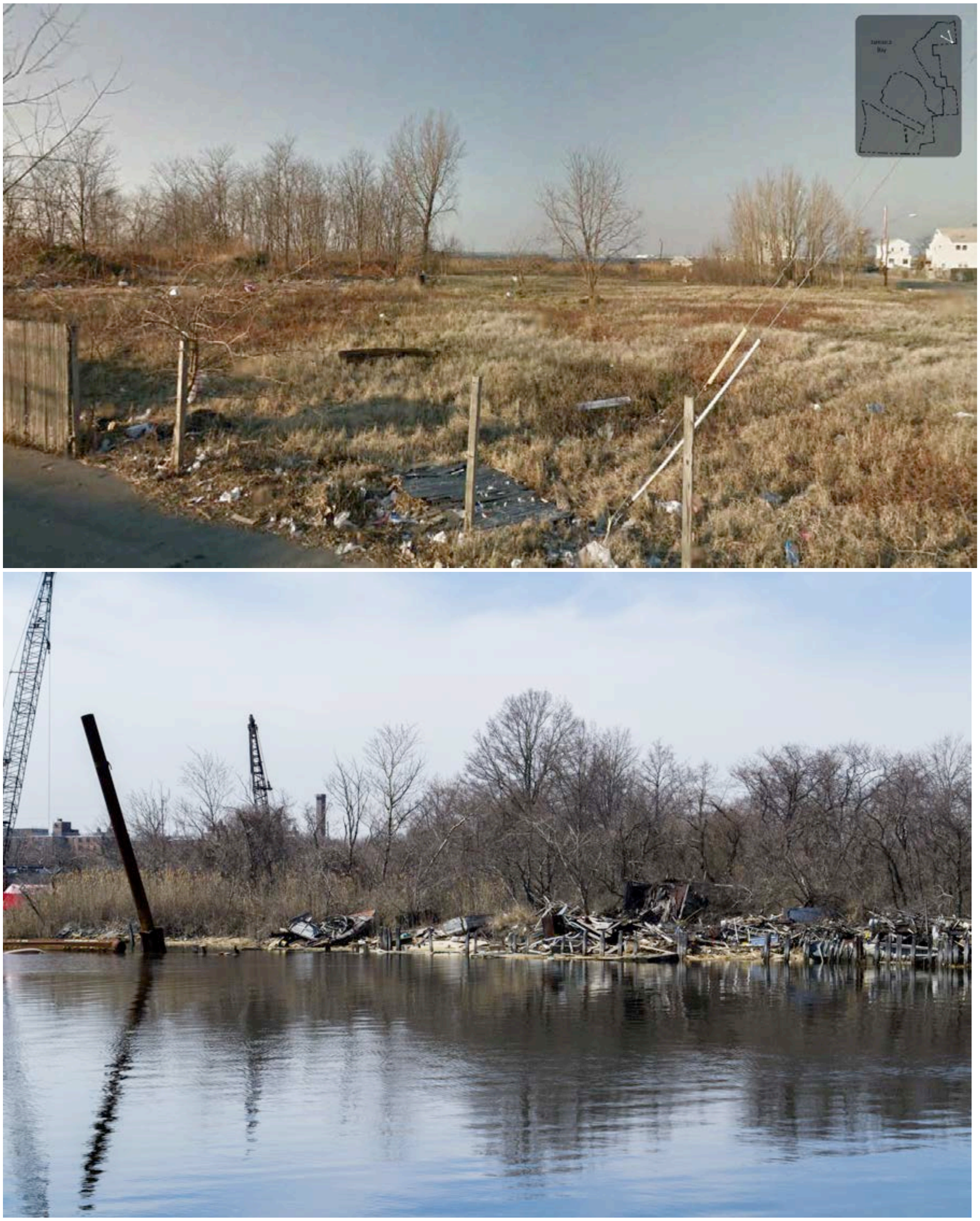

FIGURE 59. Existing 'Wildlife Parks' on Site (Wierengo)

Within the site, there are two areas zoned as parkland; both show little maintenance or efforts of revitalization, and degraded sites and debris hinder access. Surrounded by dense residential neighborhoods, the site has the opportunity to connect the two isolated open space parcels found on site act as a one cohesive public waterfront for the residences.

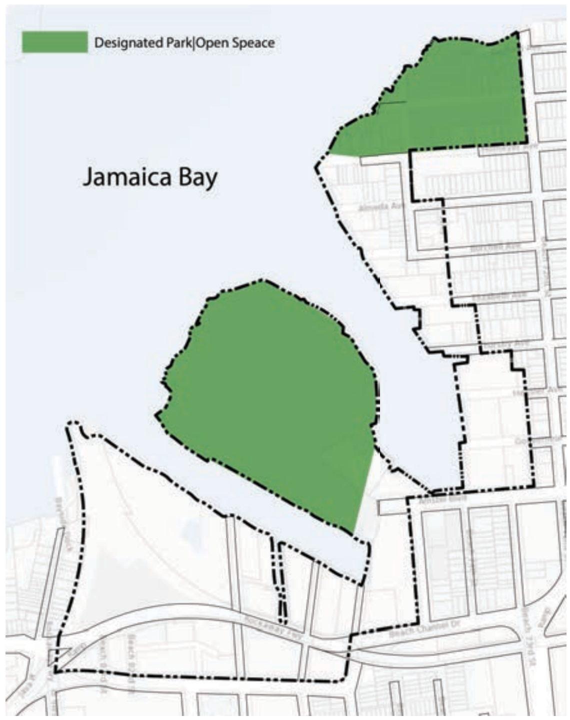

FIGURE 60.   Designated Open Space Within Site (Wierengo)

There are also multiple barges, and floating debris within the sites waterways that currently pose a risk to public health and safety.

The natural peninsula found within the site can become an opportunity if restored to function as a health habitat for the bays wildlife. Attracting this wildlife to the site, and opening the space to the public, creates a wonderful opportunity for education, environmental activism, and recreational sport. The site and it’s physical attributes also suggest an opportunity to create new wildlife habitats as sea levels change and marshland migrates shoreward.

FIGURE 61. Naturalized Peninsula On Site (Wierengo)

TIDES + BATHYMETRY + HYDROGRAPHY

Jamaica Bay experiences a semidiurnal tide cycle. This equates to experiencing two high tides, and two low tides of similar heights within one 24-hour period. The heights of these tides vary throughout the year, but have an average range of 4.1ft - 6.5ft within the Jamaica Bay water body. High tides are 12 hours and 25 minutes apart[78]. There are different forces that affect the levels of water associated with each tidal event. Lunar and solar positions compared to the earth create two (2) spring and two (2) neap tides each lunar month. Spring tides occur when the sun, moon and earth's gravitational forces are all in alignment. This creates higher than normal water levels during high tide, and very low water levels during low tide. Two weeks after the spring tide, a neap tide occurs when the sun and moon's forces counter one another, and create less than average water displacement. Local conditions affect the range of tidal heights and include: the shape of the bay, water depth, and prevailing wind directions. Offshore winds from the northwest during the winter push water out to sea and create lower tide levels. Onshore winds during the summer months, push water into the bay, and create greater tidal levels.

These tidal events play pivotal roles in the health of the water body. Each tidal cycle flushes water both into, and out of the bay. Affects of the flushing include dispersal of pollutants, circulating nutrients, and introducing cleaner

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[78] National Oceanic Atmospheric Administration, "Tides and Currents", Jan 2014 http://tidesandcurrents.noaa.gov/noaatidepredictions/NOAATidesFacade.jsp?Stationid=8517137

oxygenated water from the ocean. Tidal currents also move floating animals and plants to and from breeding areas in estuaries to deeper waters[79].

The term "bathymetry" originally referred to the ocean's depth relative to sea level, although it has come to mean "submarine topography," or the depths and shapes of underwater terrain. Hydrography includes not only bathymetry, but also the shape and features of the shoreline; the characteristics of tides, currents, and waves; and the physical and chemical properties of the water itself.[80]. Jamaica Bay is roughly semi-circular in shape, and approximately four miles wide, north to south, and eight miles long, east to west. Much of the area in the center of Jamaica Bay consists of narrow channels and tidal marsh islands that are exposed during low tides. Navigable channels, approximately 30 feet in depth, encircle most of the outer ring of Jamaica Bay, with navigable tributaries connecting to the main channel. Tidal exchange with the Atlantic Ocean is through Rockaway Inlet. Jamaica Bay contains approximately 16,000 acres of surface waters and 3,000 acres of islands and marshes. The mean depth of the bay is approximately 13 feet, with maximum depths reaching 30 to 50 feet in navigation channels and sand borrow pit areas.

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[79] *NOAA, "National Ocean Education Services", Jan 2014, http://oceanservice.noaa.gov/education/kits/tides/tides09_monitor.html*
[80] *NOAA, "National Ocean Service", Jan 2014, http://oceanservice.noaa.gov/facts/bathymetry.html*

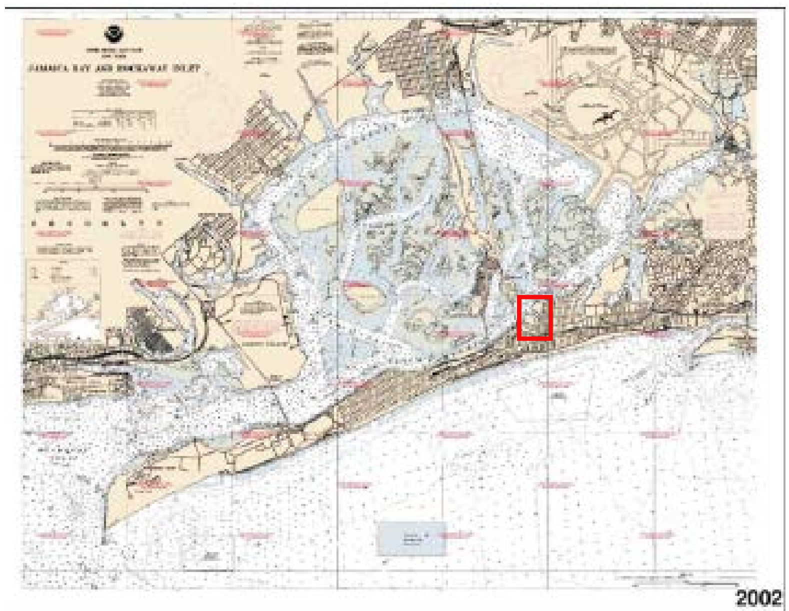

FIGURE 62. Historic + Existing Shorelines and Wetlands (NOAA +Wierengo)

The Jamaica Bay estuary is only about half of its pre-colonial extent and the salt marsh wetlands that have been a defining ecological feature of the Bay are decreasing at an accelerated rate. Over the last 150 years, interior wetland islands and perimeter wetlands have been permanently lost as a result of extensive filling operations; shorelines have been hardened and bulk-headed to stabilize and protect existing residential communities and infrastructure; deep channels and sand borrow pit areas have been dredged altering bottom contours and affecting natural flows within the Bay; natural tributaries providing freshwater inputs and coarse sediment exchange with the Bay have essentially disappeared resulting in accumulations of silts and particulates from urban runoff. These activities have altered historic flow patterns in the Bay, eradicated natural habitat, impacted water quality, and modified the rich ecosystem that was present prior to the extensive urban development of the watershed[81]. The sediment flushing time has increased 250 percent since the construction of JFK International Airport, from 10 days to 35 days[82].

The sites location within the bay is within close proximity to one of the major channel. This provides the opportunity to encourage positive flushing of the water within the two basins. The water basins that project into the site are rectilinear In nature and exhibit a long and narrow form. Both water bodies also terminate at a dead end resulting in weak water circulation within the site. Without proper water flow, suspended pollution particulates can potentially migrate (or sink) to the water bottom at the headwaters of the basins where water flow is weakest and create a layer of pollution resting on the water bottom. There may be an opportunity to connect the two water bodies and incorporate a flushing device to encourage positive flushing (*FIGURE__ Water Basin Shapes +*

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[81] *New York City Department of Environmental Protection 'Waterbody/Watershed Facility Plan Jamaica Bay and CSO Tributaries', Jan 2014, http://www.hydroqual.com/Projects/ltcp/wbws/jamaica_bay/jamaica_bay_section_8.pdf*
[82] *New York City Department of Environmental Protection 'Waterbody/Watershed Facility Plan Jamaica Bay and CSO Tributaries', Jan 2014, http://www.hydroqual.com/Projects/ltcp/wbws/jamaica_bay/jamaica_bay_section_8.pdf*

Potential Circulation Improvements). Tidal ranges are high and could be problematic when designing access points to the water.

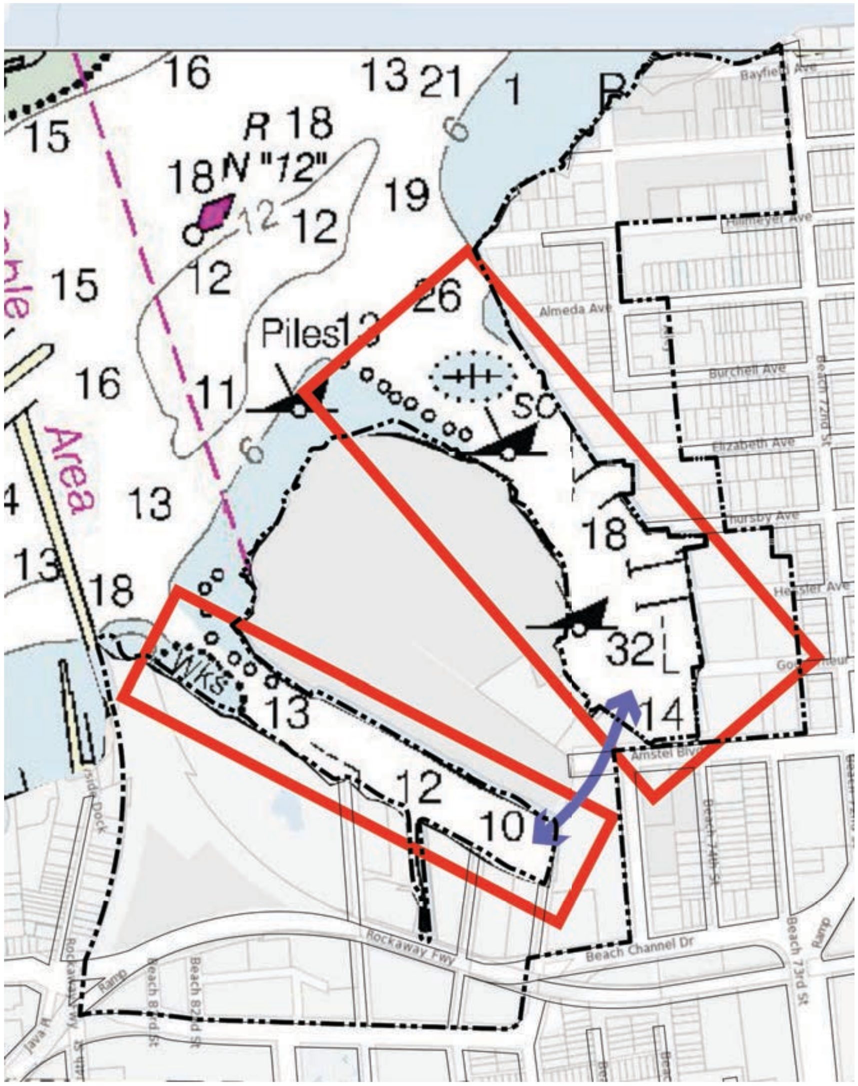

FIGURE 63. Water Basin Shapes + Circulation Improvements (NOAA+Wierengo)

This site is marked as breeding and spawning habitat for fish and other aquatic species. There is an opportunity to aide in the bays ecological recovery through the design of habitat creation. There is also the ability to encourage education and volunteer monitoring by local residence due to the sites close proximity to their residence.

CLIMATE + NATURAL DISASTERS

The site and peninsula resides close to the path of most storm and frontal systems that move across the North American continent. Weather systems often approach from the westerly direction. This has the potential to generate higher temperatures in the summer and lower temperatures in the winter that would not be expected in this coastal environment.[83] Cool onshore breezes in the summer months keep afternoon temperatures down, and relatively warmer water temperatures with the aide of urban heating effect keep winter temperatures to a degree much warmer than inland temperatures. Daily temperatures in the summer months are above 70 degrees, and the average first and last frosts are November 11th and April 1st. This gives the area 207 growing degree-days. During the winter months of December, January and February, daily high temperatures do not usually reach above freezing, except in the microclimates next to the water.

The marine influence moderates extreme weather for the site. Close proximity to the water enables the site enjoy a cooler microclimate during the summer months, and capitalizing on the winds coming off the water. During the cold winter months, when the winds shift to a more northwestern direction, the site will have to contend with cooler wind chills. It would be advantageous for the

[83] *Soil Survey of Gateway National Recreation Area, New York and New Jersey*. New York City: US Dept. of Agriculture, US Dept.of Interior, 2001. Print.

plan to encourage positive wind capture for the summer months, while protecting the site from cold winter winds.

According to the NY Department of State risk analysis, The Rockaway Peninsula is extremely vulnerable to damage and destruction as a result of natural storms and severe coastal weather events. Changing sea levels will continue to increase this risk.

