RED ROOT CREEK
RESTORATION PLAN

SUSTAINABLE RARITAN RIVER INITIATIVE

Edward J. Bloustein School of Planning and Public Policy

RUTGERS UNIVERSITY

MAY 2014

ACKNOWLEDGMENTS

The following individuals contributed time and effort towards the completion of this restoration plan:

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New Jersey Department of Environmental Protection	Jill Aspinwall, NJDEP Staff to the *Wetlands Mitigation Council*
U.S. Fish and Wildlife Service (FWS)	Elizabeth Freiday, *Certified Wildlife Biologist*
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ACKNOWLEDGMENTS

The following individuals contributed time and effort towards the completion of this restoration plan:

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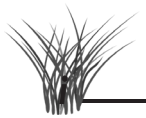


SUSTAINABLE RARITAN RIVER INITIATIVE

The Red Root Creek Wetlands Restoration Studio is a graduate planning studio of the Edward J. Bloustein School of Planning and Public Policy. The Bloustein studios provide students with a personalized and inter-disciplinary opportunity to conduct hands-on research around real-life problems, to work with real-life clients, and to devise team-based solutions.

A series of planning studios known as the Raritan River studios apply this planning process to the river at Rutgers' campus edge. The Raritan River has long been a part of Rutgers' culture and played a pivotal role in the founding of the New Brunswick campus back when it was a colonial college founded amid New Brunswick's river-based commerce. The Raritan is even the muse of Rutgers alma mater, "On the Banks of the Old Raritan". It's only natural that when the Bloustein School developed planning studios to address area concerns that we would look to this rich riparian resource.

The concept for this particular studio – The Red Root Creek Wetlands Restoration Studio – came out of a friendship between Dr. Judy Shaw, the Director of the Sustainable Raritan River Initiative, and this studio's client Peter Visceglia, Executive Director of the Federal Business Centers at the Raritan Center. Last spring, Dr. Shaw and Mr. Visceglia discussed the benefits of having students work on the Red Root Creek Wetlands as a way to both provide a new perspective for Mr. Visceglia and to give the students an opportunity to work on a real project that might have the kind of difficulties they would find in the practical world of planning for habitat restoration.

There are two partners for this studio -- The Sustainable Raritan River Initiative and Duke Farms Foundation. The Sustainable Raritan River Initiative operates out of the Environmental Analysis and Communications Group at Bloustein and supports a collaborative of over 130 member organizations that stand behind an action agenda to restore and protect the Raritan River, its estuary and its tributaries for the benefit of residents, businesses, its economy and the environment. Participating in the Raritan River studios are just one of the programs the Initiative leads to help the collaborative achieve its goals for a more sustainable Raritan River. Many of the guest lecturers for this studio are members of the Sustainable Raritan River Collaborative and the studios are also a way to train the Raritan stewards of tomorrow.

The other partner in this studio is Duke Farms Foundation. Along the banks of the Raritan in Hillsborough, Duke Farms serves as a model of environmental stewardship and inspires visitors to become informed stewards of the land. It is a place of education, enjoyment and research that enhances the environmental health of the region. This studio is the first in a new partnership between the Bloustein School and Duke Farms that promotes research in the areas of environmental planning, habitat preservation, green design and stewardship.

EXECUTIVE SUMMARY

Wetlands are important cogs in the ecological system that benefit the natural environment that we all live in. They are an organic "sink" for nutrients and filter sediments and organic matter out of groundwater. These areas play a vital role in global carbon, nitrogen and sulfur cycles by transforming and releasing these elements into the atmosphere. Among the most productive ecosystems in the world, wetlands are breeding grounds for the lowest rungs of the food chain – microbes – as well as those higher on the chain – invertebrates, mosquitoes, frogs, reptiles, birds and mammals. Besides providing environmental benefits, wetlands provide tremendous economic value as natural capital, for example by acting as water filtration and control.

The Red Root Creek study area at the heart of this concept plan is located adjacent to one of the largest industrial parks in the United States and fronts a significant body of water. The study area presents a tremendous opportunity to restore a large wetland tract severely degraded due to industrial and military use.

