DUNEBOOK The "Greater Rockaway" Coastal Resilience Training Guide



Land Acknowledgment

We would humbly like to recognize and acknowledge the land in the following plan and accredit the indigenous people: Munsee Lenape, Leckawe (Rockaway), and Canarsie.

This work seeks to better understand and re-address the needs of the land and current population in the Rockaways. Therefore, we must reflect on its origin: Reckouwacky meaning 'place of our own people' in the Lenape language. While a land acknowledgment is not enough, it is an important practice that promotes indigenous visibility and a reminder that we are on settled indigenous land. Let this acknowledgment be an opening for all of us to contemplate a way to join in de-colonial and indigenous movements for sovereignty and self-determination.

"Greater Rockaway" Coastal Resilience Training Guide

2024

Prepared by:

RISE (Rockaway Initiative for Sustainability and Equity) W X Y architecture + urban design eDesign Dynamics

Photo credit: Giles Ashford

With support from the National Fish and Wildlife Foundation

Glossary

- **1. Berm** Raised strip of land on which the boardwalk lies.
- 2. Composite seawall Protective structure adjacent to the boardwalk composed of steel beams/concrete and covered in a layer of sand to mimic the appearance and function of a dune.
- **3. Drift fence** Fences that trap blowing and drifting sand thus causing a sand dune to effectively form and build.
- Dune blowouts/depressions Gap in a dune caused by strong winds blowing sand out from under and around the vegetation.
- Groin Coastal engineering structure built perpendicular to the shore to trap sand and reduce beach erosion by interrupting the natural flow of sediment.
- 6. Herbaceous species Annual, biennial, or perennial plants that have non-woody, flexible stems that tend to die back to the ground at the end of the growing season.
- **7. Hydrology** Study or practice in the properties of water, especially the movement of water in relation to land.
- 8. Land subsidence Gradual settling or sudden sinking of the Earth's surface due to removal or displacement of subsurface earth materials.
- **9. Landward** Pointing to or on the same side as the land (or away from the ocean).
- **10.Seaward** Pointing to or on the same side as the ocean.
- **11.Light regime** Intensity, duration, and quality of light in a specific area, affecting the growth and development of plants and ecosystems.

- **12.Offshore borrow area** Location within the ocean from which sand is collected and then deposited on the beach.
- **13.Outfalls** Structures or points at which wastewater or stormwater is discharged from a sewer system, treatment plant, or drainage channel into a body of water.
- **14. Plant palette** Selection of plant species suitable for planting within designated areas or conditions. Plant palettes often identify herbaceous, shrub, and tree species which are compatible with one another.
- **15. Ponding** Accumulation of water in flat or low-lying areas without sufficient drainage, often occurring after heavy rainfall or due to poor surface grading.
- 16.Seaspray Aerosol particles formed in the ocean and ejected onto the shore, which contain both organic matter and inorganic salts. Sea spray is responsible for much of the heat and moisture fluxes between the atmosphere and the ocean, thus impacting climate patterns and tropical storm intensity. Sea spray also influences plant growth and species distribution in coastal ecosystems and can increase corrosion of buildings on coast lines.
- 17.Sewershed Geographic area that drains into a common point in a sewer system, much like a watershed but for wastewater.
- **18.Toe of the berm** Bottom edge of berm.
- **19.Wrack line** Coastal feature where organic material (e.g., seaweed, shells) and other debris is deposited at high tide.

"Greater Rockaway" Coastal Resilience Training Guide

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Welcome to the **DUNE SQUAD!**



Jeanne DuPont Executive Director, RISE

Thank you for joining the Dune Squad here at RISE, the Rockaway Initiative for Sustainability and Equity. We are so excited to have you here as part of our growing team. Together, we work to create a natural buffer to protect our community from stormsurge and flooding!

Here at RISE, we work to convene community members, building and sharing local knowledge around coastal protection. We create opportunities for shoreline stewardship for residents of all ages including community plantings, paid internships, and seasonal jobs.

As part of the Dune Squad your work is critical to the health and safety of our community.

The Dune Squad plays a fundamental role as part of The "Greater Rockaway" Coastal Resilience Plan, a multi-year initiative started in 2020 that actively engages the local community in the long-term maintenance and stewardship of a 5-mile stretch of dunes right here in the Rockaways.

This plan is led by the RISE in partnership with the NYC Department of Parks & Recreation, NYC Department of Housing & Preservation, NY State Department of Environmental Conservation, the U.S. Army Corps of Engineers, and neighbors like you. We are so grateful to have you on-board and hope that this Dunebook here, which grew from seeds of ideas planted by the 2023 Dune Squad, acts as a useful tool as we set out to protect our dunes and our community, together!

Thank you for being here. We are so excited to have you join us!

Sincerely,

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Jeanne DuPont Executive Director, RISE

Scan the QR code to learn more about **The "Greater Rockaway" Coastal Resilience Plan** and the different ways you can get involved!



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How to Use This Dunebook

The "Greater Rockaway" Coastal Resilience Training Guide (the Dunebook) is a technical training manual used to support the work of RISE's amazing restoration stewards, including the Dune Squad, Shore Corps, staff members, consultants, and volunteers.

This guide includes helpful information to use out in the dunes such as planting zone maps, flora and fauna references, core restoration ecology concepts, habitat restoration planting techniques, invasive removal guidelines, irrigation requirements, adaptive maintenance tasks and more!

Throughout the Dunebook, you also will find QR codes you can scan to access referenced materials and further readings.

Like the dunes, the Dunebook is living and growing. It is meant to ground, nourish, and support your work out in the dunes and beyond. Please let us know if there's anything that could be helpful to add.

A big thank you to the 2023 Dune Squad, whose critical feedback was the catalyst for making this Dunebook possible.

This Dunebook is divided into three sections, as outlined on this page.

Coastal Resilience Plan Refresher

What you will find: An overview of the 2021 "Greater Rockaway" Coastal Resilience Plan crafted by RISE and a team of sub-consultants including WXY architecture + design, Ana Fisyak Consulting, and eDesign Dynamics (EDD), and supported by the National Fish and Wildlife Foundation (NFWF). This Dunebook is directly informed and inspired by the work of this plan, which lays the foundation of our work here at RISE.