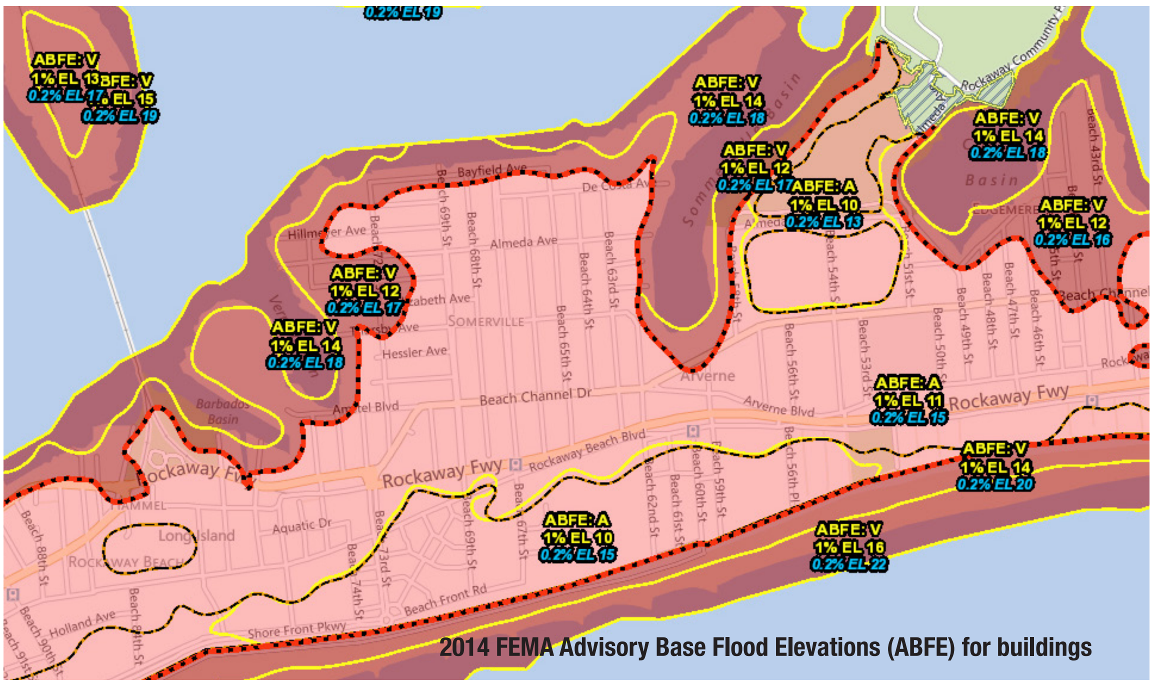

FIGURE 64. FEMA Flood Risk Zones (FEMA)

Damage incurred dating back to the famous 1992 'perfect storm' winter Nor'easter event, severely damaged the bulkhead abutting Jamaica Bay and placing homes and streets in the communities of Arverne, Bayswater, Broad Channel, and Edgemere in jeopardy of falling into the Bay. Street flooding has become common and dangerous[84]. The flat topographic relief, low elevation

[84] *New York City Department of City Planning "statement of community district 14 needs fiscal year 2014", Jan 2014, http://www.nyc.gov/html/dcp/pdf/lucds/qn14profile.pdf#profile*

relative to sea level, and its abutment to water virtually in every direction, puts flooding as the primary risk for destruction. The peninsula reacts as many barrier islands do to large storm event: direct wave action batters the beach on the oceanside of the island, while ‘backdoor’ flooding inundates the bayside area from elevated water levels in the back-bay[85]. During Hurricane Sandy, dunes on the oceanside were able to reduce water inundation, but water levels on the bayside reached in excess of 12 feet in portions of the Somerville Neighborhood next to the site. Water levels on the bayside became elevated to a level where portions of the ‘A’ train bridge washed away. Long-term plan for strengthening the coastline by the US Army Corps of Engineers and NYC Department of Parks and Recreation, and NYC Economic Development Corporation are underway to complete a beach re-nourishment project that will deposit 3 million cubic yards on the beach. This project is anticipated to be complete May 2014. The end result of this project is to provide a ‘harden’ protective infrastructure and a scenic pedestrian and recreational path for residence.[86] Unfortunately, due to the high percentage of residences in the low-income bracket, flood insurance, and means to repair damages from flooding are extremely low. When Hurricane Sandy hit the peninsula in 2012, only 14.4% of the residence had flood insurance.[87] Older Residential communities are concentrated along the bayside. Typologies of housing vary from pre-1950 single story bungalows, to mid-rise multifamily

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[85] *Rockaway West Planning Committee, “The Rockaway West Community Reconstruction Conceptual Plan” , October 2013*
[86] *Rockaway West Planning Committee, “The Rockaway West Community Reconstruction Conceptual Plan” , October 2013*
[87] *Wharton Center for Risk Management and Decision Processes,University of Pennsylvania, 2013*

housing. Risk analysis maps indicate the entire site is within the high risk zone for flooding, with specific areas falling into the extreme risk zones.

The entire site is situated within the high to extreme risk zones. This is an obvious weakness and constraint on any design. Because the site follows the bayside coastline and is located next to an extremely vulnerable neighborhood comprised predominately of aging single story bungalow housing typologies, the site has the opportunity to protect these residences from future storm events and flooding. Building typologies for the site need to anticipate future storm events, and changing sea levels in order to provide resiliency towards destruction. Flooding, high winds, and floating debris are all issues that need to be taken into consideration when determining programming and designing the site.

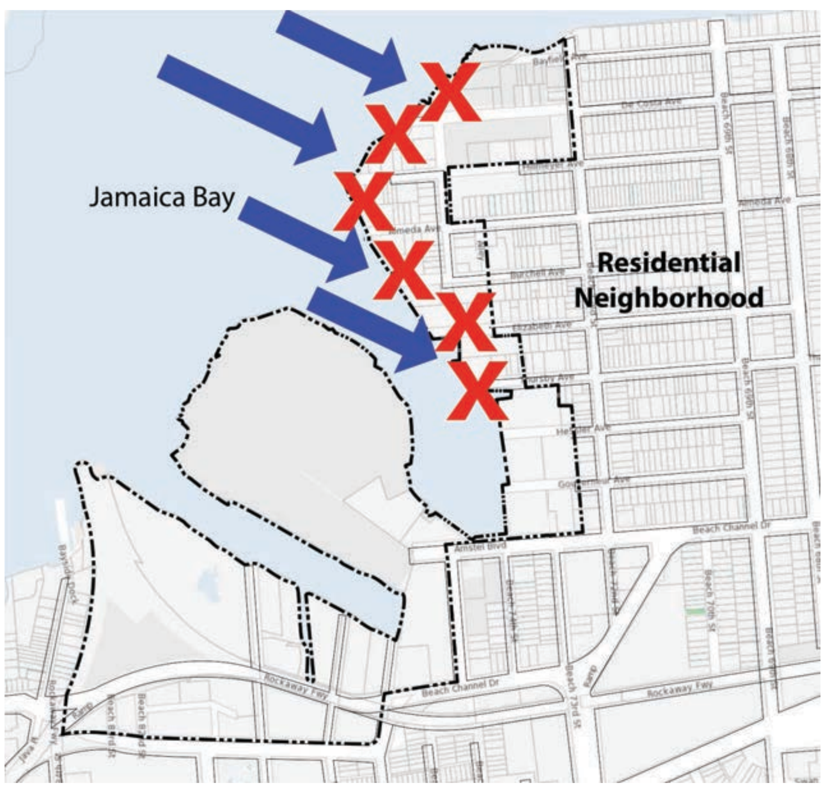

FIGURE 65. Potential Storm Surge Protection for Neighborhood (Wierengo)

From a land-based standpoint, analysis of how most people will arrive and enter from the site can prove to combine the use of certain areas within the site. For example, if it is determined there will be enough visitors to warrant overflow parking areas, and certain peak times during the year or month can be determined, these parking areas may be programmed during the non-peak times to be utilized for purposes other than vehicular parking. Precedents have been obtained where parking lots during the winter months, are used to store winterized boats. Materials choices for the parking lots might also be determined based on temporal usage. Overflow parking lots, used mostly only during the peak-times, can utilize the long periods of open exposure to the sun, and incorporate geo-pavers instead of an impervious surface material.

Waterway access to the site is also important to understand. Determining dominant directions boaters navigate towards once they leave the harbor can influence the design and flow within the harbors water channels. The internal circulation related to boaters is also extremely important. Because the goal of the harbor is to provide safe, and efficient usage of it's waterways, certain boaters may enter the harbor to locate and store their boats in wet slips, while other boaters may require their boats to be dry docked and located an a different location. There may be boaters unfamiliar with the harbor channel orientation looking for fuel or supplies. These intrinsic circulation patterns custom to harbor design highlight difficult design constraints that must be married to the land based circulation patterns.

WILDLIFE

Jamaica Bay is home to over 325 different species of birds and 91 different types of fish. Two dozen mammals area also common to the area including the Common Raccoon, Virginia Opossum, Eastern Cottontail Rabbit, Eastern Grey Squirrel, and several kinds of rats, mice, voles, and bats. Larger marine mammals have also been spotted including the Atlantic Bottlenose Dolphin, Harbor Seal, and several species of whales. The Gateway National Recreational Area has the largest concentration of beach-nesting birds in the Northeast[88]. It is also extremely important to the migratory bird species. Located in the Atlantic Flyway Migration route, the bay is used for stopovers by a large number of birds during the seasonal migration. The location of the site is of particular importance due to the change in direction of the Atlantic coastline. South this area, the coastline runs primarily north to south. The direction changes to west to East north of this area beginning with Long Island, and continuing to Cape Cop Massachusetts. The area is frequented by federally endangered and threaten bird species including the Roseate Tern and the Piping Plover. Other bird types include long legged waders, beach nesting, grassland, and raptors such as the Coopers Hawk, Peregrine Falcon, Osprey, and Bald Eagles.

There are 25 species of reptiles and amphibians that reside within this landscape. 15 of these have been reintroduced in order to provide a stronger ecosystem. Examples of the amphibians include many types of turtles including

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[88] New York City Audubon, "Jamaica Bay Project", Jan 2014, <http://www.nycaudubon.org/jamaica-bay-project>

the Diamondback Terrapin, 7 species of upland and freshwater turtles, and several sea turtles such as the Riddly Sea Turtle.

Fish species are abundant although contamination and dissolved oxygen levels are making certain waters unsuitable to thrive[89]. Crustaceans and invertebrate are common within the waters including mussels, shrimp, lobsters, and crabs. Loss of habitat, contaminated waters, and low levels of dissolved oxygen threaten these species survival within the area. The harvesting and loss of breeding habitats of the horseshoe crabs, has dropped their populations significantly. In turn, a critical food supply for migrating shorebirds has been severely limited, with the result that many shorebirds are not able to add the body fat needed to successfully complete their migration[90].

The larger context of the site provides an important ecosystem for numerous wildlife species. Surrounding the site though, there are very few natural habitats for plant and animal species to thrive. Most of the shoreline comprises of degraded fallow land, residential back yards, and industrial servicing. There are great opportunities to regenerate the degraded land and underutilized parcels that dot the shoreline into thriving shorelines for both the wildlife and resident citizens. Within the site, the naturalized peninsula, northern point, and western fallow edge offer a wonderful opportunity to connect a portion of this anthropogenic-dominated shoreline into a naturally thriving shoreline. There is also the opportunity to establish plant species that attract wildlife and

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[89] *New York City Department of Environmental Protection 'Waterbody/Watershed Facility Plan Jamaica Bay and CSO Tributaries'*

[90] The Cornell Lab of Ornithology " All about birds: migration paths", Jan 2014, *http://www.birds.cornell.edu/AllAboutBirds/studying/migration/pathways*

insects that benefit and combat mosquitos, ticks, and other harmful insects to humans. Bat attraction can also act as a deterrent to bugs and mosquitos during their active summer months.

VEGETATION + PLANT MATERIAL

Natural vegetation for the site and its context are mostly successional due to human disturbance. Prior to the current cultural landscape, hardwood forests and woodlands (swamp white oaks, mix hardwoods, and American holly), shrub land, and grassland/forblands existed. There are few natural forest stands that still exist within the area of the site. Currently, successional deciduous forests are the most common tall vegetative mass existing. Common species include the Black Cherry, Poplars, Grey Birch, White Mulberry, and exotic invasive such as the Tree of Heaven and Autumn Olive. Smaller vegetative colonies of shrub lands include Bayberry thickets, Sumac groves, and Coastal Thickets where bayberry, sumac, and beach plum species become established. The grasslands of the area are comprised mostly of Phragmite thickets where salinity is lower, and chord grass in areas with higher salinity levels. Phragmites are by far the most common plant species found within the region, create dense monocultures and inhibit the growth of plant species. Dune grass and Seaside Goldenrod inhabit unstable shorelines and is an effective stabilizer once established for shifting sands and sediments[91]. Inhabiting many of the marshes within the

[91] *Soil Survey of Gateway National Recreation Area, New York and New Jersey*. New York City: US Dept. of Agriculture, US Dept.of Interior, 2001. Print.

estuary are colonies of chordgrass, Bluestem, Weeping Lovegrass, Silver Hair Grass.

The existing vegetation on the site is primarily successional in nature. There are a few mature hardwood trees that exist in the area furthest from the waters edge in the southwester quadrant of the site. Small colonies of grassland exist along the shoreline of the peninsula and transition into a marine shrubland that occupies the central portion of the peninsula.

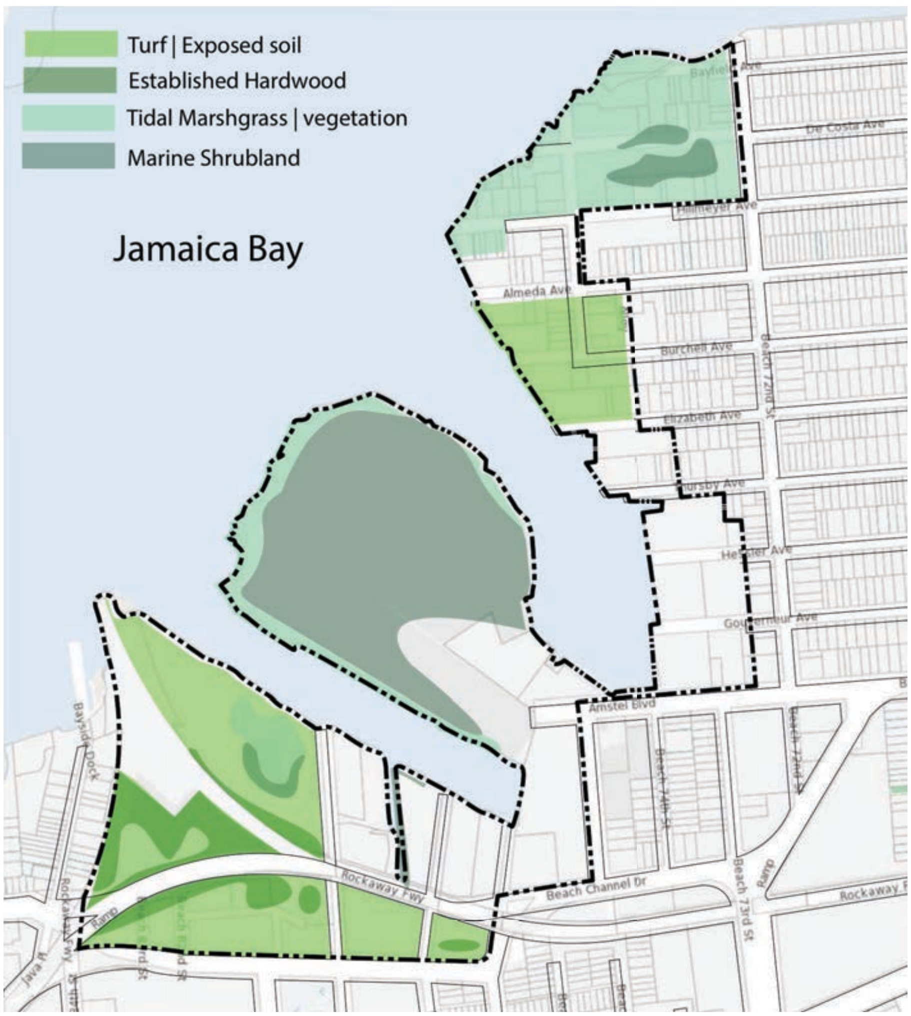

FIGURE 66. Existing Vegetation (Wierengo)

Shrubs and various grasses survive along the northern point although density along the shoreline is not evident. There are several wetland grass and shrub species surrounding the low point acting as a seasonal marsh. An opportunity arises during the design of the site to include and establish more native plant species that will aide in the ecological restoration of the site and neighboring water bodies. The compaction of the soil is a constraint in the establishment of plant species and may prove difficult in the design. The open nature of the shoreline along the northern edge of the site closest to the open channel could provide difficulty in establishing vegetation along the shore due to wave action and erosion control. Shorelines within the two water basins are better protected and could prove easier to establish plantings.

TOURISM

Tourism to the Rockaways attracts over 2 million visitors to the area each summer with close to 200,000 additional people on the Peninsula an any given summer day[92]. The beach and Boardwalk are the biggest attractions for many visitors. The peak season is between Memorial Day and Labor Day, but activities within Jamaica Bay include kayaking, fishing, sailing, and kite boarding, are popular year-round. The beaches available in this area, are one of four destination directly available via NYC train system without additional bus or shuttle transfers. The Rockaways and Coney Island are also the only two beach's directly on the Atlantic Ocean. Travel time from midtown Manhattan is

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[92] New York City Department of City Planning "statement of community district 14 needs: fiscal year 2014", Jan 2014, http://www.nyc.gov/html/dcp/pdf/lucds/qn14profile.pdf#profile

between 1- 1.5 hours long. Most of the attractions for tourists are situated along the Oceanside of the peninsula including a boardwalk, playgrounds, sports fields, and bathhouses. The bayside in comparison, does not connect to these active areas, and does not possess attractions to entice visitors to the area.

The Rockaways have an established tourism industry that relies mostly on its beaches for attracting visitors. The majority of tourist-based infrastructure is located directly on, or near the Oceanside beaches.

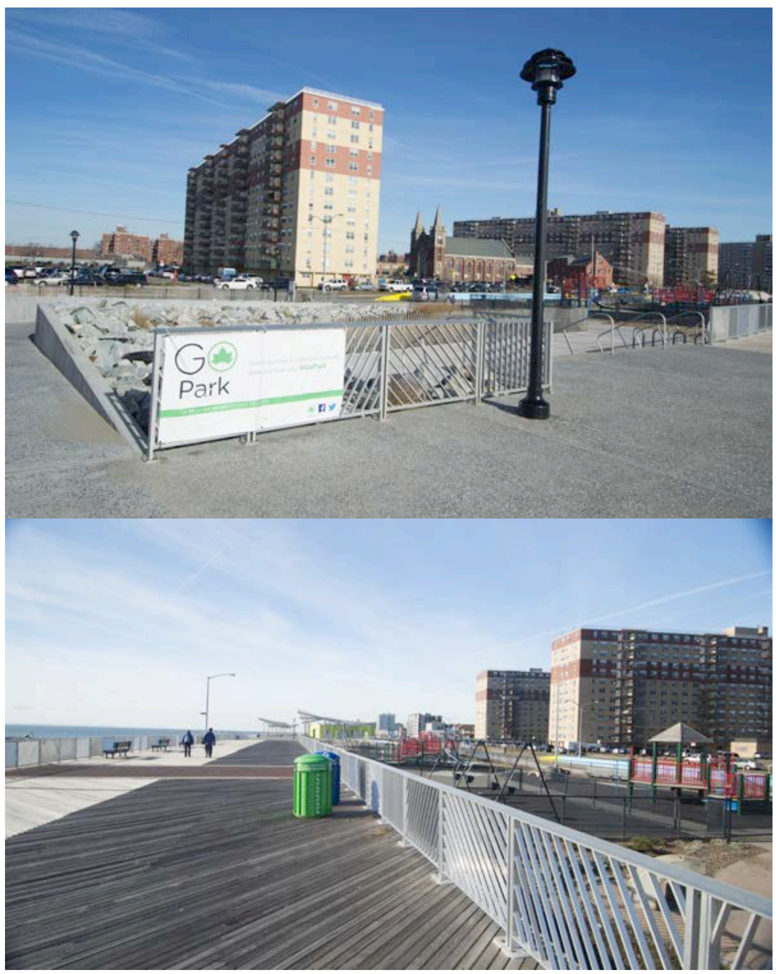

FIGURE 67. Oceanside Tourism Activities + Infrastructure (Wierengo)

Although the site is located within close proximity to the beaches and this infrastructure, it rest on the bayside of the peninsula where there is a severe lack of tourism based infrastructure. The close proximity to the beach, and desire expressed by the Local Board to connect beach and bay activities, creates opportunities to provide infrastructure, encouraging visitors to experience the bayside of the area. Stated by the District 14 Community Board, "although the area is known as the 'waterfront communities', there does not exist a legal boat ramp, or a recreational fishing pier". The sites design has the opportunity to include both of these items in the programming of the site. Because the Rockaways are one of only three beachside destinations directly accessible by a single mode of public transit, and is located within the large marine estuary of Jamaica Bay, an opportunity to establish activities and programming so millions of visitors can access the site through public transportation and enjoy what the bay has to offer should be encouraged through the design.