Who should read this: Anyone interested in learning more about why this plan was started—from rising sea levels, rising temperatures, and an increase in extreme weather events—and what the main objectives are.

How to use it: Read the text, look at the maps and data, and familiarize yourself with key concepts. Draw from this section to provide context for the work you are building on.

2 Dune Restoration Fundamentals

What you will find: An introduction to what dune restoration means here in the Rockaways, as well as general concepts that can be applied beyond the Rockaways. This includes learning about dune morphology, vegetation, fauna, and restoration specifics that are critical to the day-to-day work of dune restoration!

Who should read this: Anyone working on restoration out in the dunes as well as stakeholders interested in supporting community stewardship efforts and advocates or organizers living outside of the Rockaways who want to develop a similar dune restoration plan in your community.

How to use it: Explore the introductory overview of dune ecology and refer back to this section as needed. This section of the report can be used on its own as a guide to dune restoration in the Rockaways.

3 Dune Restoration Field Guidance

What you will find: A breakdown of instructions for RISE's Dune Squad leading the restoration efforts. This includes details from sourcing plants, to planting days, watering, data collection, and maintenance.

Who should read this: This section is meant for the RISE Dune Squad. Feel free to use this example to learn more about our process or create your own field guidance for your dune restoration teams.

How to use it: Study the text, illustrations, and maps as well as linked sources via QR codes; refer back to the recommended steps and adapt to restoration work out in the dunes!



Coastal Resilience Plan Refresher

This first section of the Dunebook offers a brief overview of the RISE "Greater Rockaway" Coastal Resilience Plan including why we do this work and where we do this work.

If you live, work, or go to school in the Rockaways, this section may clarify why this Plan is so urgent. It may also offer some guidance or inspiration as to how your efforts as a community steward can prepare us for a safer more sustainable future. In this section, you'll find:

- Why We Do This Work
- The Role of Dunes During Superstorm Sandy
- The Threat of Flooding
- How We Do This Work
- Where We Work
- Our Planting Plan

Why We Do This Work

INTRODUCTION

Our Story

The "Greater Rockaway" Coastal Resilience Plan was initiated in 2020 by the Rockaway Initiative for Sustainability and Equity (RISE), with support from New York City Department of Parks and Recreation, New York State Department of Environmental Conservation, US Army Corps of Engineers, as well as technical support from WXY architecture + urban design and eDesign Dynamics.

Our goal is to create an extensive, biodiverse, and habitat-rich dune system along the Atlantic shoreline of the Rockaway Peninsula. With 11 miles of beach along the Atlantic, the Rockaway Peninsula's southern shoreline is the largest urban beach in the United States and provides important habitat for local plants and wildlife. It is also the social and economic spine of the Rockaways. The dune ecosystem serves as the first line of defense for homes and businesses against flooding, which will only grow in importance in the future due to climate change.

Integral to this plan are initiatives that provide more economic, social, and educational opportunities for residents, as equity and economic empowerment are a central goal of this effort.



Learn more about The "Greater Rockaway" Coastal Resilience Plan! As residents of the Rockaways, this work is personal. It grew from our experience in 2012 when Superstorm Sandy hit.

We hope our work will serve as an example for other coastal communities and give more opportunity for collaboration and dialogue between local stakeholders and city agencies about the nature of our shoreline and the effects of climate change. Without these collective efforts and the critical work of the Dune Squad, this work could not be possible.



Why We Do This Work

OUR CURRENT REALITY

The big idea: Superstorm Sandy was an unprecedented storm. Sandy extended 1,000 miles from end to end (three times the size of Hurricane Katrina) and occurred during a spring high tide, when the ocean water level along the Rockaways was elevated at the peak of its monthly cycle. While most Atlantic coast storms usually curve east back out to sea when nearing land, Sandy's unusual path headed straight towards land causing massive storm surge.

Sandy is one of the many impacts of a changing climate. Read on to learn more about the ways the climate is changing and how restoration work addresses this crisis.

HOW DOES CLIMATE CHANGE IMPACT COASTAL AREAS?

Storm Surge: according to the New York City Panel on Climate Change (NPCC) 2015 Report, sea level is projected to rise as much as 75 inches in New York City by the end of the century. Forecasters also predict an increase in the frequency of extreme storm events, particularly hurricanes for the North American Atlantic coastline. Hurricane-force winds drive local sea levels much higher than normal, an effect known as storm surge. Storm surge puts coastal areas such as the Rockaways at an increased risk of flooding and erosion when coupled with the rise in average sea levels and increased runoff from upland areas. **Flooding:** During storms, hurricanes, and other severe weather events, areas where water meets land are particularly vulnerable. Buildings, parking lots, and other impervious surfaces worsen the problem as they have no ability to absorb excess floodwater. Rather than designing against the flood, we can design with the flood, and create landscapes and built systems that are adapted to a changing climate. This includes creating coastal areas that can tolerate flooding and that naturally recuperate after a storm, unlike roads and parking lots that can get torn apart and permanently damaged.

Sea Level Rise: As global temperatures rise, polar ice melts and oceans expand causing sea levels to rise. This can lead to increased erosion along the beach and dunes, threatening the stability of these habitats.

Rising Temperatures: The concentration of greenhouse gases in the Earth's atmosphere traps the sun's heat, resulting in rising temperatures at the Earth's surface. Rising temperatures can affect the distribution of plant and animal species along the Rockaway beach and dunes. Some species may migrate or shift their ranges in response to changing temperature patterns, impacting the composition of the habitat.

Extreme Weather Events: Weather patterns are altered as a result of rising temperatures; warmer temperatures lead to the atmosphere holding more moisture. As a consequence, storms and hurricanes are becoming more intense with more rainfall. At the same time, a warmer atmosphere increases evaporation, which can worsen the severity of droughts.

More severe storms can result in higher storm surges, leading to greater erosion and potential damage to the beach and dune ecosystems. This, in turn, can have negative consequences for wildlife that depend on these areas, including secondary dune habitat, for breeding, feeding, and shelter.

CLIMATE MITIGATION APPROACHES

There are three very general strategies to address risks from changing sea and flood levels:

Holding the Line is a strategy to use direct protections that keep high waters at bay. Coastal cities throughout the world are considering use of barrier protections like seawalls. These are ineffective when flood waters or storm surge rise above the walls causing protected areas to become fully inundated. Barriers can also prevent stormwater runoff from reaching open water, creating a "bathtub effect."