MARITIME ACTIVITY

Fishing and boating are major activities within the Jamaica Bay waters. The bay is used by many migratory fish species on their way to spawn. Because of the narrow channels and shallow marshlands within the bay, shallow drafted vessels are popular. Clearance beneath bridges constrains the type and size of vessels in their maneuverability within the waters. Fixed bridges within the Bay have maximum vertical clearance of 52ft. This prohibits vessels, in particularly sailboats whose masts reach 52 feet and above the waterline from reaching the site. Non-motorized vessels such as kayaks, canoes, and paddleboards are popular, and give the user the ability to navigate extremely close to wildlife and natural marshes. There are six kayak launch locations within the bay and mapped trails indicating routes suggested to paddlers.

FIGURE 68.   Kayak Launching + Water Trails (NPS)

A few marinas are offered within the waterways providing docking and marine supplies for boaters. Destinations scattered throughout the water body also offering dockage for boaters who want to head to shore for food and beverage at one of the many dockside restaurants and bars.

Many of the locations that provide access to the waters of Jamaica Bay, are not within close distance to the site. There are no kayak launch sites in the area, and very few open spaced sites along the waters edge that are maintained and safe for public use. There is a strong opportunity to provide services such as a serviceable marina, kayak launch site, dingy sailing and paddleboard rentals, a restaurant/bar destination, and other marine oriented activities to the neighboring residence. The sites two protected water basin becomes a strong attribute to the site due to their protective harboring.

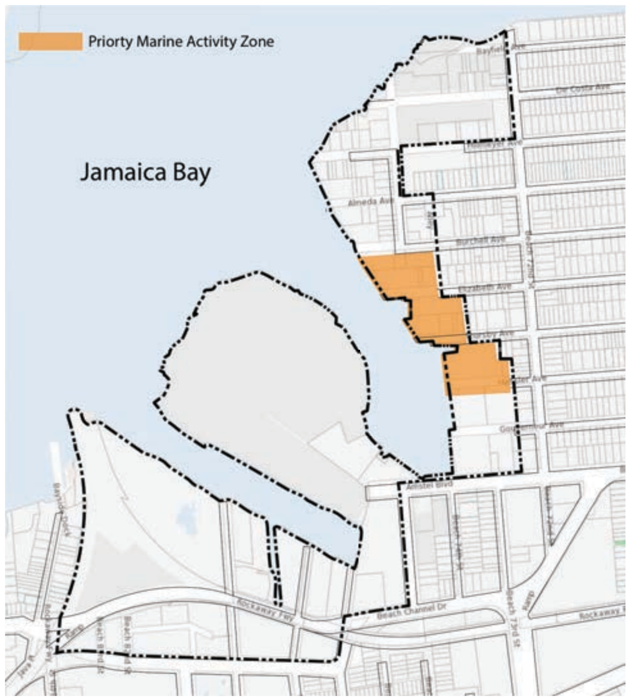

FIGURE 69.   Priority Marine Activity Zone (Wierengo)
(Data source NYC Waterfront Revitalization Program)

The ‘A’ Train’s trestle bridge is a swing bridge providing unlimited clearance access when open, but limited (24ft) vertical clearance when closed. When closed, the bridge clearance creates a constraint on the site, but is relieved when the bridge opens to marine traffic. The bridge also acts as a strength to the site, by providing habitat for fish along it’s underwater piles, creating opportunities for recreational fishing off of the site by way of piers and docks.

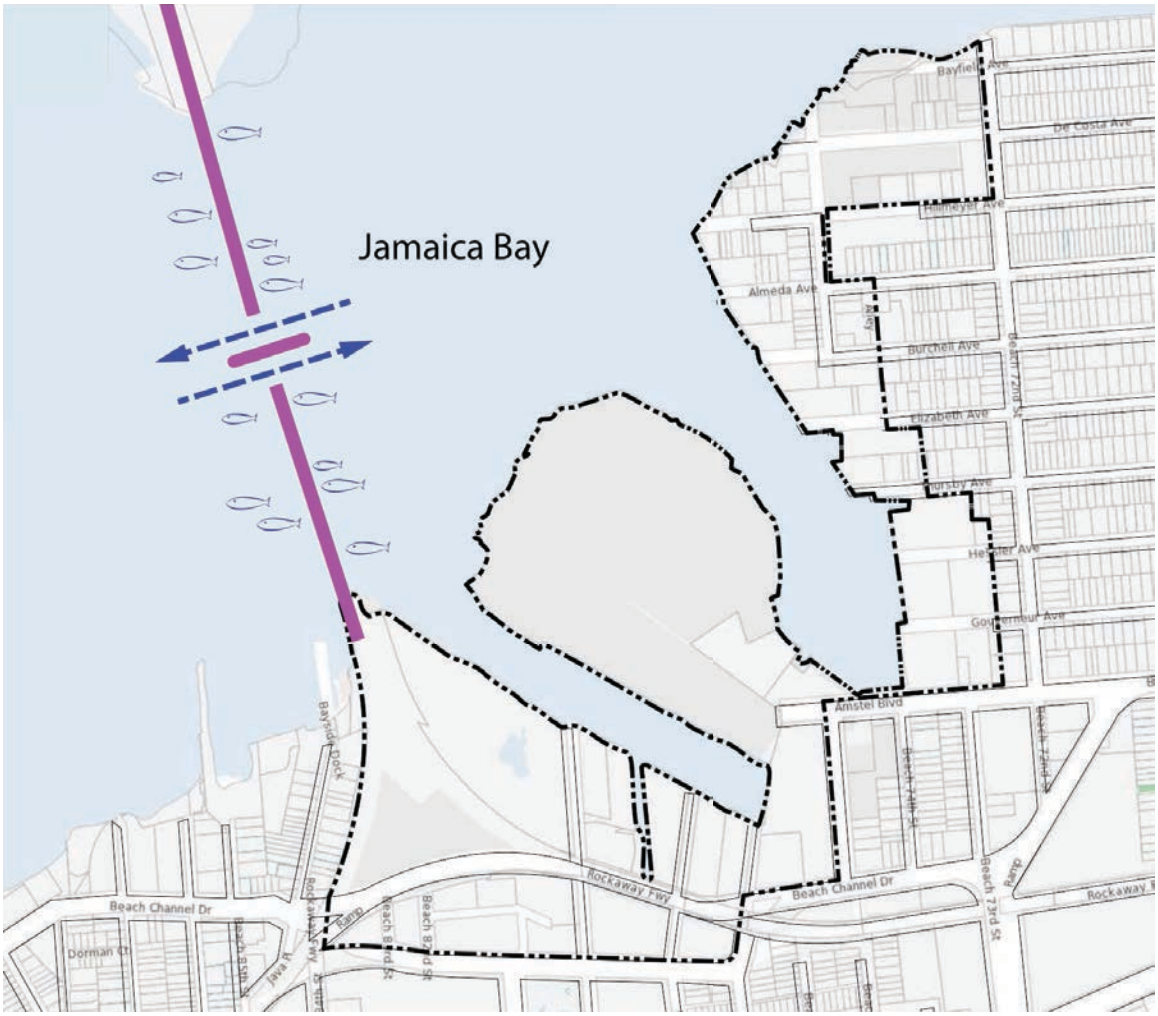

FIGURE 70. Trestle Train Bridge (Wierengo)

LAND USE

The Rockaway peninsula is part of Queens County Community District 14. The total land area is seven square miles (4,504.4 acres). The total population for the district in 2010 was 114,978. This figure rose 7.5% since 2000. The majority of the land use is shared by open space located along the western tip of the peninsula as part of the Jacob Riis, Fort Tilden, and Breezy Point Tip parks (38.4%), and residential neighborhoods on the Eastern portion (40.1% total:

29.6% 1-2 family residential, 10.5% multi-family). There is a high number of vacant lots in this district (11.6%), and very few commercial (1.7%), Industrial (.5%), and parking (.6%) facilities utilizing the space.

In 2005, the first phase of the Arverne-By-The-Sea project started which offered 2 family homes, and moving forward towards the next phase of development including a new school and YMCA. Plans have also been approved to develop 400 new 2 family homes, retail space, and two new parks in the Edgemere district.

There is lack of economic development within the district citing the majority of residents shop primarily in Brooklyn and Nassau County[93]. The two main shopping districts within the district are located between Beach 86th to Beach 96th Streets, and the Beach 116th Street shopping center. Both areas have been in decline for decades and new zoning regulations changed, promoting the development of retail and market rate midrise housing.[94] Residential housing adjacent to the site is a collection of mid-rise mulit-family complexes to the south (built in the 60's), single family detached homes to the east (most build before 1950), and brand new 2-family homes to the south east (part of the Arverne-By-The-Sea project). Land use to the west of the site is a mixture of dilapidated bungalows build on piers over the water, and a degraded boatyard and pier infrastructure.

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[93] *New York City Department of City Planning "statement of community district 14 needs: fiscal year 2014", Jan 2014, http://www.nyc.gov/html/dcp/pdf/lucds/qn14profile.pdf#profile*

[94] *New York City Department of City Planning "statement of community district 14 needs: fiscal year 2014", Jan 2014, http://www.nyc.gov/html/dcp/pdf/lucds/qn14profile.pdf#profile*

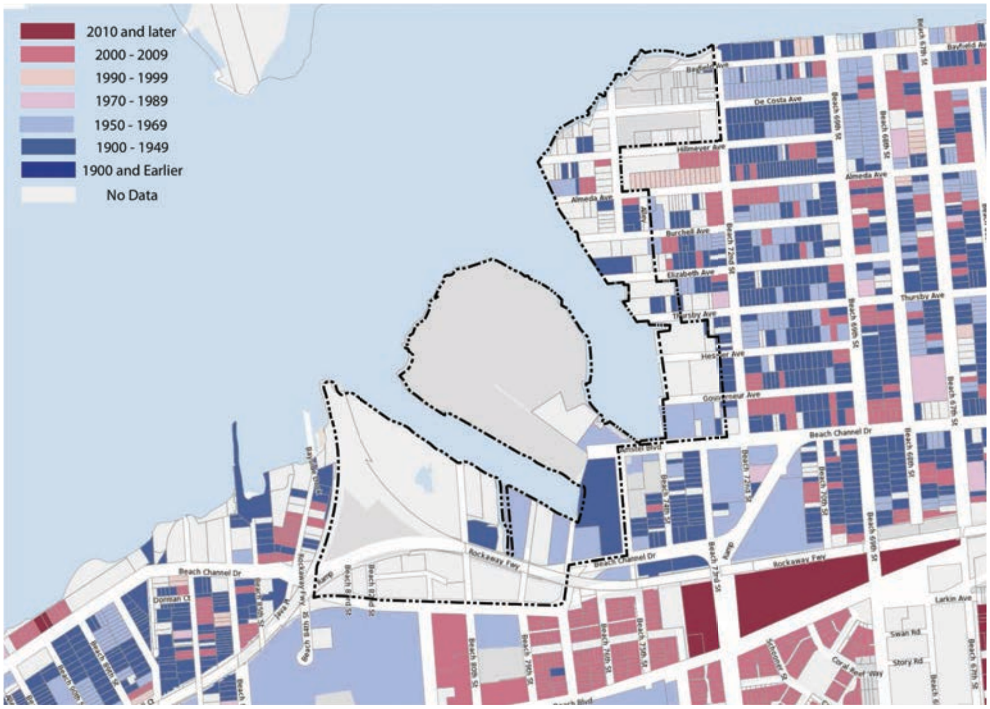

FIGURE 71. Building Construction Year + Age (Property Shark + Wierengo)

The site's location is central to most of the residential development along the Eastern portion of the Peninsula. This provides an opportunity to develop a usable space quickly accessible to the many residential neighborhoods within the district. With most of the maintained open space parkland located at a distance from residential neighborhoods, there could be a need to develop programmed open space within walking distance. This is especially important for residence who are dependent on public transportation. The District Board has also expressed great desire, as evident through their recent rezoning and approvals, to encourage economic development within the area, and provide more services to attract new residence to the area. The development of the site can become a strong feature to attract younger families to the area with its programming.

SENSORY PERCEPTION: VISUAL

There is a sense of stagnation within certain areas around the site, and then also a sense of change and progression in other areas. Visually, there are extremely different view sheds depending on the direction from the site.

Looking north out onto the bays waters and marshes, there is a very horizontal and linear pattern. Thin strips of vegetation on the marsh islands, are the only color that breaks up the shades of blue coming from the water and sky. In the distance, you are able to see houses and structures, but they appear to be very thin on the horizon.

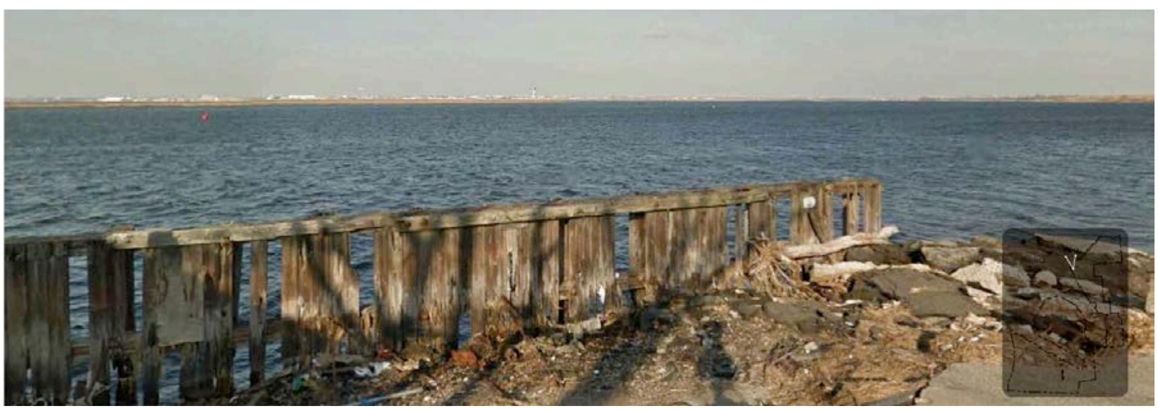

FIGURE 72. Unobstructed Waterfront View shed (Wierengo)

Directly to the south, there is a juxtaposition of housing types. On one side of the street lay dated, mid-rise multi-family public housing, with worn brick façade; the other side: newly build market-rate 2 story townhouses with planted landscapes.

FIGURE 73. Site Surrounded By New + Aging Residential Buildings (Wierengo)

Looking to the west, under the train tracks, there is a collage of debris and structures extending into the water. Dilapidated housing is situated on piles and docks; some inhabited, others on the brink of collapse. Large barges with buildings are half in the water and part pushed up on land in an uninviting fashion. In the distance, piles sticking out of the water and half sunken barges and floats rusting away are visible.

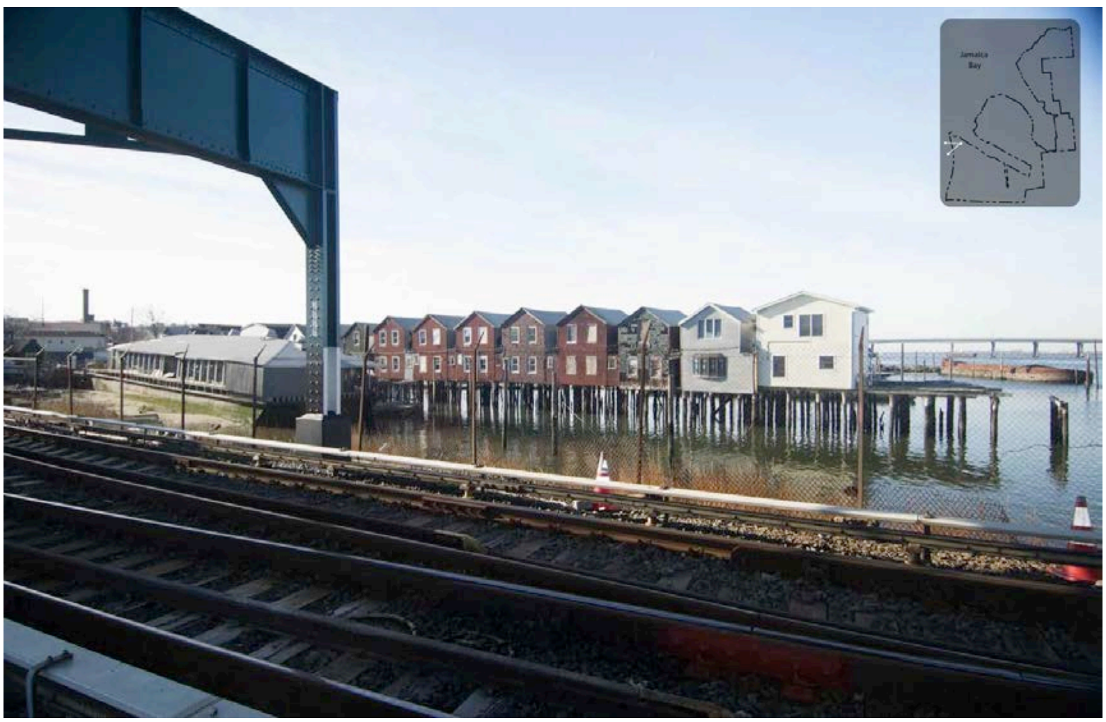

FIGURE 74. Historic Pier Bungalows Not Structurally Sound (Wierengo)

Two bridges dominate the horizon line; one bridge is used by the "A" train coming from Manhattan; the other, the Cross Bay vehicular bridge, connecting the community of Broad Channel. Neither are necessarily architecturally striking or modern, but both are in fair condition. The elevated train lines continue along the edge of the site and curve east and west at the southern portion of the site.

FIGURE 75. Train Bridge Commands View shed (Wierengo)

Open lots containing dry-docked boats dominate the Eastern portion of the site with small warehouse structures exist along the shoreline. Single and two story residential housing are bungalow in style, and aged.

FIGURE 76. Existing Marina Facilities + Scattered Debris (Wierengo)

The southeastern edge of the site has the appearance of a storage space for construction and manufacturing items that cannot find a proper place to be disposed of. Piles of rusted material such as sheet metal, wooden timber, and concrete masonry blocks are visible behind tall wire fencing covered in vines.