Managed Retreat is a strategy that moves structures and people to higher ground, and creates or relocates natural shoreline habitats that help to limit flooding.

Accommodation requires a design approach to buildings and utilities that accepts higher flood levels without damage to structures. Lower elevations become accessible again once floods recede.

OUR HOPE

In the aftermath of Superstorm Sandy, the shoreline areas with dune systems in place fared much better than areas without. The level of protection from the dune system is even greater when the dunes are planted. That's where RISE and other coastal restoration leaders come into play: restoring secondary dune with native planted habitat while hiring and building capacity among local residents to steward and lead the work. It is critical to focus on the resiliency of both the dunes and of our communities to ensure a thriving Rockaways.

Have you observed or heard about any impacts of climate change in your community?

Which mitigation approach(es) do you think would work best where you live (holding the line, managed retreat, or accommodation) and why?



Pictured: Volunteers during a RISE community stewardship event.

The Role of Dunes During Hurricane Sandy

WITHOUT Dune (94th St)





BROOKLYN

JAMAICA BAY

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WITH Dune (56th St)



Sources: NOAA, PlaNYC 2013, NYC Special Initiative for Rebuilding and Resiliency (SIRR), Accessed 2024



As residents were reminded in 2012, when Superstorm Sandy inundated the Rockaway shore, the beach serves as the first line of defense for homes and businesses against flooding, which will only grow in importance in the future due to climate change."

Jeanne DuPont, Executive Director, RISE, Local Resident

In my world, on that small peninsula, the ocean met the bay and nearly every inch of land went under water. Electrical fires lit the night sky destroying entire neighborhoods. The beach and boardwalk for which Rockaway was known, along with the lives of hundreds, was destroyed. In spite of that, what followed the storm is something that can only be described as amazing. Men, women, and children – some with nothing left – came together to rebuild."

Christopher Carr, SHORE Corps, Local Student, Rockaway Stories, Excerpt from Untitled Piece

This place we called home has been destroyed and ruined... covered in the ocean that's so vast and blue... lives were threatened, people were scared... no heat, no water, and no light anywhere."

Loriann Lawrence, SHORE Corps, Local Student, Rockaway Stories, Excerpt from Ruined

QUEENS

RISE

ATLANTIC OCEAN

- Dune Preserve

The Threat of Flooding

JAMAICA BAY

RISE

"Greater Rockaway" Coastal Resilience Training Guide

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Sources: NYC Flood Hazard Mapper, New York City Department of City Planning, New York State Department of Environmenta

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How We Do This Work

OUR APPROACH

The RISE 2021 Coastal Resilience Plan brought community stakeholders to the table during a year-long engagement process to develop a framework for community stewardship and shoreline enhancement for the restoration of the Rockaway peninsula. Below are the key objectives:

Key Objectives

- 1. Help stabilize the Rockaway peninsula, especially as we face more frequent and intense storms, by planting local trees, shrubs, grasses, and wildflowers that root into the sand and anchor the dune in place.
- 2. Enhance and restore coastal habitat with biodiverse plant communities that can adapt to a changing climate.
- 3. Support social resilience and community involvement through citizenscience, environmental education, community plantings and workforce development in the long term.



Pictured: Shore Corps Tour with Mike Feller.

The Three E's

RISE's work is guided by the following values based on community engagement during the development of the RISE 2021 Coastal Resilience Plan.

Economy: How individuals and communities survive, thrive, and share; this includes local businesses and retail, employment, housing, and the overall livelihoods of residents and communities.

Ecology: This refers to the health of the Rockaway's environment, including plants, animals, and their habitats, and the relationship between these habitats and the humans who live in and around them.

Equity: This relates to the varying levels of power and access held by different groups of people, both historically and today. Equity is a value that seeks to give more power, access, and resources to those groups who face oppression on the basis of race and ethnicity, ability, language, religion, age, gender, sexual orientation, and more.



Education & Awareness



Environmental Stewardship

Pictured: Focus areas of work that emerged from engagement while developing the 2021 "Greater Rockaway" Coastal Resilience Plan.



Youth Employment



Green Economy

Where We Work

ROCKAWAY BEACH

The RISE 2021 Plan area comprises land north of the Rockaway boardwalk, extending from Beach 19th Street to Beach 73rd Street. At 15 acres in area, the plan area acts as a protective buffer. Along the plan area the dune buffer ranges in width from 20-feet to 100-feet depending on who owns the land, the current condition of the land, pre-existing development plans, and the owner's interest in partnering on stewardship and planting on that land.

USACE & RISE Working Together

The United States Army Corps of Engineers (USACE) has focused their efforts on reinforcing the primary dunes south of the boardwalk. USACE's work includes the installation of sand to create engineered dunes and the Rockaway beach area, construction of an impermeable seawall buried beneath the engineered dunes, and the construction of groins, or breakwater rock structures that run perpendicular to the shoreline to restrict the movement of sand drifting away from the beach.

RISE has focused their restoration effort on the north side of the boardwalk, within the secondary dunes from Beach 19th-73rd Streets. RISE's work includes the installation of native plantings to enhance the secondary dune ecosystem and stabilize the shoreline naturally.

Arverne East Nature Preserve

The Arverne East Nature Preserve is a 35acre preserve, managed by the NYC Dept of Parks & Recreation, at Beach 44th St. to



Figure 1. Working in Community, Examples of Our Areas of Work

Beach 56th Place, complete with walking paths, interpretive signage and native coastal plants open for the public to explore.

Arverne East Welcome Center

Located at Beach 44th St. in Far Rockaway, NY, the Arverne East Welcome Center features space for educational and community programs led by local community partners. The Center is adjacent to the Dune Preserve, and supports the surrounding ecological benefits of the Rockaway shoreline and greater appreciation of the coastal dune habitat.

RISE Native Plant Nursery & Pollinator Garden

RISE is developing a one-acre site of the Arverne East Development, at Beach 44th St., as a native plant nursery and seedbank to grow native shrubs and grasses, exclusively for the dune preserve restoration. The nursery will employ and train a team of local residents and interns to learn seed collection and propagation of native shoreline plants. An adjacent space will be developed as an educational garden for K-12th grade classes in partnership with local public schools, to learn about pollinators, the history of the Rockaway shoreline, and the importance of the dune ecology.

This space will be an integral resource for this vulnerable coastal community and ecosystem; providing nature-based solutions for increased resilience against rising seaslevels, more intense storms, increased flooding and erosion.



Figure 2. Our Growing Coastal Resilience Network Protecting NYC





RISE

Beach 59th

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Pictured: Community members participate in a dune planting event organized by RISE.

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Dune Restoration Fundamentals

This section offers an introduction to the fundamentals of dune restoration here in the Rockaways. It also includes an introductory overview of dune ecology.

It's a great section to refer back to while working out in the dunes! Here, you'll learn answers to critical questions and explore these dune topics:

- Dune Morphology
- Restoration Approach
- Dune Vegetation
- How Dune Systems Protect Us
- Dune Fauna

Dune Morphology

THE DUNE

The big idea: Though the dunes are always changing, there is typically a naturally established arrangement, or morphology, of the dune system, that occurs in this sequence: Lower Beach (closest to the ocean); High Beach; Primary Dune; and Secondary Dune (furthest from the ocean). In general, the Lower Beach experiences the most fluctuation, being regularly washed by waves while the Secondary Dune, located furthest inland, is the most stable section of the dune system, allowing it to host a wide diversity of vegetation.

Thousands of years ago, glacial debris was deposited along the Long Island shoreline of New York, and over time, wave action, erosion, and sediment transport created the Rockaway peninsula. Only with the protective Rockaway peninsula in place could Jamaica Bay and its sensitive salt marsh habitats form behind it, protected from the open Atlantic Ocean. While this arrangement of coastal features has been in the same place for what seems like forever, the coastal environment is always changing due to wind, waves, storm events, and human intervention. The structural backbone of the Rockaway peninsula is a dynamic, ever-changing dune system with constantly shifting sands.

Here are a few key points of dune morphology that are helpful to know.

Lower Beach & Wrack Line

Within a typical beach and dune configuration, the dunes run parallel to the

beach with the dunes being upland of the beach. Along the portion of the beach closest to the water, known as the **lower beach**, the constant movement of sand through wind, waves and tides create a dynamic environment. This area of the beach just above the high tide line is an especially harsh environment. The change in salinity and temperature, constantly shifting sand, and lack of water result in an area along the beach with little to no animal or plant life.

However, there is a **wrack line**, or sliver of beach where material is deposited during high tide, including shells, sea-grass, decomposing seaweed, human garbage and plastic, animal remains, and other materials. This composition of decaying material at the wrack line is high in organic content and allows for water storage, creating unique habitat for several species such as horseshoe crabs, mussels, beetles, white worms, and carrion flies.

High Beach & Embryonic Dunes

Along the beach further away from the water and upland of the lower beach and the wrack line, is an area known as **high beach** consisting of **embryonic dunes**, or dunes that are still in the earliest stage of development. Embryonic dunes are not very tall, have sparse vegetation, and frequently change in shape due to wind and wave action. These unstable, young dunes mature and stabilize as plants colonize the dune, trapping windblown sand, putting down roots.



High beach/embryonic dunes between Beach 17th St and Beach 26th St. Dominant vegetation includes dune grass (Ammophila breviligulata). Federally endangered sea beach amaranth (Amaranthus pumilus) present in this area.

Primary Dunes

Behind the embryonic dunes, there are primary dunes that stand taller with a more defined shape of a continuous ridge of sand and relatively steep slopes on the sea and land sides. Primary dunes are created as sand along the beach is blown by the wind and deposited within the dune. Sand grains are generally fine in these areas, creating conditions ideal for dune grass growth. Denser dune grass leads to increased sand catchment; as sand builds up, burying stems, it stimulates dune grass colonization resulting in dune expansion. For example, American beach-grass (Ammophila breviligulata) forms an intricate web of underground stems, or rhizomes, that send shoots both upward and roots down into the sand by as much as three feet below the surface.

Secondary Dunes

Further inland from the primary dunes, **secondary dunes** form which are more developed and more stable with well-defined crests and troughs. Secondary dunes

continue to evolve and accumulate sand, albeit with less intense sand movement than primary dunes. The more stable environment of secondary dunes contributes to the establishment of more diverse plant communities with a greater abundance of vegetation. The landward side of the secondary dune is especially stable as it is the area of the dune most protected from winds and ocean spray. In addition, the secondary dunes have a greater buildup of decomposing organic material given the diversity of plant life and bacteria living in these dunes. The broken down organic plant material increases the nutrients available in the sandy soil and facilitates the secondary dune's capacity to hold moisture. This allows for larger shrubs and trees to take root here, not only contributing to enhanced biodiversity, but to an enhanced structural support system within the natural protective barrier of the secondary dune.

Secondary dunes are unique within the dune ecosystem as they both stabilize the shore and host a great diversity of flora and fauna. In addition, the work of planting, maintaining, and monitoring the secondary dune lends itself as a community-wide effort, instrumental to the civic and youth development driven-mission of RISE.



Secondary dunes north of the Rockaway boardwalk between Beach 26th St and Beach 32nd St. Dominant vegetation includes dune grass (Ammophila breviligulata), seaside goldenrod (Solidago sempirvirens), and non-native camphorweed (Heterotheca subaxillaris).

Restoration Approach

HABITAT RESTORATION APPROACH

The big idea: To ensure that the dune restoration can stand the test of time, it's important to select the right plants for the job. The design team first evaluated the existing conditions of the secondary dune restoration area to inform the plant selection, including how wet or dry or how sunny or shady an area was. A diversity of hardy plants adapted to the existing conditions of the site were selected, serving as the building blocks for a strong and stable dune ecosystem.

Within the Rockaways, the secondary dunes provide the greatest opportunity to restore a vital stretch of biodiverse habitat. Unlike the primary dunes which are exposed to constant shifting and weathering with a limited number of species that are adapted to such harsh conditions, the more stable environment of the secondary dunes facilitates a greater diversity of flora and fauna.

To inform the design, both desktop studies and field visits were performed by the team to assess the critical components of a successful native habitat restoration: hydrology, soil and light regime. For the hydrological assessment, the team evaluated the site drainage and topography, including identification of rainwater catchment areas and areas that have greater soil moisture and/or are prone to ponding and flooding. Soil texture was analyzed in the field, including an assessment of how sandy or gravelly the existing soil was.