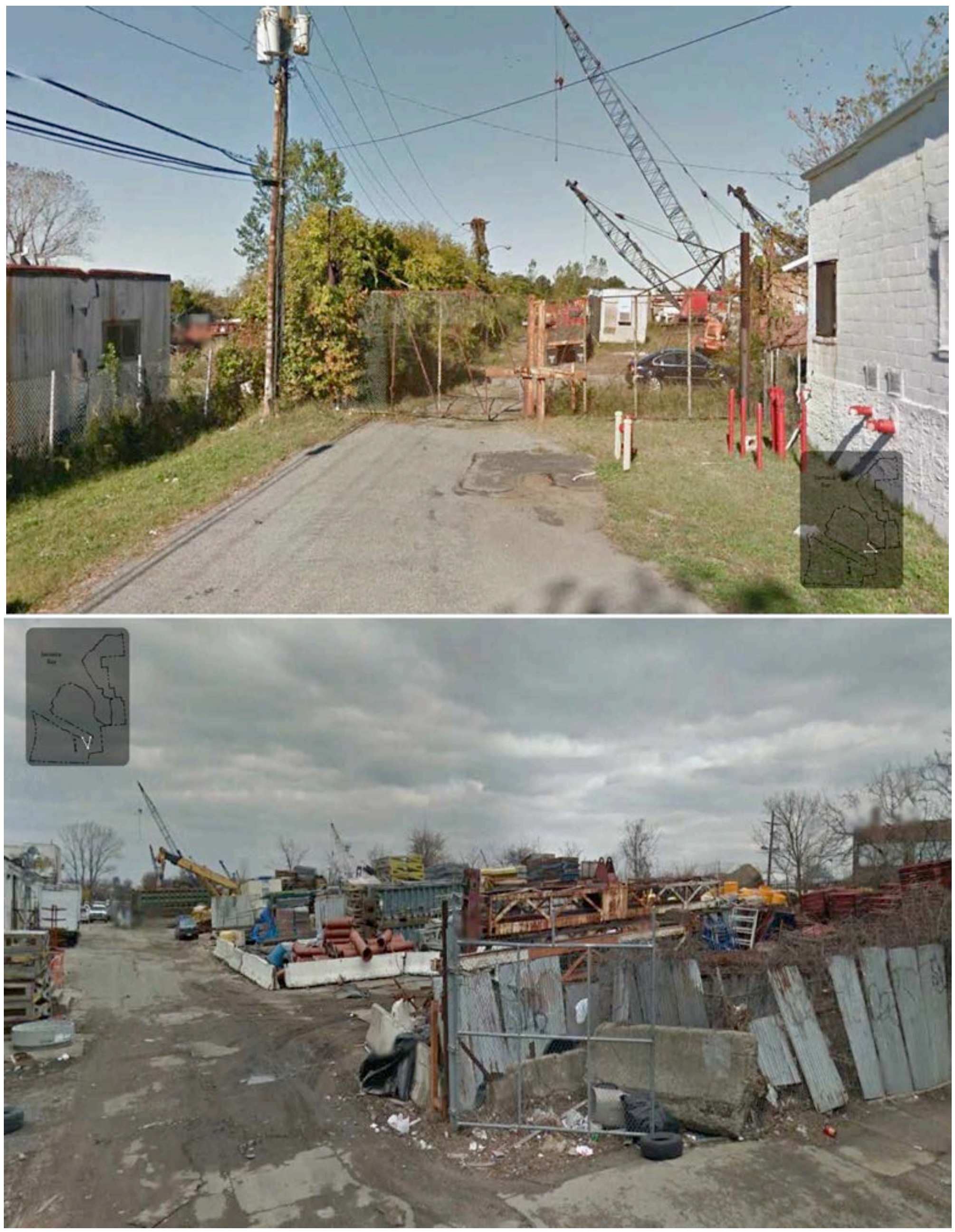

FIGURE 77.   Dangerous And Limited Access To Public Spaces (Wierengo)

The only area within the site somewhat reminiscent of the surrounding wildlife refuge, is the natural peninsula in the middle of the site. Even in the winter months, the vegetation blocks the view from one side of the site to the other. The only visible sign of human manipulation are the weathered and broken pilings protruding into the water from small sandy beaches and colonies of marshgrass.

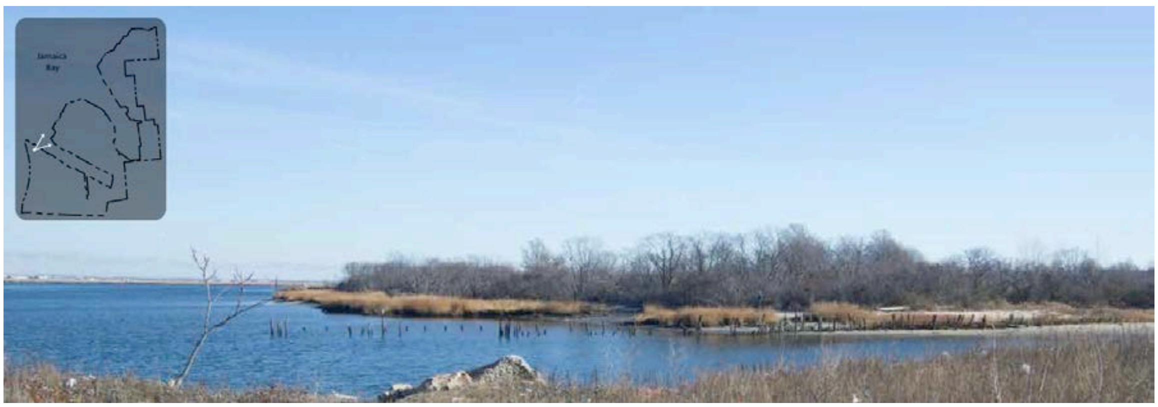

FIGURE 78. Natural Peninsula Within Site (Wierengo)

Currently, the visual quality and appeal of the site is lacking. Trash, debris, and aging infrastructure are visible in most direction both within, and outside the site. The only redeemable qualities are the natural peninsula in the middle of the site, and the view looking onto Jamaica Bay, both the two biggest strengths of the site visually. The elevated train line could be considered a constraint to the site because it blocks views looking outward, and gives the site a sense of enclosure and being peered into while in portions of the site. View sheds should be directed inward towards the natural areas of the peninsula, and out toward the waterfront. Because the site is visible from residence houses, there is the ability to design the site to act as an extension to their backyards.

Sensory Perception: Noise and Odors

Offensive odors are not present on site during the author's site visits. There was the smell of saltwater and algae from the shoreline riprap. The sound of the train is very apparent when it travels past the site, although there are never horns and whistles heard associated with it. Traffic sounds are noticeable only when close to the streets on site along the southern edge. There is also the distant noise of shorebirds within the natural areas and along the shore.

Site Inventory + Analysis

Because the site is situated next to the train line, and has the Beach Channel Drive traveling through it, the noise of these two transportation systems is a weakness, and will need to be taken into consideration. The advantage of being close to the water, is that there is the familiar smell of the ocean and saltwater, in addition to the constant sounds of shorebirds and seagulls. It would be advantageous for the design to take advantage of the close proximity of the water and its odors and sounds, while reducing the impact from noise and odor associated with the train and vehicular traffic.

CIRCULATION

The Rockaway peninsula is accessible through various modes of public transportation, and personal methods or transport. Vehicular access is available over two bridges, The Marine Parkway Bridge, and the Cross Bay Bridge. The Marine Parkway Bridge is located 4.5 miles away from the site. This bridge connects the peninsula to Brooklyn with Flatbush Avenue continuing through the borough, and leading directly through Prospect Park, and over the Manhattan

Bridge into the lower east side of Manhattan, Chinatown, and Little Italy. The Cross Bay Bridge is located a half mile away from the site, and connects the peninsula to Broad Channel, the only developed island within Jamaica Bay. The Cross Bay Boulevard (CBB) continues across the bay and ends at Howard Beach, located directly across the bay from the site on the northern edge, and part of Queens. The CBB then intersects the Belt parkway and continues to terminate at the intersection of Queens Boulevard and Queens Midtown Expressway. The Belt Parkway wraps around the northern edge of Jamaica Bay and continues west to Coney Island and all the way around the shoreline of Brooklyn meeting up with Interstate 278 close to the Gowanus Canal. The Belt Parkway also continues East towards Long Island eventually becoming Highway 27 and leading towards the Hamptons. Access to the Peninsula is also accessible via Rockaway Boulevard that extends past JFK Airport and through Far Rockaways East of the site.

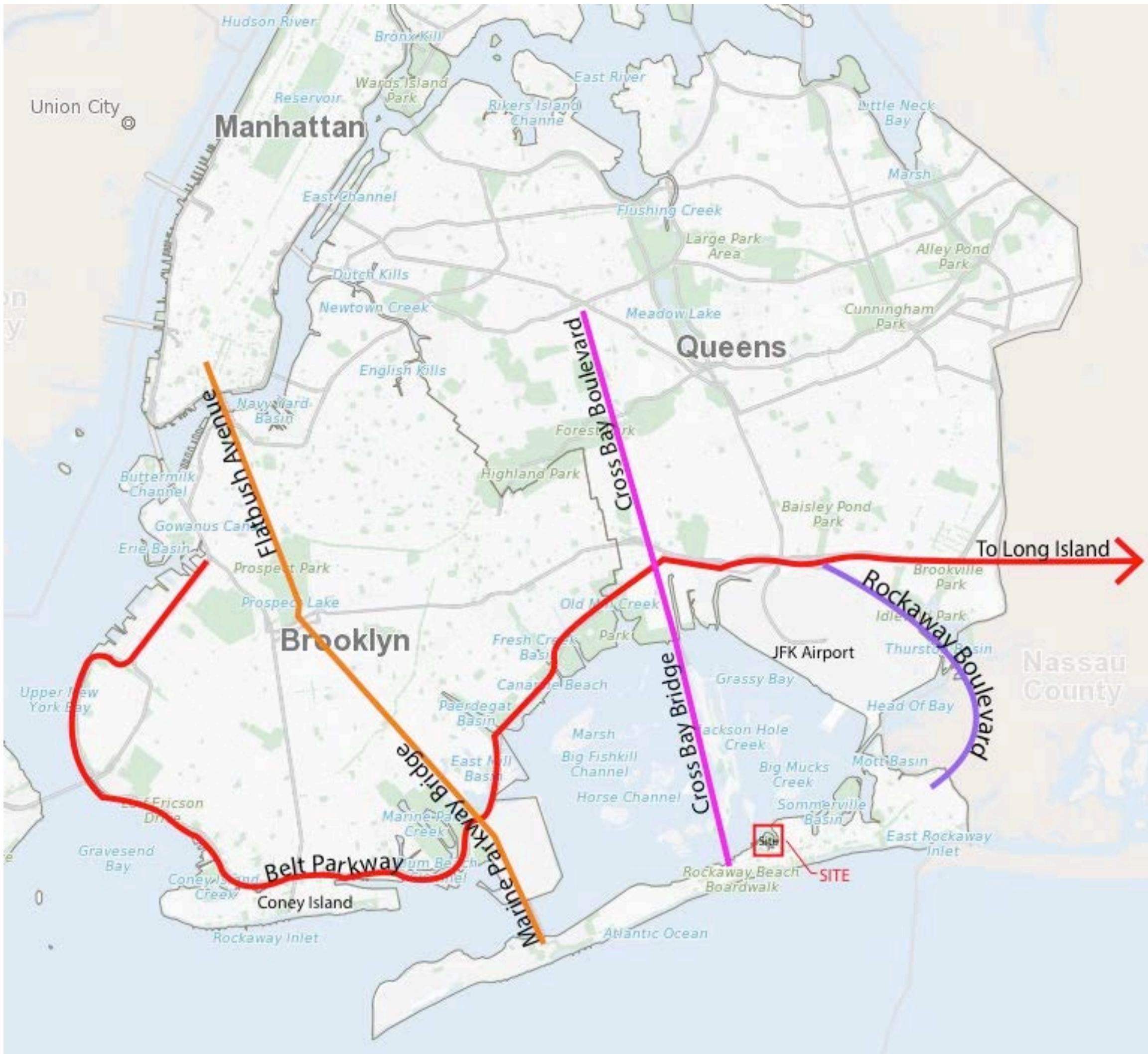

FIGURE 79.   Major Vehicular Corridors To Rockaways (Google + Wierengo)

Two streets dominate vehicular circulation through the peninsula. Beach Channel Drive is oriented and located parallel to the shoreline of the bay. This street connects the tip of the Rockaway Peninsula where most of the open park space and Breezy Point neighborhood is located, with the more urbanized East and Far Rockaways. This transportation corridor runs through the site segregating the southern portion of the site from the water. Beach Channel Drive is a two-lane street as it passes through the site, but becomes four lanes on either side of the site. Rockaway Point Boulevard is the other main byway on the Peninsula. It is also oriented West to East, but located in the center of the peninsula creating an Oceanside and bayside division.

FIGURE 80. Two Major Vehicular Streets On Peninsula (Google +Wierengo)

Hammels Boulevard runs adjacent to the sites southern edge. Although wide, it does not connect to major landmarks used for immediate residential use only. Amstel Boulavard extends off of Beach Channel and terminates at the site. The residential streets to the East of the site are small side streets used by residence and offer side street parking. Streets in this area oriented north-south are dominate with Beach 69th and Beach 67th streets offer residences direct access to the Atlantic beaches. Streets in this area that orient east west, are mostly dead ends that terminate at the bays shoreline.

Official parking lots are not located around the site. Beach Channel Drive offers side street parking to the east of the site, but not within the confines of the sites. Hammels Boulevard offers side street parking, as does Amstel Boulevard.

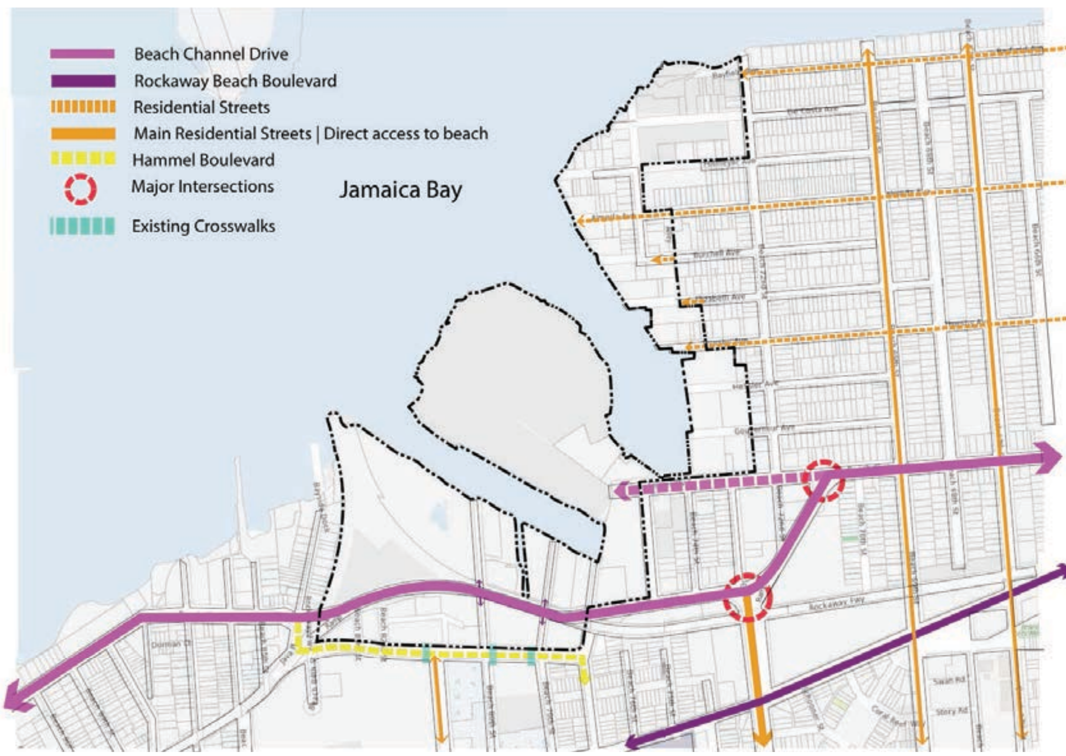

FIGURE 81. Vehicular Access Surrounding Site (Wierengo)

Public Transportation options include Train and Bus lines. The A train connects the Rockaways to the New York City Subway system and runs directly to lower Manhattan, including a direct stop for the JFK Airport. The A line continues along the west side of Manhattan and terminates at the northern tip of the island.   There are multiple train stops along the Rockaway Peninsula. Two of these stations are between and quarter and a half mile away from the site. The commute time to Manhattan currently is over one hour, but three (3) improvements are being sought by Local Officials to cut this commute time down to 35-45 minutes. These initiatives include the revitalization of the Old Rockaway Railroad Line, which would allow for an approximate 30-minute commute to midtown, High-Speed Commuter Ferry Service, and an am/pm express subway service on the “A” train. The local government board believes cutting transportation times down, would spur economic development and attract your families.

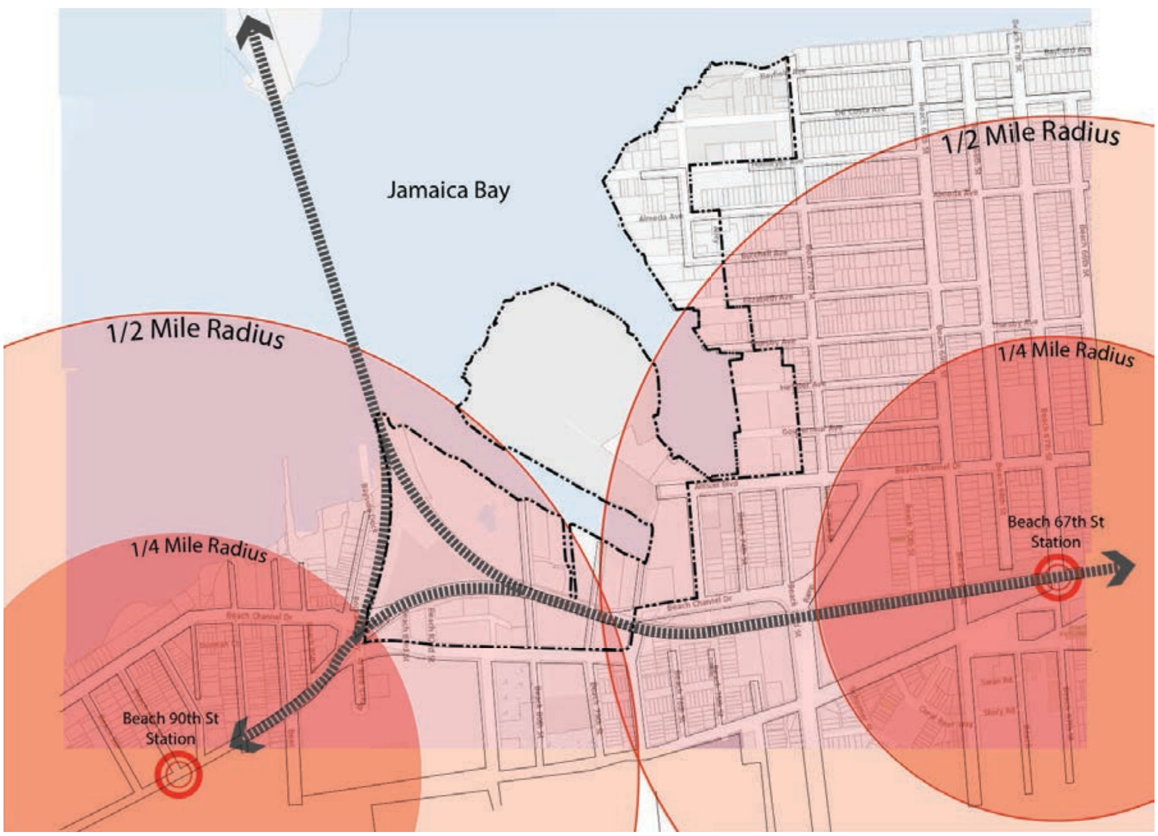

FIGURE 82.   “A Train” Proximity + Access To Site (Wierengo)

Throughout the Peninsula, train lines are elevated on viaducts with streets and makeshift walkways beneath. There are a set of train tracks that run through the site on the eastern edge, and above the section of Broad Channel Boulevard through the site.