The team made note of the existing plants growing on-site, which served as an indicator of the types of plants that could be introduced within the unique conditions of the Rockaway secondary dune environment. For example, if there were many weedy or invasive plants growing, this served as an indication of an area with more disturbance and where the soil was higher in nutrients (compared to the naturally low-nutrient sandy dune soil). The light regime was assessed to determine areas that could have partial shading from buildings or structures and to inform the level of sun and shade tolerance for proposed restoration plantings.

In addition to planting native habitat, the restoration design included the mechanical removal of invasive, exotic species that were established in disturbed areas. In disturbed areas with a higher density of weedy and invasive plants, native plants were proposed that thrive in a wide range of soil conditions. These native "tough guys" were located in planting zones most at risk of weed invasion. Examples of such species are switchgrass (*Panicum virgatum*) for wetter areas and seaside goldenrod (*Solidago sempervirens*) in drier areas. Less disturbed areas included a wider breadth of native species to improve diversity and support native fauna.

10 TENETS OF URBAN HABITAT RESTORATION

- 1. Community stewardship: Involvement of the community is necessary for long-term success of any project while also creating the opportunity for education on restoration and habitat creation.
- **2. Target selection:** Carefully select a realistic target ecosystem appropriate to the site (i.e. complementing nearby and regional ecosystems, similar disturbances).
- **3.** Soil selection: Select the appropriate soil to accommodate native species (e.g. low-nutrient, slightly acidic soil to favor the establishment of native plant species and limit invasive species).
- **4. Hydrologic understanding:** Assess local hydrology to limit potential sedimentation or erosion. Select plant species that tolerate the site's hydrologic conditions.
- **5.** Light conditions: Analyze both existing and future light conditions to ensure planting will be successful in their proposed locations.
- 6. Native, diverse, local plant selection: Select native plant species based on survivability and project specific goals (i.e. biodiversity, dune stabilization).
- 7. Construction practices and timing: Proper construction techniques are necessary to limit disturbances and allow for successful establishment of plantings.
- 8. Succession as a tool: Use ecosystem succession as both a design tool and a cost saving measure by designing a plan that allows for the change of plant species composition over time.
- **9.** Adaptive management and maintenance: Employ adaptable maintenance strategies to support establishment and guide the trajectory of the ecosystem, while considering possible adaptations to the management approach in response to unanticipated events.
- **10. Protection from predators:** To protect the ecosystem from common predators, strategies include constructing waterfowl barriers, planting densely to ensure full coverage, replacing species which become targets of predators, and sometimes trapping predators.



Pictured: Volunteers helping to collect trash and debris.

What are your hopes for the shoreline (or for habitats in your community) 10 years from now? 50 years from now? 100 years from now?

What do you think can be done today to make sure these hopes become reality?



Dune Vegetation

WHAT'S GROWING HERE?

The big idea: Plant roots in the dunes help to stabilize the sand. For example, according to the 2013 Biodiversity Assessment Handbook for NYC, "American beach grass (Ammophila breviligulata) is found farther back from the influence of daily tides. This species reproduces vegetatively, and its extensive root and rhizome system quickly stabilizes loose sand. A single large plant can create a dune nearly 2 feet (0.6 meters) tall containing 70 to 106 cubic feet (2 to 3 cubic meters) of sand."

Dune vegetation includes native plants with mature and deep root systems that play a fundamental role in anchoring sand and preventing it from being washed away. Dune habitats are also home to a diversity of plant and animal species, and restoring these habitats provides a refuge for native species, promoting biodiversity and helping ecosystems adapt to changing climate conditions.



More details on dune vegetation from the New York State Department of Environmental Conservation!

Grasses and Sedges

These plants have fibrous root systems that help bind the sand, preventing erosion.

American beachgrass (*Ammophila breviligulata*) is one of the most adaptable plant species that grows within the dune environment. American beachgrass stabilizes the dunes by holding sand in place with its extensive root and rhizome (underground stem) system.



American Beachgrass (Ammophila breviligulata)



Switchgrass (Panicum virgatum)

Herbaceous Plants

Herbaceous plants have relatively soft, flexible stems that typically die back at the end of the growing season. These plants typically grow, flower, and produce seeds within a single growing season. Herbaceous plants add a colorful diversity to the plant community, support pollinator species, and contribute to a biodiverse habitat. Some examples include:



Seaside Goldenrod (Solidago sempervirens)



Common Milkweed (Asclepias syriaca)



Butterflyweed (Asclepias tuberosa)



Spotted Joe-Pyeweed (Eutrochium maculatum)



Flat-top Goldenrod (Euthamia graminifolia)



Evening Primrose (Oenothera biennis)

Woody Plants

Woody plants have hard, sturdy stems or trunks that provide structural support to the plant. Woody plants include shrubs and trees that can grow tall and can live for decades.

Within the sandy dune shorelines of the northeast, coastal scrub-shrub habitat can be



Bayberry (Myrica pensylvanica)



Carolina Rose (Rosa carolina)



Beach Plum (Prunus maritima)

found, dominated by woody vegetation that typically grows less than 20 feet tall. Some examples include:



American Holly (Ilex opaca)



Pitch Pine (Pinus rigida)



Eastern Red Cedar (Juniperus virginiana)

Invasive Plants

Plants that are introduced and do not naturally occur within a local environment, and that can reproduce and spread aggressively are referred to as invasive plants. The plants are termed "invasive" because they can invade or take over an area by outcompeting native vegetation for resources such as water, sunlight, and nutrients. Invasive plants have a high reproductive capacity, allowing them to spread rapidly. Invasive species spread themselves by producing a large amount of seed and/or by generating new plants via clonal growth in the form of rhizomes (underground stems) or stolons (above -ground stems). The movement of invasive plants from their natural origin to new places in the world was and continues to occur due to their unintentional or intentional spread by people as a result of international trade, travel and agriculture. As invasive plants are

relatively new to an environment (e.g., they only started growing in an environment within the last century), they have limited natural predators, unlike the native plants that have evolved within the same ecosystem of flora and fauna. In addition, invasive plants can adapt to a variety of environmental conditions, making them able to thrive in a diversity of habitats.