FIGURE 83.   Elevated Train Tracks + Underutilized Under-space (Wierengo)

Bus stations offer direct access to Manhattan via express routes and local routes to nearby destinations. There are four (4) bus stops within 1000 feet of the site.

FIGURE 84. Bus Stop Location + Proximity To Site (Wierengo)

Pedestrian walkability is not prioritized around the site and existing neighborhoods. There are few crosswalks and stoplights to slow traffic. Three (3) crosswalks exist that connect the southern portion of the site to neighboring housing developments. There is currently not a clear route from the site to train or bus stations. More emphasis towards pedestrian friendly streets is evident along the beach side of Rockaway Point Boulevard. Pedestrian and bike paths with vegetative buffers, a boardwalk with play ground equipment, and traffic lights are visible. New housing development to the southeast have also included pedestrian friendly streets with vegetative and tree buffers.

FIGURE 85.   Arverne-By-The-Sea Development (Wierengo)

There is a great potential to strengthen the access to the site through existing circulation routes. With close proximity to both train and bus stations, the site can be accessible to the millions of people who reside within the New York public transit area. Access to the site from these public stations should be strengthened in order to provide a safe and efficient connection. The elevated train lines pose a threat to the programming of certain activities close to the tracks. There are strengths associated with the site's close proximity to the tracks though. Visible awareness of the sites amenities could be offered to all who use the train.

The opportunity exists to strengthen the walkability for the residence that reside in the communities adjacent to the site. Public access to the waterfront is hindered by the lack of crosswalks and streetlights, but the close proximity makes the site a feasible destination for daily usage to nearby residence. East-west streets terminate at the site and provide the opportunity to create strong visual connections to the site from neighboring residential sites. Parking is limited and therefore should be increased to provide quick access access to the site for vehicular commuters. The division of the site by Beach Channel Boulevard creates a constraint within the site. This produces logistical issues in creating the safe passage of pedestrians through the site.

FIGURE 86. Boulevard Dividing Site In Two (Wierengo)

CHAPTER 6: DESIGN INVESTIGATION

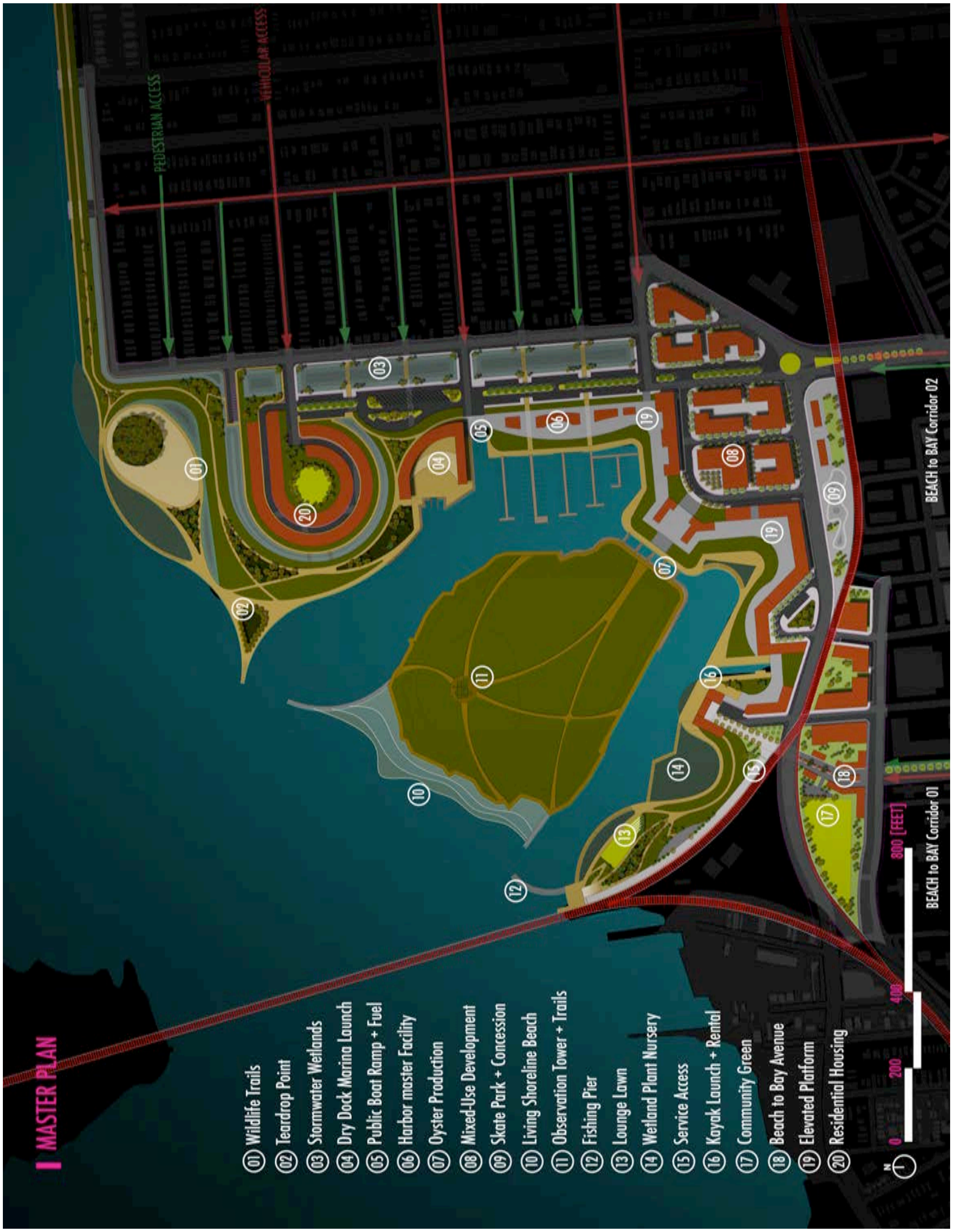

FIGURE 87. Master Plan (Wierengo)

DESIGN STATEMENT + NARRATIVE OVERVIEW

Located along the bayside shoreline of the Rockaway Peninsula in Queens, New York, the design protects the neighborhoods of under-privileged residents living along the coastal back-bay. It will offer the community a platform that will stimulate economic activity and give meaningful access to Jamaica Bay. The design integrates resilience and ecological systems by sculpting approximately one mile of shoreline to embrace sea level rise. These interventions provide a 'first line of defense' and enhance the economic value within the community establishing environmental and social initiatives that encourage activity at the community level and within the larger urban context.

Hurricane Sandy caused severe damage to the communities along the Rockaway Peninsula. Storm surges as high as 12 feet inundated many of the low-income bayside neighborhoods that were built prior to flood regulations on filled marshland of the Jamaica Bay. Today, the bay is experiencing accelerated salt marsh island loss, high nitrogen outflows and eutrophication. Due to anthropogenic urbanization, Jamaica Bay's watershed has turned into a 'sewer-shed'. Shoreline stabilization along the bayside coastline of the Rockaway Peninsula is primarily dilapidated to non-existent, exacerbating stormwater runoff and the lack of flood protection for the vulnerable communities. Numerous ongoing efforts protect the Oceanside shoreline but few interventions directly address the bayside shoreline, where many of the low-income neighborhoods are located.

This design proposal intends to illustrate solutions that increase the environmental integrity of urban waterfront design through the usage of ecological resilient infrastructure naturally found along a coastal landscape as precedents for resilient landscape features. To achieve this, research was conducted to classify and catalogue core principles applicable to *Small Craft Harbor [SCH]* design and programming, which were then cross-referenced with feasible coastal resilient design strategies, integrating systems within a dynamic landscape that connects the residence to their surrounding bodies of water.

Three natural landforms found along the mid-Atlantic shoreline were determined to provide the most resilience against damage incurred by flooding and wave energy: salt-grass marshes, dunes, and reefs (sandbars). Based on these natural landforms protective qualities, and the existing vulnerable building typologies, the design created a continuous dune line connecting two structured high points along the shoreline to act as the datum for the design. By manipulating the dune structure in certain areas, a series of typologies were created to illustrate the dune's multi-purpose performance in regard to the determined design programming.

A critical feature of the project was the acceptance of *controlled loss* without compromising community viability. The design maintains residential density needed for a thriving community by building vertically, reducing the amount of vulnerable infrastructure at lower elevations, and replacing the horizontal plane with a more flood resilient landscape. Accepting the lowest elevated land will eventually become permanently inundated as sea levels rise, a ‘cut-and-fill’ concept sculpts the shoreline to strategically allow water levels to inundate areas designed to welcome and encourage marshland migration. The excavated fill material is then used to create the protective dune line, and elevate infrastructure to a suitable elevation above flood levels. The reuse of material on-site reduces the dependence of off-site material; minimizing carbon consumption and logistical issues of transporting fill through municipal circulation routes.

Envisioning the SCH amenities to extend beyond the traditional uses for just pleasure crafts, the dockage and protective qualities of the harbor now become staging and launching areas for environmental initiatives. Ongoing efforts to replant marsh grasses within the bay, will now have an opportunity to conduct research within these protected cut areas programmed as a wetland plant nursery; where modular plant plug trays can be loaded directly onto a boat, and transported throughout the bay to the many islands and living shoreline projects within the area.

Oyster production and research is conducted along a sculpted portion of the site encourage positive water flushing within the harbor by connecting the two water basins. Floating oyster cages below docks filter water moved by tidal currents, and create underwater habitats boosting harbor ecology; while out of water oyster setting tanks use a pump system to filter water into tanks used to grow oyster spat.

Paramount to the design concept is connecting the community and entire urban population to their local water bodies. New York City has over 524 miles of coastline, and this design encourages use by all the cities residence. The sites proximity to (2) public train stations within ¼ mile away, connects the harbor and community directly to the rest of the city. Capitalizing on the underused space below the elevated train tracks, the design installs a pedestrian thoroughfare between the site and the public train stations encouraging the site to be used as a tourism destination. Beach-to-Bay corridors are also established to strengthen the connection between established oceanside tourism activities, and those recreational water related activities offered along the bayside; thus creating the ‘foundation’ for a thriving tourism destination, available through public transportation to all New York residents and out of town tourist alike.

This design accepts that change is inherently natural, and the belief that the resilient coastal cities of the 21st century will never be completely shielded from all climate change effects, but should instead be able to respond quickly after the most severe events via adaptable landscape design. This allowed the design to act as a living organism and evolve based on climatic conditions. Intended to provoke continued discussions as to resilient strategies applied within established urbanized coastal areas in a broader context, this proposal suggests resilient landscape design, based off natural landforms that exhibit resilient attributes, could offer designers unique opportunities to design urban waterfront landscapes that afford urban residence (1) an honest interaction with their local water bodies and local ecology, (2) a thriving and desired coastal community connected through public and sustainable transportation, and (3) protection against most sea level threats designed within an integrated landscape system where functionality compliments aesthetical value. The following sections explain in more detail the methodology used to create the design for this specific project.

DESIGN OBJECTIVE + GOALS

Goals and objectives for the site specific design are based on the preliminary research. The design responds to the original design questions that guided the research to answer:

3. How coastal resilient design infrastructure function on integrated levels to not only provide reasonable protection to a coastal community, but enhance the character of the landscape and way of living?
4. What potential benefits, in addition to the traditional harboring of pleasure craft, can a Small Craft Harbor provide the residents living along an urbanized coastline?

The design also considers broader goals suggested within strategic planning initiatives presented through the numerous documents created by New York City Departments. The objective of the design is to decrease, increase, and promote specific goals and programming that fall under the four categories of resiliency, social, ecological, and economic. Based on these goals, site-specific objectives were established (FIGURE 88).

FIGURE 88. Site Goals and Programming Strategies (Wierengo)

These broader goals and more site specific objectives, establish a landscape capable of increasing protection against flooding and damage to the existing infrastructure, while establishing an opportunity to experience integrated urban living; where an amalgamation of urban vibrancy and convenience, are paired with a sustainable lifestyle and honest experience and interaction with nature can be achieved (FIGURE 89).

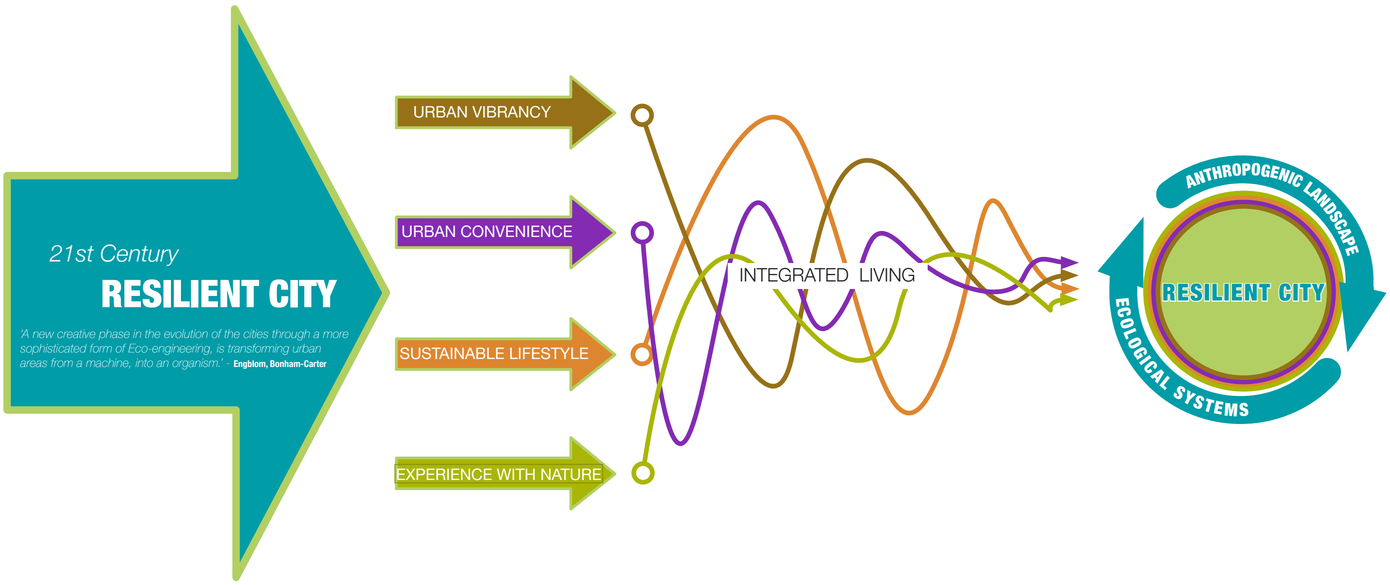

FIGURE 89. Integrated Living Through Integrated Design (Wierengo)

DESIGN CONCEPT: CONNECTION

Elements within the design connect the Rockaways to NYC residence in order to become a viable tourist destination. This is achieved by connecting the site to existing public transportation hubs, and establishing Beach-to-Bayside corridors that connect oceanside recreational activity with the newly established water related activities offered along the bayside. The design also works to better connect Rockaway community residence to their local waterways. Current land uses and shoreline conditions obstruct enjoyment and use of the bay's waters (FIGURE 90).

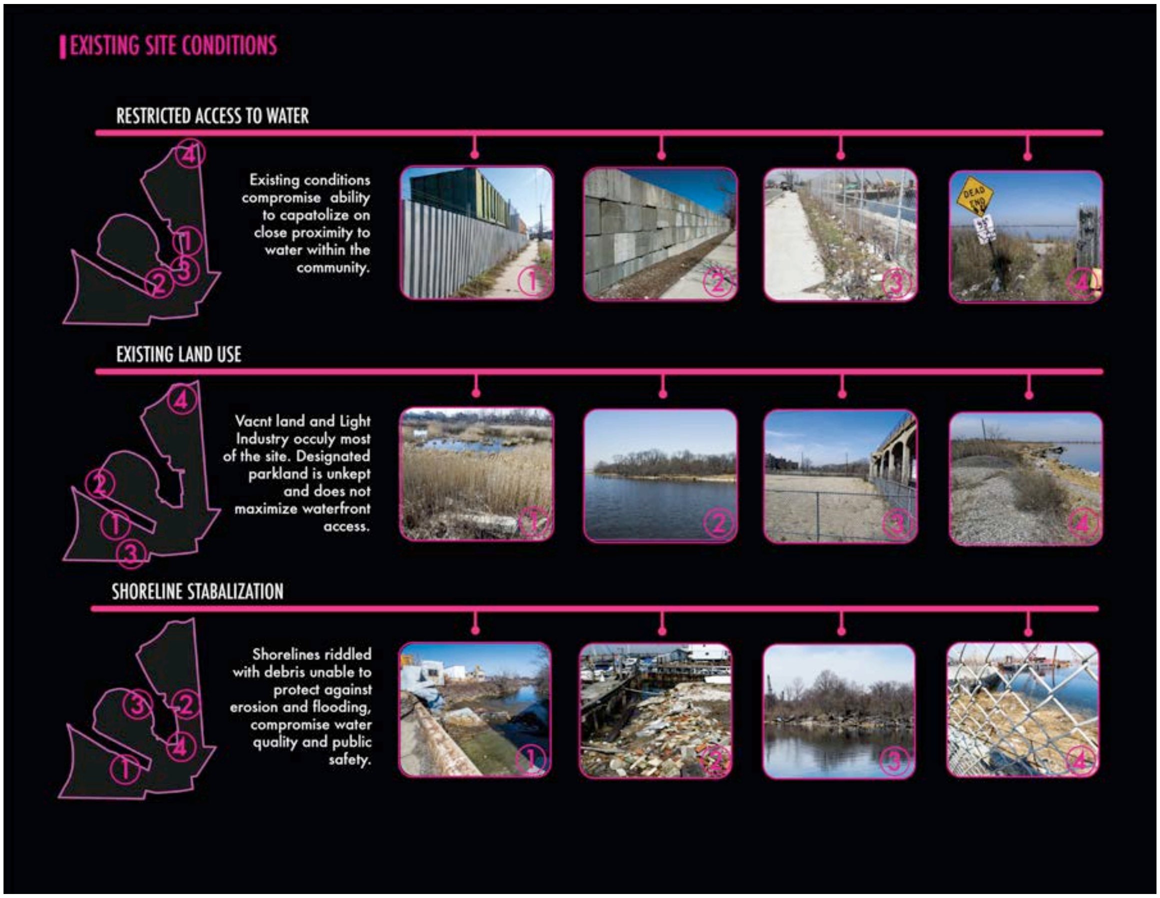

FIGURE 90. Existing Site Conditions (Wierengo)

The design re-purposes shoreline land uses to better serve the residence. Finally, connection between programming common to Small Craft Harbors is connected to resilient design strategies applicable to protecting urban waterfronts. Based on the research conducted for this project there appears to be similarities between elements used to protect SCH waterways, and resilient strategies on the broader reach scale. best suited to protect large swaths of urban coastlines. Illustrated within the design, is how programming based on those commonly found within a SCH, can help coastal communities as they establish resilient infrastructure, to also enhance ecological conditions, provide access to waterways, and create economical opportunities to generate revenue.

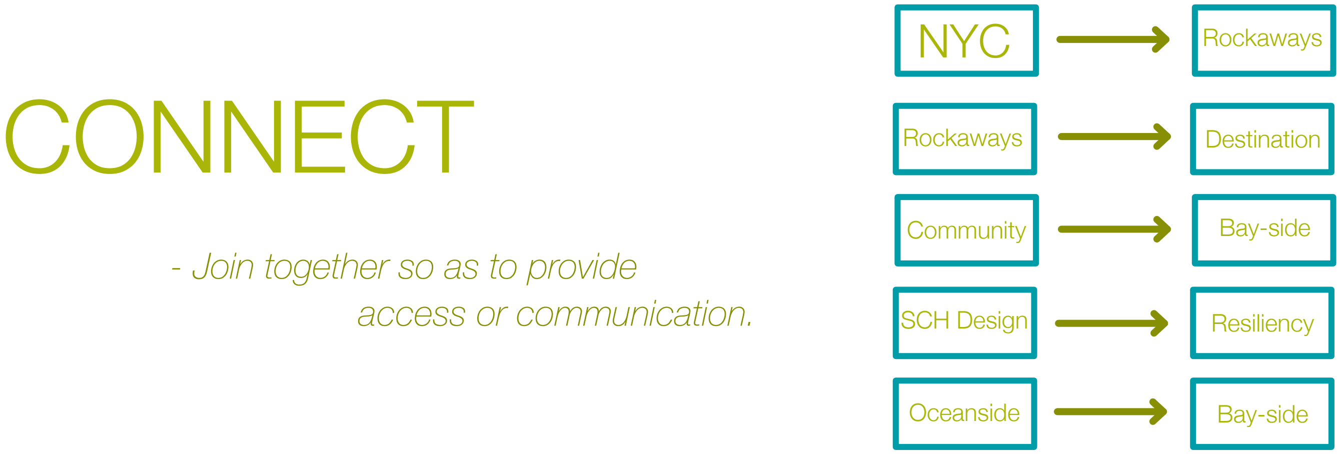

FIGURE 91. CONCEPT: CONNECT (Wierengo)

DESIGN CONCEPT: CUT-AND-FILL

The concept of Cut-and-Fill is based off the acceptance that change is inherently natural, and resilient coastal cities of the 21st century will never be completely shielded from all climate change effects. The city should instead be able to respond quickly after the most severe events via adaptable landscape design. This design accepts that the lowest elevated land will eventually become permanently inundated as sea levels rise. The '*cut-and-fill'* concept sculpts the shoreline to strategically allow water levels to inundate areas designed to welcome and encourage marshland migration. The excavated deposits are then used to elevate infrastructure above base flood elevations (FILL). The two landforms that result from the Cut-and-Fill concept resemble the naturally resilient landforms of wetlands and dunes. This system embraces change and establishes an adaptable landscape resilient enough to cope with sea level changes and storm related flood surges. The reuse of material on-site reduces the dependence of off-site material; minimizing carbon consumption and logistical issues of transporting fill through municipal circulation routes.

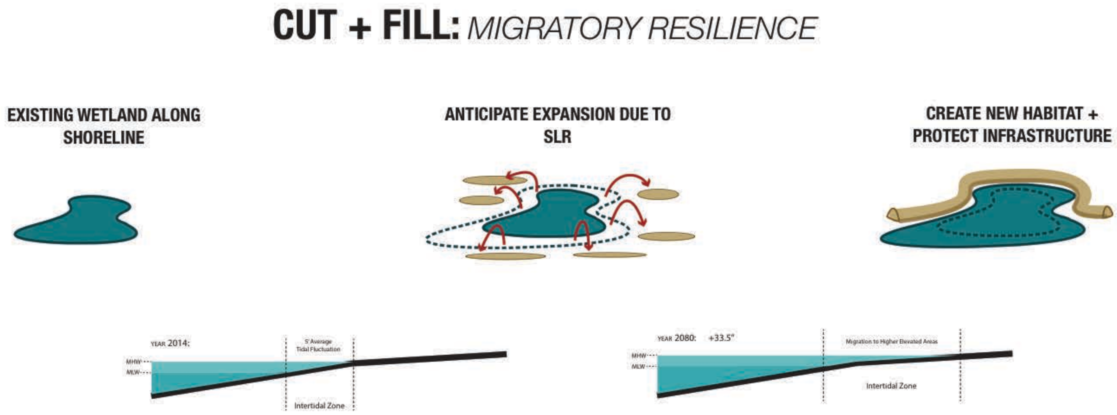

FIGURE 92. CONCEPT: Wetland Migratory Migration + Cut-and-Fill

FUNCTIONAL DIAGRAMMING + ACCESS INTEGRATION

Initial diagraming of the site first determined the most appropriate location for the marina facilities and dockage based on protective harboring qualities, water depths and recommended priority marine activity zones identified by the NYC Waterfront Revitalization Program (FIGURE 93).

FIGURE 93. Determined Marina Location for Design (Wierengo)

The rest of the site was then broken into general “programmatic” zones of residential, public waterfront, aquatic recreation, commercial mixed use, habitat, and community integration. This was based off existing land uses surrounding the site, and proximity to beachside activities.

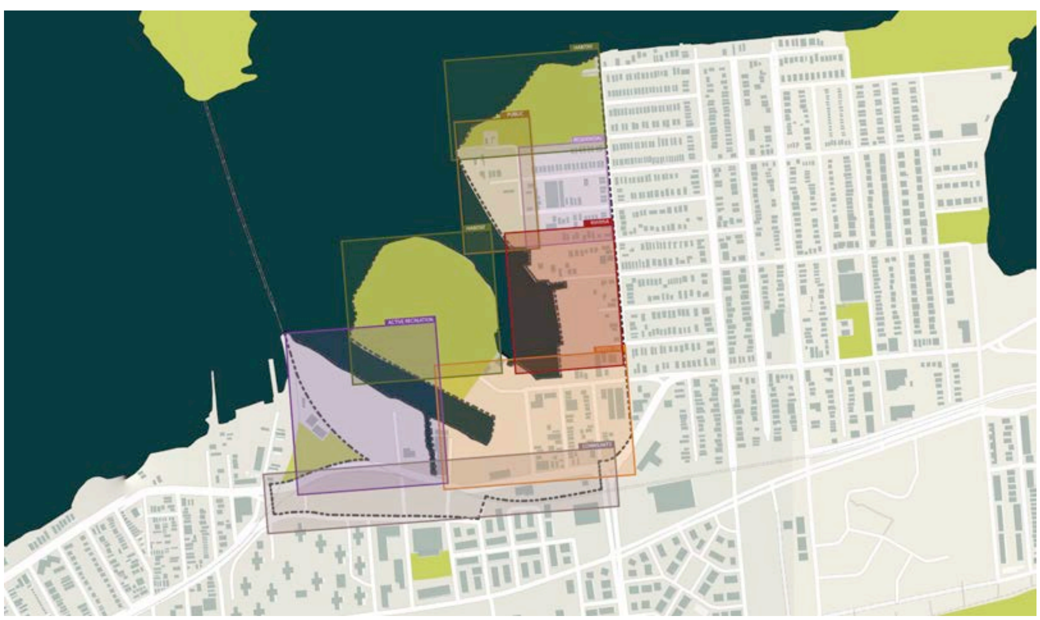

FIGURE 94. Site Design Programmatic Zone Designation (Wierengo)

FIGURE 95. Distance to Oceanside Activities (Wierengo)

In order to integrate seamlessly into the neighbored, existing access corridors from the community are identified and utilized to provide two vehicular accesses off arterial streets that connect the shorelines of Somerville. The remaining secondary side streets provide pedestrian access points into the site. Two potential 'beach to bay' avenues are also identified, based on existing road infrastructure and building locations. The existing streetscapes are extended into the site to strengthen the circulation between the ocean and bay.

Finally, the elevated 'A train' provides an extremely important connection for the site. Because of the close proximity to the station (FIGURE 97), and underutilized space beneath the tracks, a pedestrian thoroughfare is created to encourage tourism traffic between the station, site, and neighborhood (FIGURE 98).

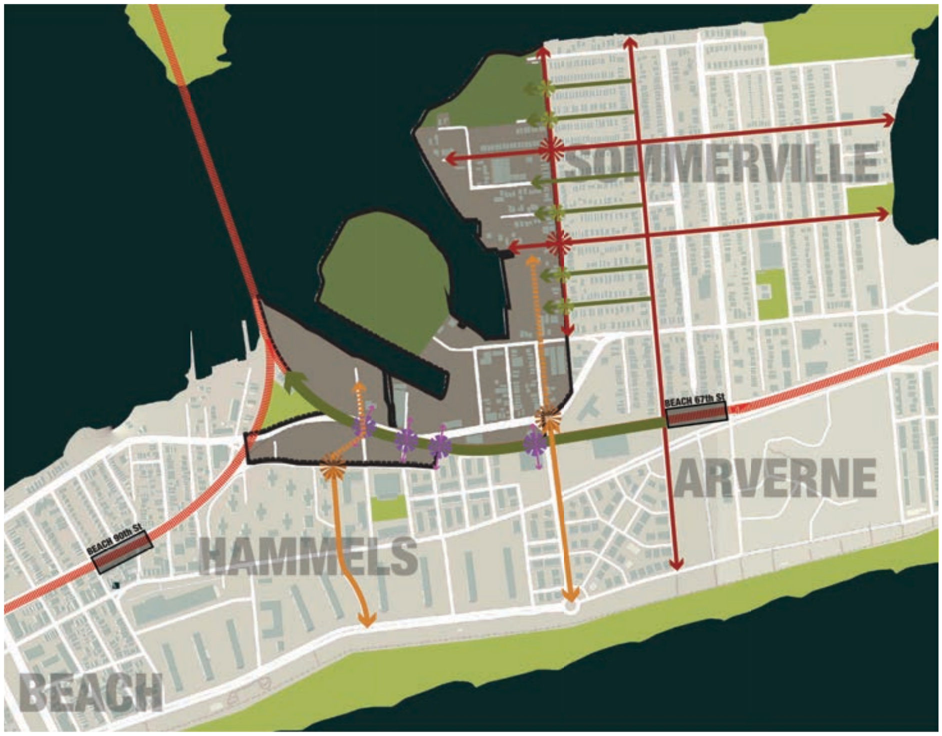

FIGURE 96. Determined Access Points for Site Design (Wierengo)

FIGURE 97. Train Station Proximity to Site (Wierengo)

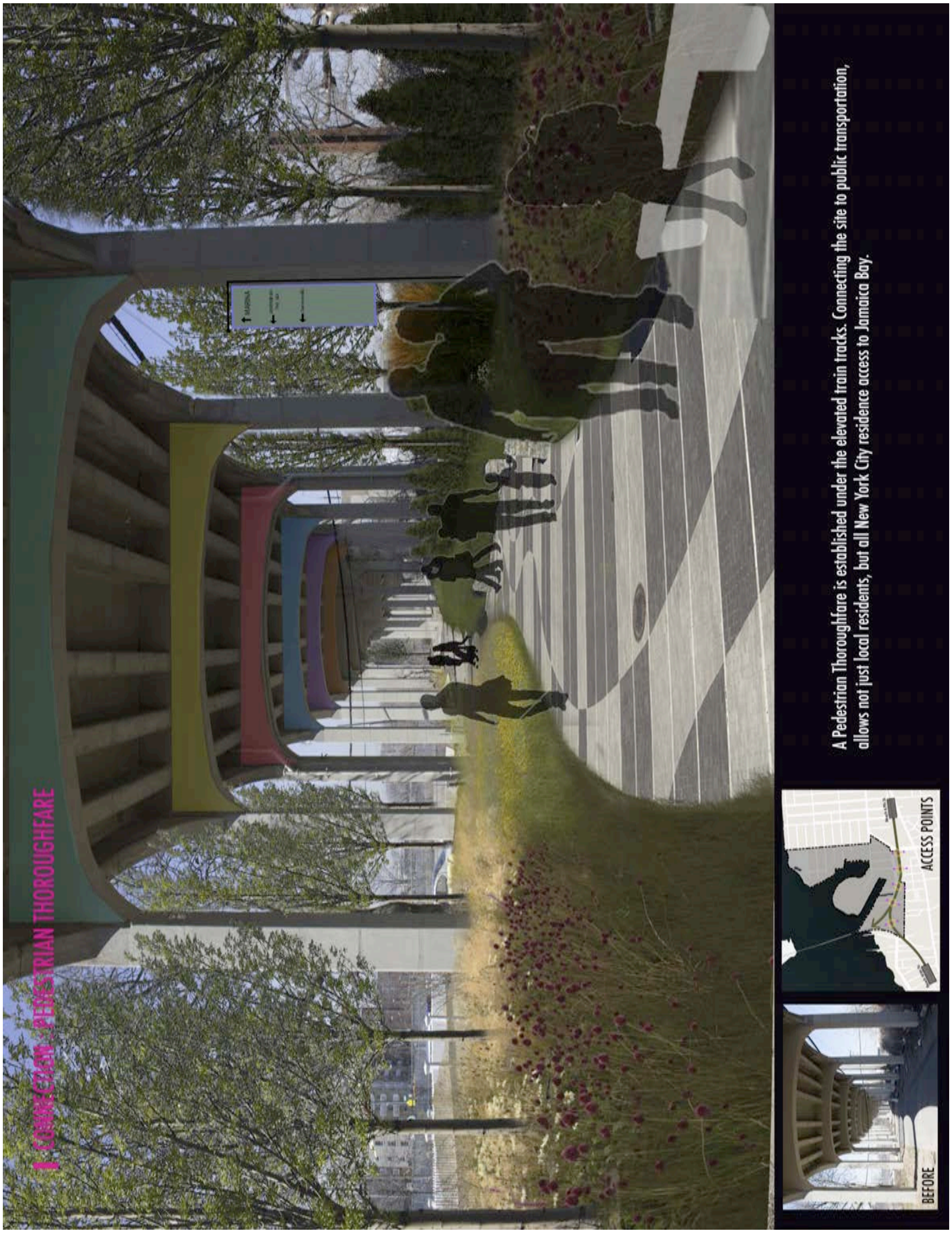

FIGURE 98. Pedestrian Thoroughfare

RESILIENT INFRASTRUCTURE

A critical feature of the project was the acceptance of *controlled loss* without compromising community viability. The design maintains residential density needed for a thriving community by building vertically, reducing the amount of vulnerable infrastructure at lower elevations, and replacing the horizontal plane with a more flood resilient landscape.

Three natural landforms found along the mid-Atlantic shoreline were determined to provide the most resilience against damage incurred by flooding and wave energy: salt-grass marshes, dunes, and reefs/ sandbars (FIGURE 99). Preliminary design exercises explored the integration of resilient infrastructure within the design to protect the surrounding neighborhoods and maintaining the established circulation routes. The difficulty to protect against flooding, and still provide unobstructed access to the water’s edge, became apparent very early into the design process through quick design sketches.

Based on the sites location along the back bay, which saw storm surges reach 12+ feet during Hurricane Sandy; and the average age of housing within the Somerville neighborhood dating before flood-protective construction regulations existing, the use a continuous duneline structure, or berm, to act as the design’s datum, was determined to be the most appropriate central resilient solution (FIGURE 100). The duneline landform is based on principles from both the multipurpose levee, and the ecological engineering of a sand dune. This reach strategy is only applicable if it can connect two elevated points so as to provide a continuous barrier against normal storm. The site’s design capitalizes

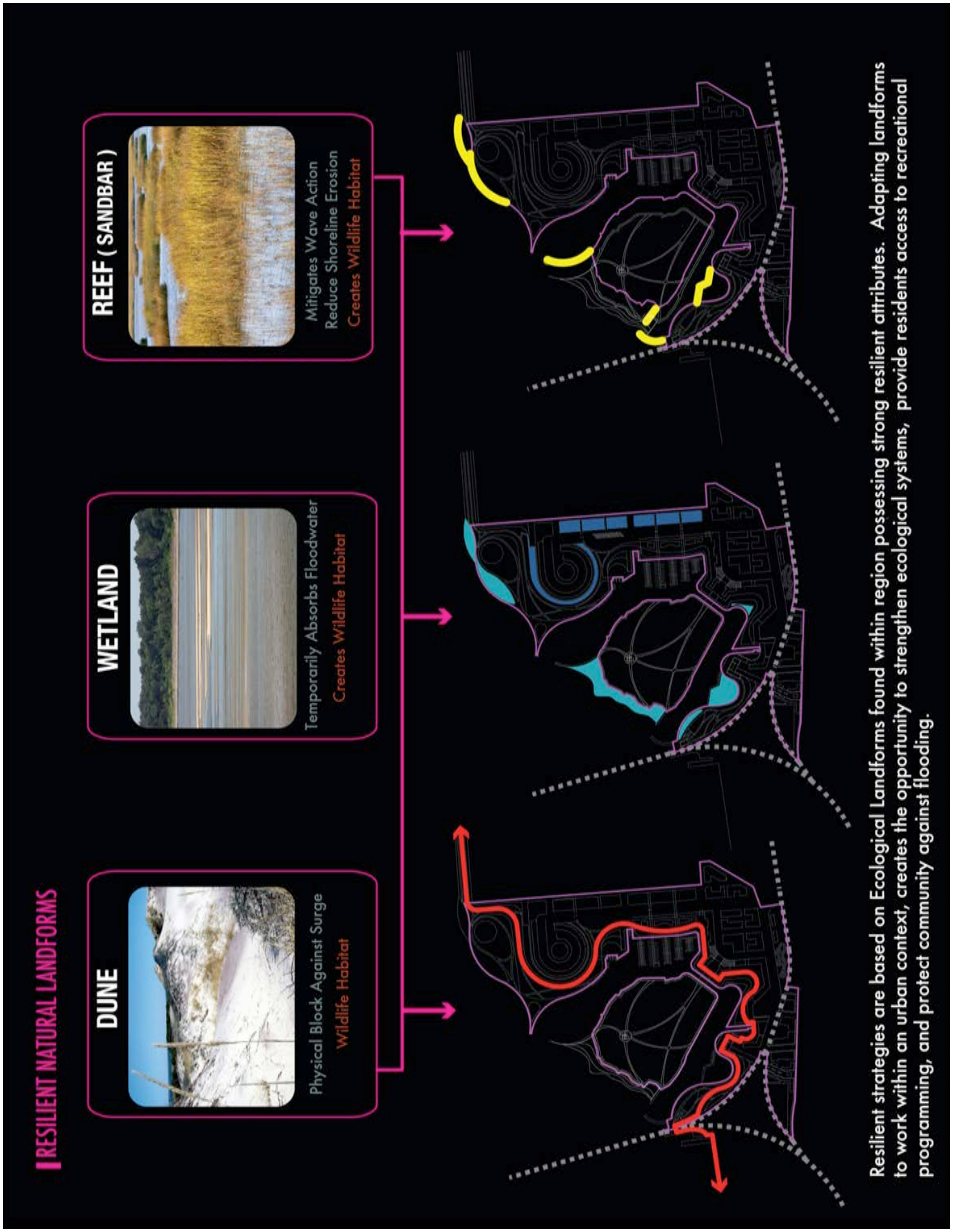

FIGURE 99. Resilient Natural Landforms Used as Precedents

FIGURE 100. Continuous Duneline Resilient Reach Strategy (Wierengo)

on an elevated sea wall under the Cross Bay Bridge, and the Edgemere Community Park, a past landfill with extremely high elevations, to function as the two terminus high points (FIGURE100).