Within the secondary dunes of the Rockaway peninsula, a coastal habitat restoration can only be successful if invasive plants are first removed then consistently monitored and kept in check, otherwise the invasives will take over the native plantings within a restoration area. Some examples include:



Mugwort (Artemisia vulgaris)



Common Reed (Phragmites australis)



Japanese Knotweed (Fallopia japonica)



More details on invasive plants from the Plant Invaders of Mid-Atlantic Natural Areas!

How Dune Systems Protect Us





Dune Fauna

WHAT'S LIVING HERE?

The big idea: A coastal dune system provides a unique and dynamic habitat for a diverse range of animals, or fauna, including various animals adapted to the challenging conditions of sandy environments near the coast. Fauna in coastal dune systems are often specialized to withstand salt spray, shifting sands, and fluctuating environmental conditions.

All faunal species, from ants and beetles to shorebirds and sea turtles, play unique and vital roles in dune ecosystems, contributing to their complexity, resilience, and functionality. Some examples of animals found within the Rockaway dunes include the following:



More details on dune fauna from iNaturalist!

Insects and Arachnids

- Butterflies & Moths: Key pollinators (along with bees), allowing for a diversity of flowering plants to establish in the dune.
- Sand Wasps: Insects that nest in sand, preying on other insects, helping maintain pest populations in the dune.
- Ants: Certain species are well-adapted to sandy habitats and play a role in soil turnover.



Monarch butterfly (Danaus plexippus)



Juniper hairstreak (Callophrys gryneus)

Birds

- Shorebirds: Species like piping plovers, • sandpipers, and terns are well-adapted to coastal environments and may nest or forage in the dunes.
- Songbirds: Birds that utilize the dunes for nesting and foraging, such as the song sparrow (Melospiza melodia) and the yellow-rumped warbler (Setophaga coronata [formerly Dendroica coronata]).
- Birds of Prey: Raptors like kestrels and owls • may use dune habitats for hunting as well as the osprey and the northern harrier.



Piping plover (Charadrius melodus)



American oystercatcher (Haematopus palliatus)

American kestrel (Falco sparverius)



Yellow-rumped warbler (Setophaga coronata)



Black skimmer (Rynchops niger)



- Sand Crabs: These crabs are adapted to burrowing in sandy substrates and are commonly found in coastal dunes.
- Ghost Crabs: Nocturnal crabs welladapted to sandy beaches and dunes.



Atlantic ghost crab (Ocypode quadrata)

Mammals

- Small Rodents: Some species of mice and voles may inhabit the dunes such as the meadow vole.
- Rabbits: Coastal dunes can provide suitable habitat for certain rabbit species such as the eastern cottontail (*Sylvilagus floridanus*).
- Foxes: Foxes may be present in dune systems, utilizing the habitat for shelter.



Meadow vole (Microtus pennsylvanicus)

Reptiles and Amphibians

- Sea Turtles: Coastal dunes may serve as nesting sites for sea turtles, and protection efforts are often in place to preserve these critical habitats. For example, Kemp's Ridley sea turtle (*Lepidochelys kempii*) is the smallest and most endangered species of sea turtle. In the summer of 2018, there was an unprecedented event in which baby Kemp's Ridley sea turtles were observed crawling from their nest to the ocean along the Rockaway dunes.
- Fowler's toad (*Anaxyrus fowleri*) can burrow into the sand to escape extreme temperatures and predators and typically breed in shallow, temporary pools of water, which are often found in or near their dune habitats.



Sea turtles (Chelonioidea)



Fowler's toad (Anaxyrus fowleri)

NOTES:



Dune Restoration Field Guidance

This section of the Dunebook is a breakdown of the steps for restoring and maintaining the secondary dune system. This includes details such as what you'll need for planting days, watering, data collection, and maintenance.

Study the text, illustrations, and maps as well as linked sources also made available as QR codes; refer back to the recommended steps and prepare for restoration work out in the dunes. Reach out to RISE staff when you need additional guidance or support! This section includes checklists for the following tasks:

- Preparing for Planting Day
- Planting Day!
- Adaptive Maintenance
- Invasive Plant Management

Preparing for Planting Day



BEFORE GETTING STARTED

Pictured: Shore Corps student at Sandy Anniversary Planting Day.

Terms to Know

On-center (O.C.): spacing from center of plant to center of adjacent plant.

Existing vegetation: vegetation present on site prior to start of the planting.

New plantings: plant material installed as part of RISE's ongoing restoration efforts.

Patch: a subset of the overall planting area.

Clumps: a cluster of one type of plant species. Each clump typically has either 5, 10, 15, or 20 plants of the same species. The goal is to create a diverse plant community within each patch, therefore there should be a diversity of plant clumps.

Rootball: the mass formed by the roots at the bottom of a plant and the soil surrounding them.

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DEFORE GET TING 5

Sourcing Plants

Native plants can be sourced and ordered from the following nurseries:

- 1. Greenbelt Native Plant Center, Staten Pinelands Nursery, Columbus, NJ
- Other native plant nursery with native plant material that is propagated within ~150 miles of the planting site.

Pre-Planting Site Preparation

- □ **Clear the area to be planted** ahead of planting day of existing non-native and existing invasive vegetation.
- □ Confirm the areas of existing native plants that are to be preserved before any existing vegetation is removed.
- Refer to the Dunebook section 'Invasive Plant Management' for more information on proper invasive species control.

Planting Day Planning

- Makes plans to plant during the spring and fall, ideally the months of April and May and September and October. Do not plant when the ground is frozen.
- □ **Check the weather forecast** for planting day and adjust the work schedule and watering schedule, if needed.



Refer to rainfall forecasts for the weather station at JFK Airport from NOAA.

- □ Assign roles and responsibilities to available personnel based on their skill level, familiarity with planting activities, and prior experience. Here is one example of the breakdown of roles:
 - 1 person flagging planting clumps
 - Several people digging and planting
 - 1 person watering at the end of day.

Plan to divide volunteers into groups as needed. Planting groups typically have at least 3-4 people per group.

□ (Optional) Assign a particular species to plant for each group, depending on the number of people available to plant in a given day. Species assignments are based on the number of groups available and number of different species to be planted and their respective quantities. If the quantity of plants is disproportionately high for a particular species, multiple groups should be tasked with planting that species.

ITEMS TO PREPARE FOR PLANTING DAY

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planting plan with plant list
measuring tape
sharpies
landscape flag stakes
hat & sun protection
drinking water
closed-toed shoes
gardening gloves
hand shovel
gardening knife
water buckets (1 gal. & 5 gal.) or gardening hose connected to water supply



Pictured: Shore Corps student during Sandy Anniversary Planting Day.

Planting Day!

PLANTING TASKS

□ 1. Identify Planting Areas

Identify areas in the planting patch where different **clumps** (a cluster of one type of plant species) will be installed. The goal is to have a diversity of species clumps throughout the patch. Typical spacing requirements for the different types of plant material include:

- 2-inch plug: 15 inches to 18 inches on-center
- Shrubs #1 and #2 containers (1 and 2 gal. pots): 30 inches on-center
- Trees larger tree material to have a custom arrangement: refer to the planting plan and confirm locations with the Dune Squad lead

□ 2. Identify Plants for Clumps

Using the planting plan RISE will provide to you, identify the quantity of plant material needed within each species clump. Write the species name and the number of plants to be installed within the clump on the flag of a landscape flag stake.

TO NOTE: Coordinate with other gardeners before designating an area for a particular species clump to confirm that there is a diversity of other species throughout the planting patch.

□ 3. Mark Plant Locations

Mark each planting hole with a spray-painted "X" within each clump based on:

- Spacing requirement of each plant
- Location of existing vegetation
- Location of any newly planted vegetation

4. Dig Planting Holes

Dig the planting holes using this guide:

- 2-inch plug: hole shall be 2-inches wide and 6-inch deep
- #1 container (1 gal. pot): hole shall be 8-inches wide and 8-inches deep
- #2 container (2 gal. pot): hole shall be 10-inches wide and 10-inches deep
- For larger plant containers, check-in with the Dune Squad lead for specific planting guidance

TO NOTE: Verify hole dimensions by inserting the container into the hole – if it fits, the plant fits.

5. Move Plants to Planting Area

Move plant material from the storage area to the planting area: Handle plant material by supporting the rootball or container. DO NOT lift the plant by its stem only.

□ 8. Install the Plant!

Install plant material:

- 2-inch plug: (a) Install plugs such that the stem base is at or slightly above (mounded) finish grade. Plant plugs fully into sand (b) Install plugs to their full depth. A "j-root" .installation is not acceptable. (c) Tamp each plug in place with your hand so that it is firmly seated in the soil with no air pockets.
- #1 & #2 containers: (a) Before planting, verify hole dimensions to ensure that the hole is not too deep for the plant material. If the hole is too deep, scoop back in some of the sand previously removed to provide a base for the plant material. (b) Install plants such that the stem base is at or slightly above finish grade. Plant fully into the sand. (c) Fill around rootball with more sand and tamp in place with hand so that it is firmly seated in the soil with no air pockets. (d) Evenly spread-out excess sand or soil around new plantings.

□ 6. Remove Plants from **Containers**

Remove plants from containers prior to installation (for containerized plants only):

- 1. Place one hand around the base of the plant, on top of the potted soil. With the other hand, tip over the pot so that the plant and soil slide out together.
- 2. Loosen the soil from the edges if needed by tapping the pot on the side. DO NOT pull the plant out of the pot to avoid damaging the roots.

□ 7. Tease Plant Roots

Tease roots of plant material before installation:

- 2-inch plug: Tease roots of plugs by massaging to loosen up roots prior to installation.
- #1 & #2 containers: Scarify the • rootballs of container plants. Using a sharp knife, make vertical cuts the full height of the rootball at a depth of 2 inches and every 3 inches O.C. Tease roots of rootball by massaging to loosen up roots prior to installation.

Pictured (left): before installing during a planting

Volunteer teasing plant roots

day.

Pictured (right):

Hula Hoops used to guide planting spacing during a planting day.

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Planting Day!

WATERING TASKS

Watering or irrigation of plants must occur the same day of the planting.

□ 1. Flood Plants After Planting

Flood all plants after planting. Take care to avoid saturating adjacent soils where planting operations are ongoing. Watering can be done at the end of the same day after planting has been completed to avoid any disruptions.

□ 2. Monitor Water Pressure

Monitor water pressure to prevent displacement of sand.

□ 3. Plan for Weekly Watering

New plantings shall be watered on a weekly basis for at least one (1) growing season or until deemed necessary by the Dune Squad lead. If the amount of rainfall for three (3) consecutive calendar days is below 0.15 inches, watering shall be performed until an amount of water equivalent to 0.15 inches has been applied to the site, assuming that the rainfall forecast for the next three (3) consecutive calendar days does not exceed 0.15 inches.

\Box 4. Water As Needed

All plants not planted within the same day shall be watered as necessary to maintain optimal health until planting.



Weather data for JFK airport from NOAA here, including precipitation!



Pictured: Volunteer watering during a planting day.

COMMUNITY MEMBER ENGAGEMENT

We encourage community members to ask us questions and learn about our work! When you're out in the field you'll likely get curious local residents or visitors from all over the world asking you what you're working on. Here are some ideas for what to share with them:

I. Develop Your Elevator Pitch!

Here's a potential idea for what to say, but take this and make it your own and personalize it to your own reasons for doing this work. Making it personal will make it more likely to inspire folks to get involved! "Hi! Thanks so much for your curiosity. My name is, and I work as a member of the Dune Squad at RISE. We're a group of local residents working to restore this secondary dune habitat to protect our community from flooding and storm surge. What brings you to the Rockaways?"

□ 2. Share the Brochure (if available)

At some of the planting sites, RISE has put both signage and small plastic containers that hold brochures that explain the project! If there are brochures available, share one with the person you are speaking with if they are curious to learn more.

3. Encourage Community Members to Scan the QR Code on Signage Shown Below

This link will take them to the website where they can find links to various work RISE is doing and to get connected to our work.



Check out the "Greater Rockaway" Coastal Resilience Plan website!



Pictured: Signage and brochure along the planting area.

Adaptive Maintenance

The big idea: For dune restoration to be resilient long-term, especially in the face of a changing climate, the first few years of maintenance are pivotal to the success of the restoration. This section outlines these critical maintenance tasks including monitoring the progress of new plants, adaptive maintenance practices like weeding and watering, and removal of trash and invasive species.