Applying the duneline within the most urban and commercial areas of the site became a challenge. Part of the design achieving success, is to create a landscape that naturally extended from the existing infrastructure and circulation corridors of the neighborhood. The rigid street systems did not permit the sinuous curve of the dune line to seamlessly mess with the existing streetscape. It was determined, that within these areas, the elevated protective line would be best situated within the building infrastructure in order to maintain a vibrant streetscape along existing roads.

Marsh wetlands are programed within the protected 'CUTS' and establish living shorelines mitigating floodwaters, establishing ecological habitats, and treating stormwater before it enters the bay.

The final element that can be seen within the design that originated from the three resilient natural landforms is breakwater structures similar to the reef or sandbar. SCHs commonly use outer breakwaters such as stone breakwaters and attenuators to protect the inner waterways from waves and disruptive agitation. This design utilize these functions to not only mitigate the wave action before it reaches the shoreline, but introduce vegetation and shellfish colonies to encourage underwater habitat creation. These structures will also protect the cut areas within the design, and allow vegetation to establish root structures that protect against shoreline erosion. Underwater, the rock structures create important habitat areas for young fish and aquatic species needing protective areas to grow and spawn.

MASTER PLAN

The final master plan for the 83 acre site came to fruition after overlaying design sketches to create a bayside waterfront district that takes advantage of the protective harboring qualities of the two water basins, and protects the neighboring communities while ‘laying the framework’ to enhance and connect tourism and recreational activity on both the ocean and bay side locations of the peninsula.

Manipulating the dune structure into a series of 'dune typologies' creates performance landscapes that fall into the categories of: *access, habitat, inhabit, lounge, protective, storage, and urban*.

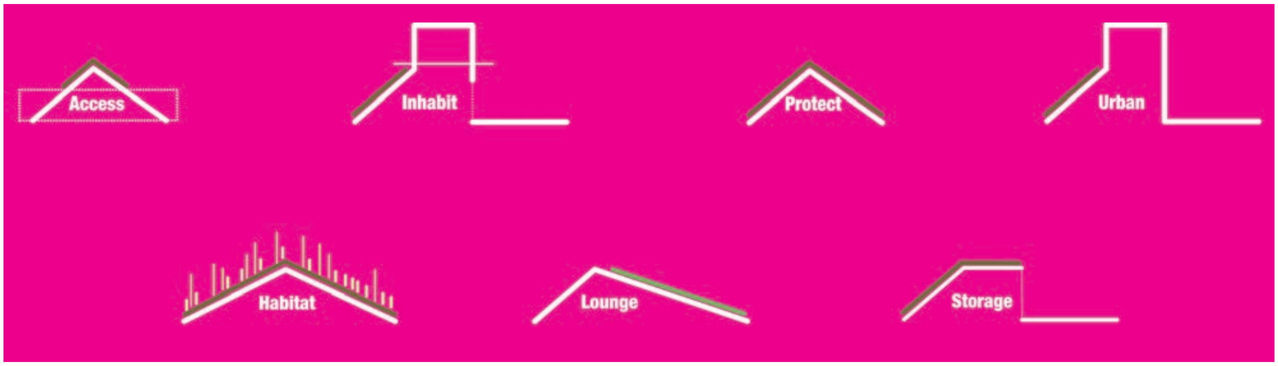

FIGURE 101. Duneline Typologies (Wierengo)

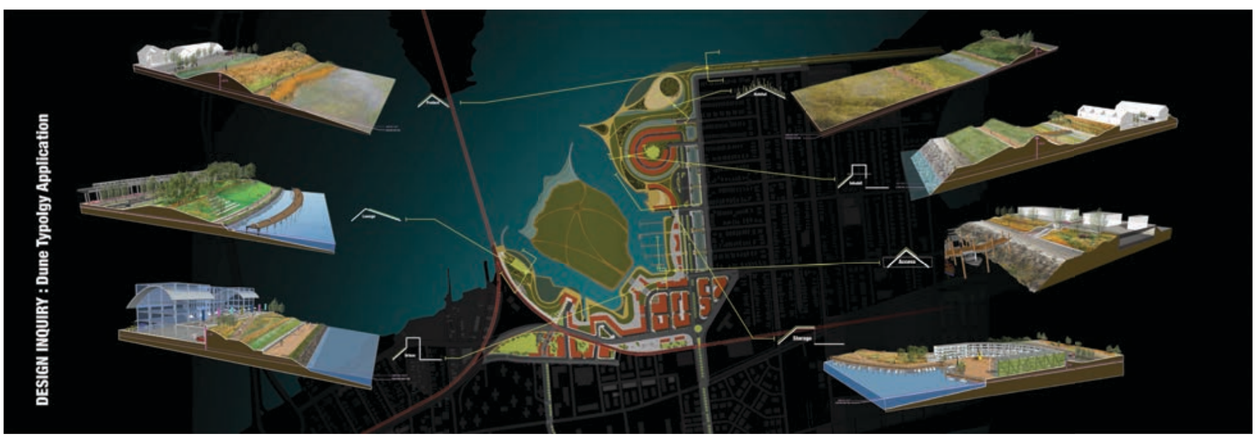

FIGURE 102. Duneline Typology Application Within Design (Wierengo)

ACCESS

Access allows a continual connection, unobstructed by elevation change. To maintain a physical barrier during flood events, built-in inflatable air bladders are deployed to block access. In the event water were to breach the dune system, either from onsite, or from the ocean side, de-activating the air bladders allow these access gates to quickly drain water once surge levels decrease. Public restrooms and marina facilities can be accessed through these areas to make use of the buried space within the dune structure. An elevated platform situates marina facilities above flood levels, and allows the harbormaster to enjoy an unobstructed view over operations. Buried cisterns store water boat owners can use to 'wash-down' their vessels by catching stormwater runoff from the buildings and elevated platform.

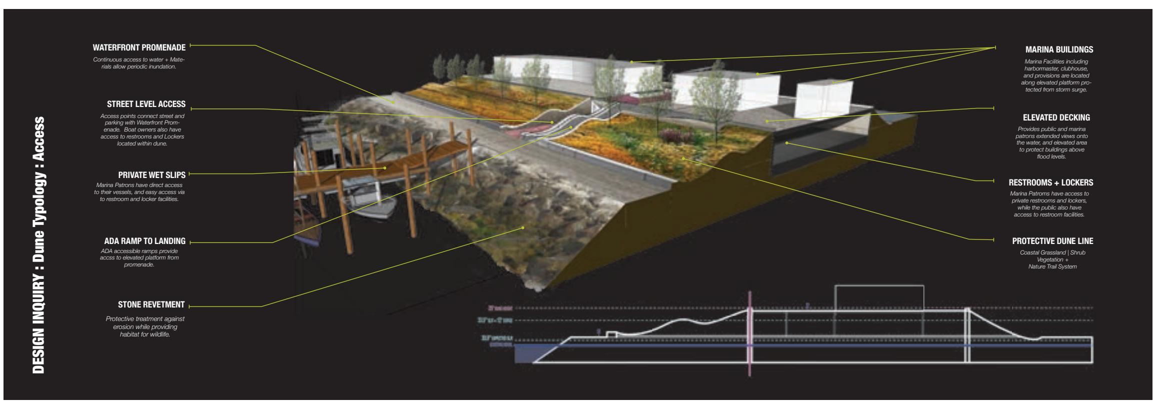

FIGURE 103. Duneline Typology 'Access' Detail (Wierengo)

HABITAT

Habitat dunes provide necessary space for wildlife to thrive, and humans to have a chance to enjoy their company. Areas where this typology is implemented, creates various habitat settings where a diverse wildlife community establishes. The landscape is able to withstand inundation periods by using materials and plant material capable of periodic inundation from saltwater.

During low water periods, visitors can access the marsh and grasslands. These areas are designed to withstand periodic inundation. During high water periods, access through the space is still available via trails located along the ridge of the duneline landform. As water levels increase to a point the area is submerged on a more regular basis, the site furnishings will be removed, and the area will allow marshland migration to occur naturally.

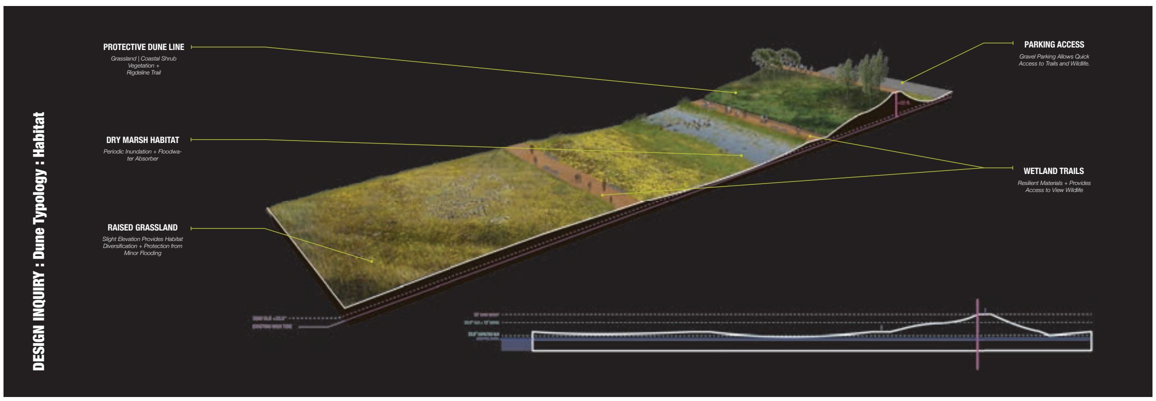

FIGURE 104. Duneline Typology 'Habitat' Detail (Wierengo)

INHABIT

Inhabit typologies provide residential structures in the form of attached townhouses at lower densities than the urban typology. On the street side, the inhabit design maintains a walk-able street scene and interaction with neighbors. The backside of the dwellings take advantage of the elevated second level and allow views out towards the water. A two-tier dune system is established within these areas. A first duneline close to the waterline provides the primary defense against storm surge. A second dunline built against the residential structures provides an additional protective agent and continuous access from the second floor of the buildings into the naturalized landscape. Between these elevated landforms a dry-marshland collects stormwater runoff from the streets and restricts contamination from entering the bay. Habitat is created for wildlife and can be enjoyed by the residence from their elevated decking. The curved design provides maximum units the opportunity to have views overlooking the water and increased potential real estate value and rent revenue.

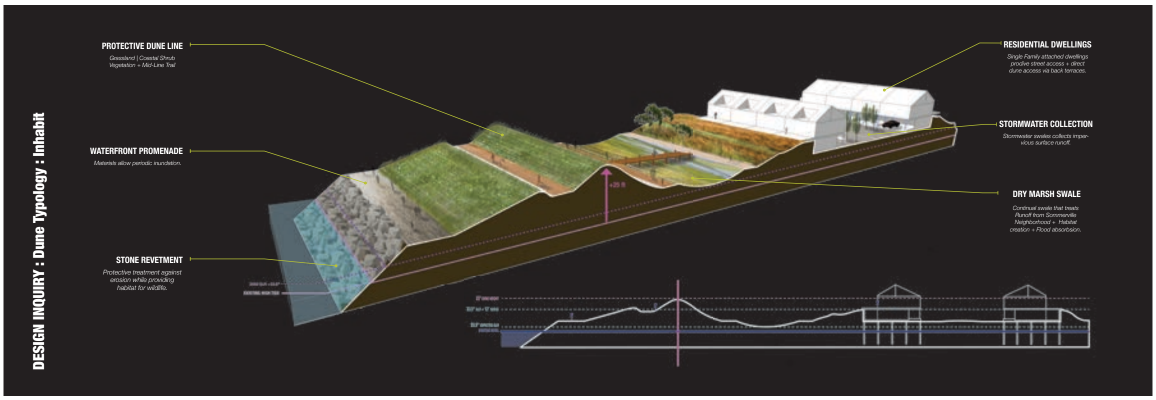

FIGURE 105. Duneline Typology 'Inhabit' Detail (Wierengo)

LOUNGE

Lounge dunes provide passive open space for the public to enjoy views overlooking the water. This area is publicly oriented and allows community residence and visitors to take a moment to reflect on the scenery. A grassy lawn area with large stone step seats, provide ample space to lounge under the sun. The elevated area along the dune ridge, provides shade and an opportunity to relax while swinging in a hammock. The edge opposite the water, and located along the pedestrian thoroughfare is programmed as a welcome plaza to provide a wayfinding node with seating and interpretive signage.

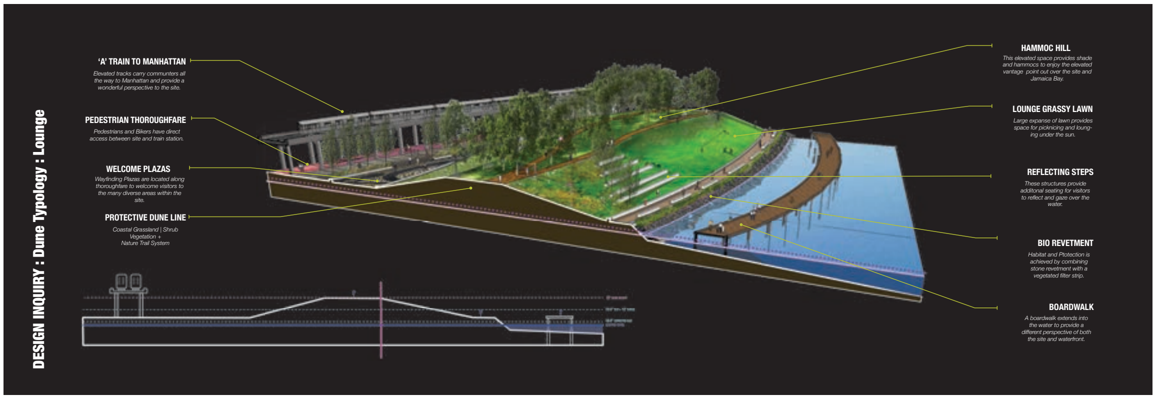

FIGURE 106. Duneline Typology 'Lounge' Detail (Wierengo)

PROTECTION

Protective dunes fulfill the dunelines basic duties as a physical barrier against flooding, and are used in areas where horizontal space is limited. The dune creates a dry upland grass habitat and continues to maintain a continual trail system along the ridgeline. To aide in the protective qualities, a living shoreline accompanies the protective dune and creates an ecotonal area between the aquatic and dry upland where a trail meanders and is accessible during lower water periods. Outer water stone breakwaters protect against large storm wave activity, but allow normal high tide waters to pass into the living shoreline.

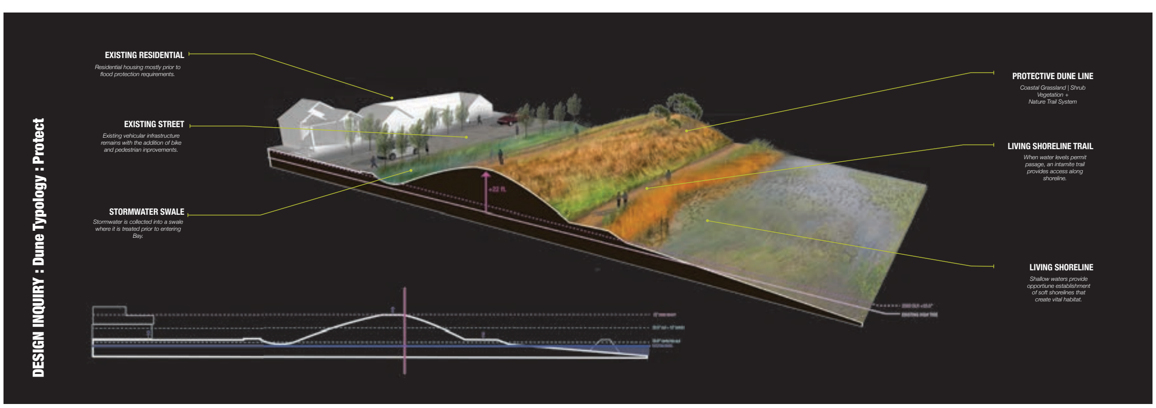

FIGURE 107. Duneline Typology 'Protect' Detail (Wierengo)

STORAGE

Storage dunes utilize space underneath for vehicular or boat parking. This typology is also used to for the dry dock storage of boats within the marina facility. More than 300 boats are capable of being stored, in an efficient and protected area, so that owners may retrieve them upon request. This area of the site is restricted and off limits to the public due to safety and light machinery usage, but the dune trail system circumvents around the storage structure and grants the user a close up experience to the living green wall that masks the dockage structure. The living greenwall creates a screen and visual icon for the site, enclosing the stored boats, but allowing winds to pass through unobstructed during high wind events. This decreases the risk of structural failure caused by wind sheer to the dry dock structure.

Other areas within the site utilizing the storage dune typology utilizes the space within the dune to provide parking for vehicles or kayak storage racks for owners to store and secure their personal vessels.

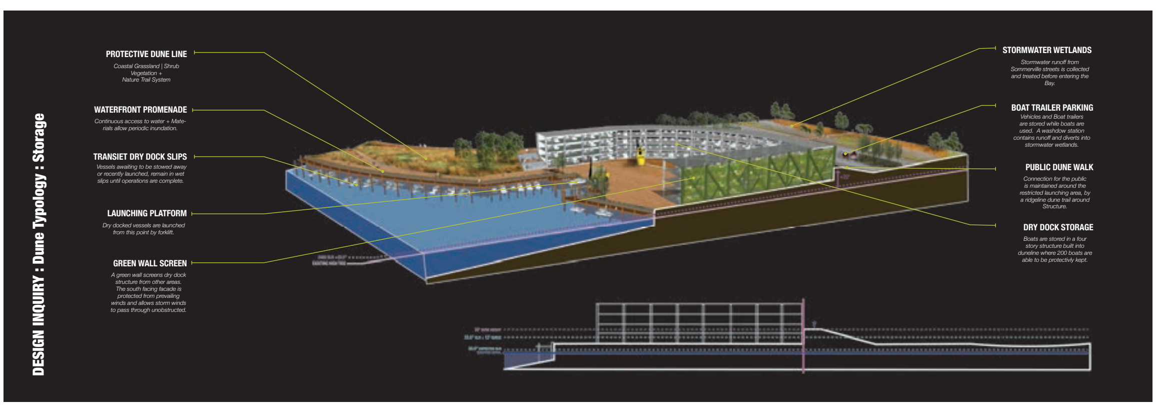

FIGURE 108. Duneline Typology 'Storage' Detail (Wierengo)

URBAN

The Urban Dune maintains the street scene, while providing protection along the landward side of the structure. This typology is used to maintain the essence of the streetscape and functionality of an urban environment, but provides access via an elevated platform on the waterside. The elevated platform creates terraced space that overlooks the water with enhanced view-sheds, and is ideal for commerce and dining programming. Beneath the platform, vehicular parking and access via elevators and stairwells, allow quick access from the street to the waterside of the structure. Mixed use buildings are used to anchor these dune types with commercial space occupying the bottom two floors, and residential units above. Usages of mid-rise building structures maintain density within the community, and are strategically located closest to public transportation for quick access via the pedestrian thoroughfare. Vertical structures reduces the amount of residents and infrastructure susceptible to flooding and allows utilities to live about flood levels. Stormwater runoff from the platform and buildings are contained within buried cisterns used to irrigate dune vegetation.