EQUIPMENT REQUIRED FOR MAINTENANCE

planting plan & plant list
hat & sun protection
drinking water
close-toed shoes
gardening gloves
weeding fork
gardening spade
trash grabber
garbage bags

WEEDING

□ 1. Know Your Plants & Weeds

Get familiar with what has been intentionally planted and what should be weeded using the planting plan, the plant schedule, and Dune Squad lead.

\Box 2. Move & Observe with Care

Walk slowly throughout the planted restoration areas and avoid stepping and damaging existing plants.

\Box 3. Remove Weeds

Remove weeds by pulling from the base of the weeds to remove weed roots. Pro-tip: a weeding fork can help make the task easier.

4. Dispose of weeds in the garbage

TO NOTE: Japanese knotweed, common reed, and mugwort are highly invasive and require intensive maintenance - refer to the Invasive Plant Management Task. Common weeds that have been observed:

- Weed Plantain
- Cheatgrass
- Hare's-Foot-Clover
- Sheep's Sorrel

DATA COLLECTION

Monitor all maintenance activities in the RISE log



Access the RISE log!

TRASH REMOVAL

□ 1. Move & Observe with Care

Walk slowly throughout the planted restoration areas and avoid stepping and damaging existing plants.

□ 2. Safely Remove Trash

Remove trash with gloved hands or a trash grabber and place into a garbage bag.

WATERING

$\hfill\square$ 1. Move & Observe with Care

Walk slowly throughout the planted restoration areas and avoid stepping and damaging existing plants.

\Box 2. Water with Consistency

Plan to water new plantings on a weekly basis for at least one growing season or until deemed necessary by the Dune Squad.



Weather data for JFK airport from NOAA here, including precipitation!

TO NOTE: If the amount of rainfall for three consecutive calendar days is below 0.15 inches, water until an amount of water equivalent to 0.15 inches has been applied to the site.



Pictured: Rockaway residents participate in beach clean up with RISE.

What are you noticing as you continue to care for the plantings? What is changing? What needs more support?

Be sure to log these important observations.



Checklist: Invasive Plant Management

4 INVASIVE SPECIES THAT REQUIRE CONTINUOUS MAINTENANCE:



Autumn olive (Elaeagnus umbellata)

- During the growing season (May-October), areas with autumn olive shall be monitored monthly.
- Saplings shall be hand pulled. Hold the plant at its base and pull out the roots from the soil. Pulled plant materials must be removed from the site and disposed of properly.
- □ Larger shrubs must be cut down as low as possible. If feasible, an organic weed killer can be applied to the stumps monthly during the growing season. A recipe for organic weed killer includes: 1-gallon of white vinegar; 1 cup of table salt; and 1 tablespoon of liquid dishwashing soap. Blend all ingredients together then funnel into a plastic spray bottle.
- Plant the areas where autumn olive previously grew with aggressive native herbaceous species as specified in the planting plan.



Common reed (Phragmites australis)

- During the growing season (May-October), volunteers shall monitor and cut common reed monthly. Common reed should be cut at the base of the plant. Cut plant materials must be removed from the site and disposed of properly.
- Early in the growing season, in areas of recently cut common reed, install a dense planting of native tree and shrub species and/or aggressive native herbaceous species (such as switchgrass).
- Remaining common reed plants shall be cut back annually after dormancy (on or around mid-November). Cut plant materials must be removed from the site and disposed of properly.
- □ All areas with common reed shall be monitored for at least 2 growing seasons.



Japanese knotweed (Fallopia japonica)

- Before the growing season (May-October), volunteers shall clear all surface growth of Japanese knotweed and remove all plant materials.
- □ All areas with Japanese knotweed growth shall be covered by 0.5" X 0.5" wire mesh hardware cloth. The hardware cloth shall be adhered to the ground with metal stakes and shall be no more than 4 inches above the soil surface.
- During the growing season, volunteers shall monitor areas receiving treatment for Japanese knotweed monthly. Any new growths above the hardware cloths shall be cut down to the surface of the hardware cloth.
- Cut pieces and any remnants of the Japanese knotweed are to be bagged and disposed of properly.
- All areas with Japanese knotweed shall be monitored for at least 2 growing seasons.
- Once it has been deemed that the Japanese knotweed will not return to an area, plant competitive native shrub and tree species in these areas such as bayberry, beach plum, or winged sumac.



Mugwort (Artemisia vulgaris)

- During the growing season (May-October), areas with mugwort should be monitored monthly.
- Mugwort shall be hand pulled. Hold the plant at its base and pull out the roots from the soil. Pulled plant materials must be removed from the site and disposed of properly.
- Plant the areas where mugwort previously grew with competitive native herbaceous species such as common milkweed, seaside goldenrod, and switchgrass.

Planting Habitats Example from ZONE 1: 3-B

100ft

25

50



Sources

- Biodiversity Assessment Hand Book for New York City. Copyright © 2013 by Elizabeth A. Johnson and Erik Kiviat.
- Greater Rockaway Community and Shoreline Enhancement Plan, August 2021.
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- **USACE Final Report, Integrated Hurricane Sandy General Revaluation Report** and Environmental Impact Statement, Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, May 2019.

A Big Thank You To All Involved!

LEAD PARTNERS:

New York City Department of Parks and Recreation United States Army Corps of Engineers New York City Housing Preservation & Development E-Design Dynamics WXY Studio

COMMUNITY PARTNERS:

Arverne By the Sea Development Bluestone Organization **Edgemere CLT** FRANC (Far Rockaway Arverne Nonprofit Coalition) Garden by the Bay Garden Club of Lawrence Goldfarb Development/Wavecrest Apartments L+M Development Partners Living Cities Project National Parks Conservation Association **NYC Plover Project** NYRP Seagirt Garden **Ocean Bay CDC Rockaway Beach Civic Association** Science and Resilience Institute Jamaica Bay St. John's School for Boys Surfrider Foundation **Skudin Surf** Waterfront Alliance Living Cities Project

EDUCATIONAL PARTNERS:

P.S. 183, P.S. 104, P.S. 105, P.S. 106, P.S. 43 Channel View Scholars Academy Rutgers University Pratt Institute Stony Brook University

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