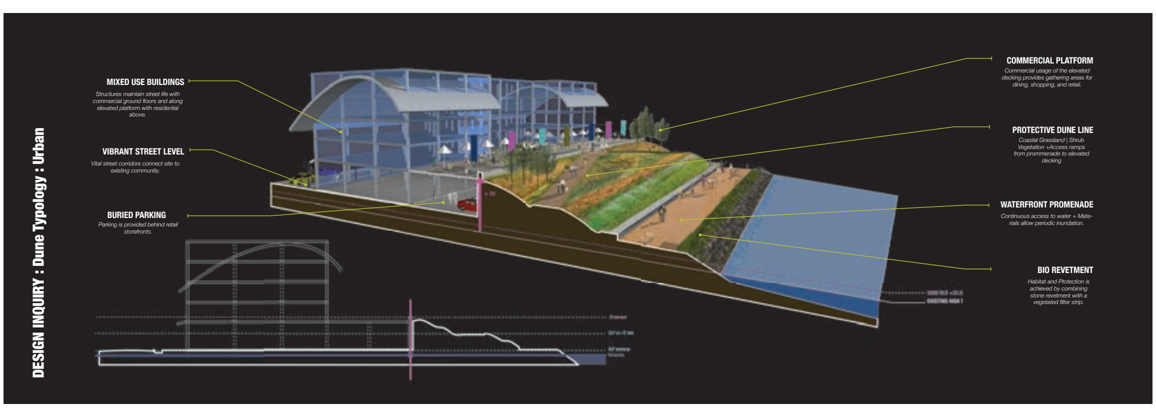

FIGURE 109. Duneline Typology 'Urban' Detail (Wierengo)

EXPANDING THE ROLE OF SMALL CRAFT HARBORS:

Although this design elaborates on the traditional roles and functions a SCH provides a community, there are still ample spaces within the harbor where pleasure boating activities take place. The marina is designed to accommodate the frequent boater, as well as the occasional boat user.

Frequent boat owners who use their vessels often, are able to store there boats in one of the 200 wet slip docks overlooking the natural peninsula (FIGURE 110). Boaters traveling greater distances, and who may not use their boats as often, have the opportunity to store their vessels in the dry storage structure described previously in the 'Storage Dune' Typology. This system allows the boat user to call ahead, prior to arriving to the marina, and have their boat forklifted into the water and ready for use by the time they arrive. This is a wonderful system for those traveling via public train from Manhattan because the average travel time of 1 hour, gives the marina facility time to have the boat ready for use in the water. Once the boat owner is finished using the boat, transient docks are provided to store the boat until facility personnel dry store the vessel once again. By using this system, the boat owner is able to enjoy the waters with their boat, with the confidence it will remain secure during the long durations between uses.

FIGURE 110. Perspective A 'Marina Docks (Wierengo)

PLANT NURSERY

The design envisions the harbor amenities to extend beyond the traditional use of docking personal boats and pleasure craft. Protected ‘Cut’ areas, used for a wetland plant nursery, provide staging and launching areas for community environmental initiatives to replant marsh grasses within the bay. Of particular importance is the Spartina alterniflora, a key plant species, which is affected by high nitrogen outflows. Modular plant plug trays grown within the nursery can be loaded directly onto a boat, and transported throughout the bay to the many islands and living shoreline projects within the area. These areas allow local organizations working to protect and revitalize the local bodies of water, a place to display their efforts to the general public through demonstrations and informative signage. It will also alleviate the dependence of transporting young plant material to be shipped in from outside sources. There will now be a space provided within the bay, where research and production can be accomplished locally. Once plants have reached a mature enough state and are needed for projects, dockage and watercraft are available to distribute the material. Close proximity to public transportation, and many public gathering areas, allows volunteer involvement to be accomplished efficiently.

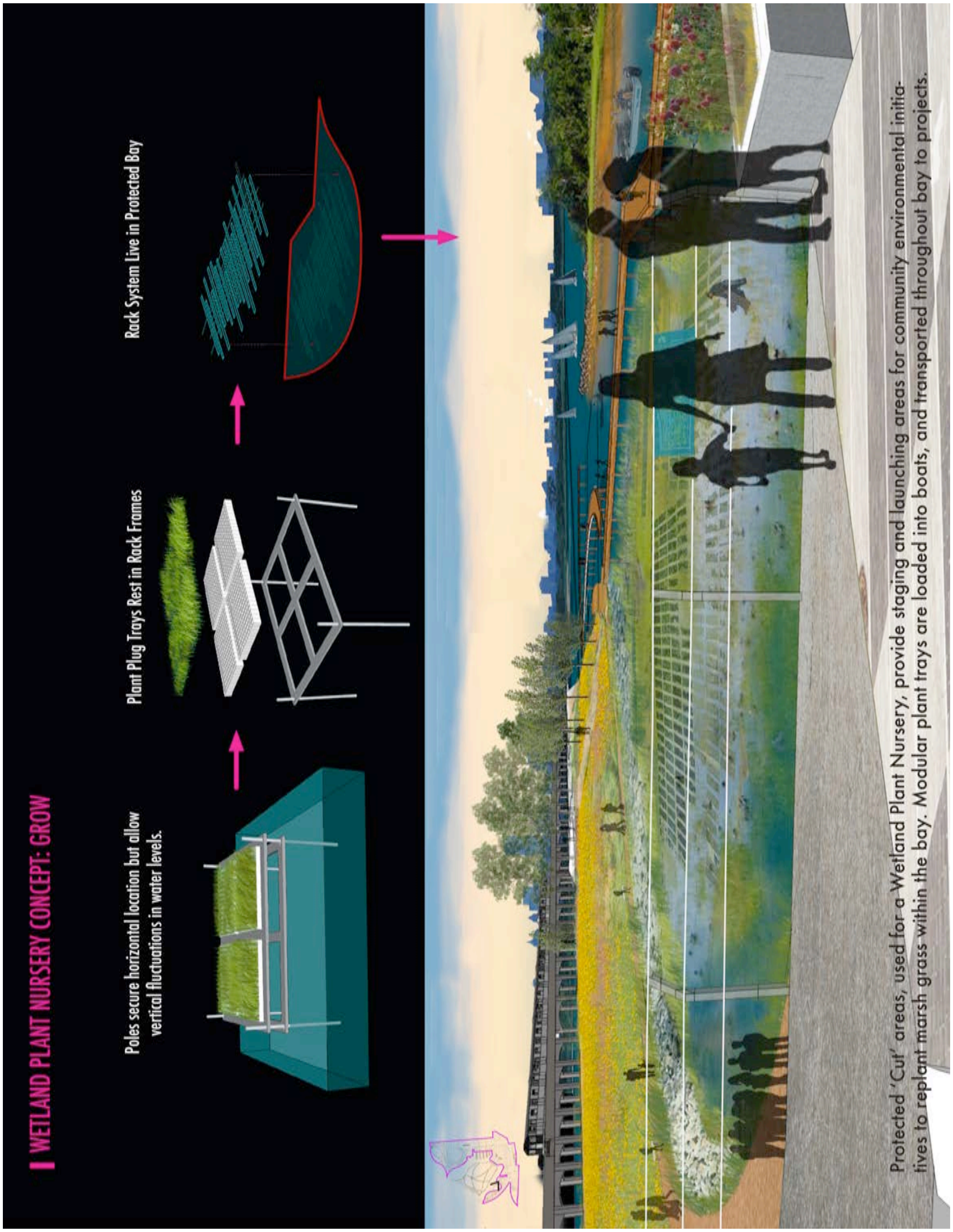

FIGURE 111. Wetland Plant Nursery Detail + Perspective (Wierengo)

FIGURE 112. Wetland Plant Nursery Distribution (Wierengo)

OYSTER PRODUCTION + WATER QUALITY

Oyster production and research is conducted along a sculpted portion of the site encouraging positive water flushing within the harbor by connecting the two water basins. Currently, these water bodies have minimal flushing qualities, resulting in floating debris and pollutants unable to flush out of the dead end portions of the basins.

Floating oyster cages below docks filter water moved by tidal currents, and create underwater habitats boosting harbor ecology. Out of water oyster setting tanks utilize a pump system filtering water into tanks used to grow oyster spat, and circulating water from one basin to the other. Research can be conduced within the same waters the mollusks will be eventually established in. Similar to the plant nursery, public awareness of community efforts will be enhanced, and watercraft will be provided dockage and staging space to initiate distribution.

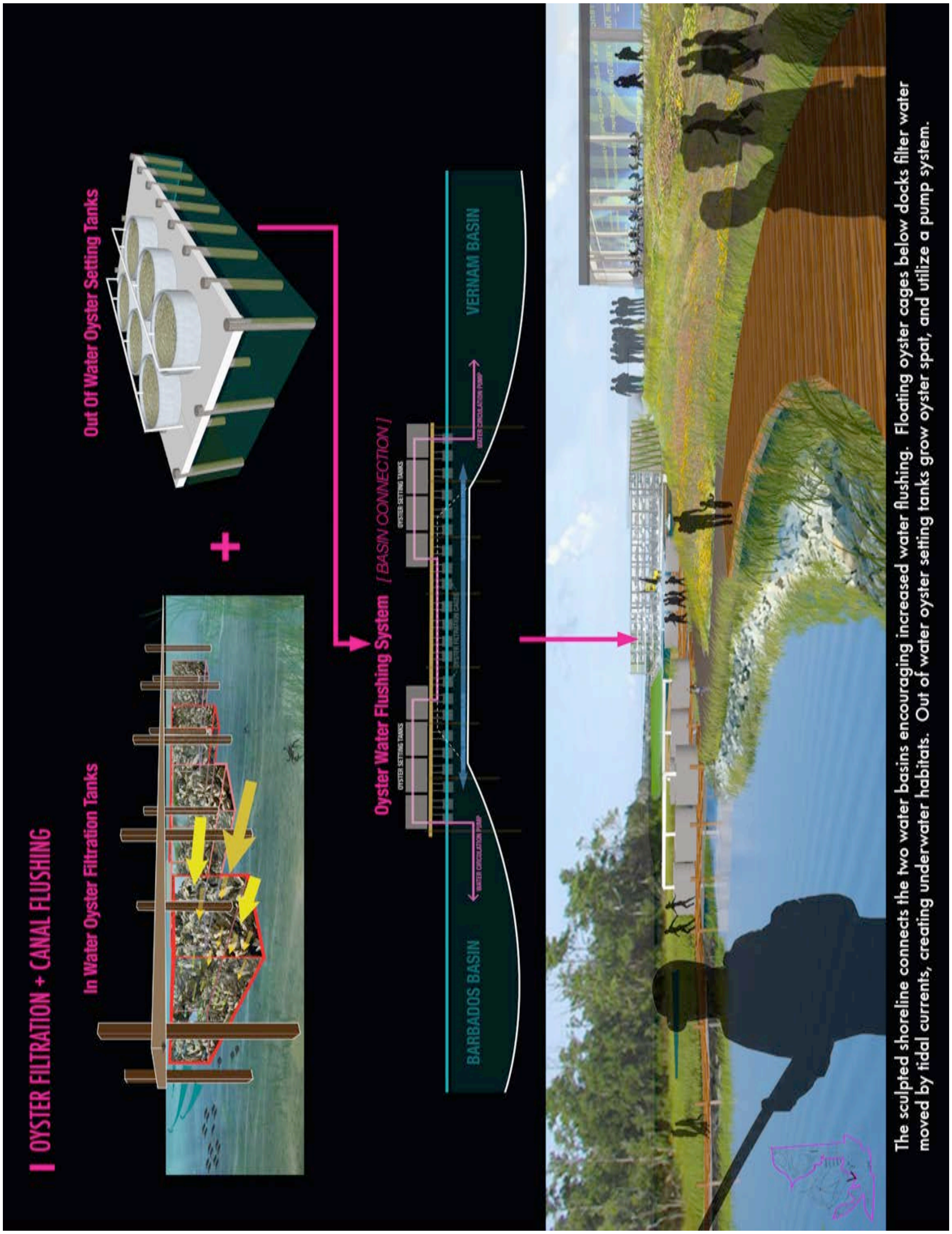

FIGURE 113. Oyster Production Detail + Perspective (Wierengo)

INTERACTION WITH ECOLOGICAL FEATURES

A set of nature trails are established throughout the naturalized peninsula centrally located within the site. The space is currently designated as parkland, although access is severely obstructed, and the shoreline is scattered with trash debris. Along the outer shoreline, located between two breakwater structures, sand deposits will increase the already present beach visible during low tides. To take advantage of the slightly elevated area on the peninsula, an observation tower will be constructed so visitors can enjoy a 360 degree elevated perspective of the site and out onto the Jamaica Bay. Shoreline treatment will be primarily soft living shoreline, reinforced with stone revetments.

FIGURE 114. Perspective B Living Shoreline Trails (Wierengo)

Two fishing piers entice visitors to venture to the furthest areas of the site. These dock structures accompany numerous other boardwalks that meander into the aquatic spaces, framing the protected cut shorelines programmed as marshlands. Not only do these structures allow visitor to experience the site with a new perspective, but also provide opportunities to create habitats below the waterline around the piles and protective stone revetments surrounding their foundation. This is accomplished with floating oyster cages and vegetated bins placed within the stone revetments.

A kayak launch/rental creates a hub for recreational equipment rentals including bicycle, paddleboard, and kayak at the terminus of one of the beach to bay corridors (FIGURE 115). A vehicular circle around a major intersection, and the continuation of existing streets into the site create the other major Beach-to-Bayside corridor. This provides parking and access to commercial and marina facilities. Both of these connective elements provides opportunities for visitors to enjoy both the beachside amenities and watersports on the bayside, through pedestrian friendly corridors guiding visitors clearly from one area to the other.

FIGURE 115. Perspective C Beach-to-Bay Corridor Kayak Launch (Wierengo)

CHAPTER 7 CONCLUSIONS

RESILIENCE

This design accepts that change is inherently natural, and the belief that the resilient coastal cities of the 21st century will never be completely shielded from all climate change effects, but should instead be able to respond quickly after the most severe events via adaptable landscape design. This allows the design to act as a living organism and evolve based on climatic conditions. The design intends to provoke continued discussions as to potential resilient strategies applied within established urbanized coastal areas in a broader context, this proposal suggests resilient landscape design, based off natural landforms that exhibit resilient attributes, could offer designers unique opportunities to design urban waterfront landscapes that afford urban residence (1) an honest interaction with their local water bodies and local ecology, (2) a thriving and desired coastal community connected through public and sustainable transportation, and (3) protection against most sea level threats designed within an integrated landscape system where functionality compliments aesthetical value. The following sections explain in more detail the methodology used to create the design for this specific project.

It should be noted, that although this project's design was specific to the needs of the Rockaway Community, the application of the material and research data, can be tailored to any number of unique coastal communities. The author believes the thought process is reasonably the same:

1. Determine the source from which damage is attributed to.
2. Understand all possible options of protection against this source
3. Identify and analyses specific needs and desires of the community.
4. Integrate resilient infrastructure into programming that benefits the communities needs and future goals, while providing the maximum amount of protection against damage source.

There are no silver bullets when it comes to protection against sea level rise and storm surge. Unfortunately, testing and modeling within a controlled environment can only provide a certain degree of certainty when it comes to the performance protective infrastructure will illustrate during a storm; or in the decades to come as sea level changes occur. Every storm event is unique and unfortunately, it takes a major storm event with the potential to severely damage a community, to ultimately see if resilient infrastructure will perform the way the designer intended. This is a difficult realty to come to terms with as a designer for coastal landscapes. Never would a storm capable of harming communities be desired, but until one occurs, the designers strategies will never be know to succeed.

This project was focused on a community that is still rebuilding after the most recent natural disaster. The design was in direct response to the affects Hurricane Sandy unleashed on the Rockaway Peninsula. For this design to be considered successful on the resilient basis, the integrated systems of resilience should be able to protect the community from all but the most devastating storm's storm surge levels based on the magnitude of Hurricane Sandy.

SMALL CRAFT HARBOR

The marina portion of the design intends to illustrate that a harbor situated within an urban setting, does provide the community with beneficial usage of its shoreline. In addition to the harbor providing an opportunity for boaters to store their vessels, the harbors infrastructure is able to act as a catalyst for improved community awareness to the quality and state of the local waterways. Specific to this site, is the idea of wetland restoration within the islands of Jamaica Bay. Although not directly connected to the design, if the grasses and plants grown within this design can be used to slow the wetland loss within the bay, and raise awareness of the bays troubled state within the community, the design would be working towards fulfilling its goals.

Implementation of specific ecological boosters within the design should elevated the landscape to become a healthier ecological landscape than it was prior to being a SCH. Habitats should survive around the floating oyster cages below docks, and wetland plants grown within the rocks of stone revetments. If this can be achieved, then the design will illustrate marinas and harbors do not need to be considered point pollution sources if designed to mimic natural landforms, and think creatively how ecological habitats can be integrated into necessary dockage and protective infrastructure.

TOURISM + ECONOMIC STIMULUS

The design introduces the framework to create once again, a beachside destination for all of New Yorkers. Connecting the designs activities and all water related commerce provided throughout the bayside shoreline of the Rockaways into a desired destination accessible via public transportation, has the opportunity to increase real estate prices, and help generate tax revenue for the city to further improve the area. By creating a mixed use district close to the train stations, this site has the appeal necessary to attract younger residence capable of energizing the area into a thriving sustainable community. With density increasing and residing above flood levels, the area can continue its population increase, but minimize the vulnerable infrastructure susceptible to flood damage. This should reduce the amount of damage that occurs after the next storm will hit the area.

THE NEXT STEP

Design solutions to combat climate change, will continue to evolve as new theories and strategies after each new storm event reveals the pros and cons of existing protective infrastructure. It is the author's hope that this document will provide material for discussion related to the use of ecologically engineered solutions to coastal resiliency as this discussion continues. The integration of ecological systems within the urban coastal fabric could create an entirely new urban coastal landscape for the 21st century cities, and is an exciting opportunity for landscape architects to help improve coastal landscapes performance.

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