In this plan, the site's strengths, weakness, challenges and opportunities were identified in order to properly formulate a comprehensive plan for its future. Its greatest strengths include its location – for its high value of ecological services, outstanding accessibility coupled with containment from harmful uses and adjacency to a major tidal river – and its geology, with hydric soils and deep bedrock. The weaknesses of the site were the severely degraded wetland habitat, including a decades-old phragmites colony and high levels of contamination. The site is challenged by storm surge events and potential climate change induced sea level rise. Other challenges for wetland restoration of the site are ongoing remediation, serving multiple functions and the impact on a multitude of stakeholders. Despite this, the site presents extraordinary opportunities to capture the benefits of restoration, such as resiliency and protection from storm surge, stormwater management, creation of multiple habitats and public access, research and outreach.

The Red Root Creek Restoration Plan provides a framework to restore a very important tract of wetlands for ecological, economic and aesthetic benefit. The goals of restoration were defined as follows:

1. Enhancing wetland ecosystem services provided to the Raritan Center, including storm surge protection, flood control and stormwater treatment

2. Enhancing the biological diversity and quality of the wetland system on a species and habitat level

3. Restoring the system to a state more resilient to sea level rise in the long term and storm surge events in the nearer term

4. Enabling long-term wetland research and monitoring opportunities on the site

5. Providing managed public access to the restored wetland for targeted audiences to promote awareness and enhance community and tenant relations

6. Capturing natural, societal, educational and economic value from the restored wetland

7. Creating a demonstration project that can be replicated elsewhere

The Red Root Creek Restoration Plan (restoration plan) provides a vision of what could be, outlines measures to achieve it, quantifies the potential benefits and offers a strategy for implementation and funding.

OVERVIEW

The Red Root Creek study area (study area) is situated in Middlesex County, New Jersey, split between Edison and Woodbridge Townships along the banks of the Raritan River in what is now known as Raritan Center. Historically, the site consisted of tidal marsh, clay and sand pit quarries and farmland. A map of Middlesex County during the American Revolution in Figure 2 shows Red Root Creek, which branches north off of the Raritan River. The area was nicknamed "Salt Meadows" through 1850, as shown in Figure 3.

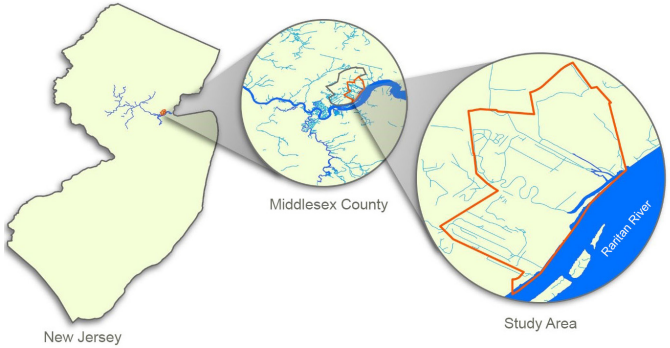


Figure 1: *Study Area Location*
Source: *NJGIN, NJ OIS*

In 1917, the U.S. Army Corps of Engineers (USACE) constructed the Raritan Arsenal on the site, encompassing approximately 3,227 acres surrounding the creek. Until 1963, the Arsenal was in operation as an ordinance, arms and machinery hub – receiving, storing, shipping and decommissioning materials in support of foreign wars. Magazine areas were built atop the tidal wetlands on over 800 acres of uplands created with dredge spoil from the Raritan River and Raritan Bay. The dredging operations were conducted to allow barges into the lower Raritan River. The Army built over 2,000 feet of linear wharf to support maritime shipment and delivery and also diked the Red Root Creek and other ditches, stopping tidal flow and transforming the "salt meadows" to freshwater wetlands.

With the closing of the Raritan Arsenal in 1963, approximately 2,300 acres of the site were sold to private firms for redevelopment. A majority of that land was purchased by Summit Associates, Inc. (SAI) and Federal Business Centers (FBC), which then converted most of the site to an industrial park – the current Raritan Center. Smaller portions of the land were sold to the General Services Administration (GSA), now home to the Environmental Protection Agency (EPA) and Middlesex County, which then used its land to create Thomas A. Edison County Park and Middlesex County College. The southern half of the site has remained primarily freshwater wetlands, with limited development since 1963 (Schmid & Company, 1987).

The study area for this concept plan contains much of the former tidal wetlands around the Red Root Creek and is wholly owned by FBC. This study area delineation is shown in Figure 4 below in aerials from 1930 and 2012. The total area within its boundary is 667 acres. At the center of the study area is the Red Root Creek, flanked to the east by distribution centers for Wakefern Food Corporation and FedEx Corporation and to the west by additional wetlands scattered with the remains of munitions buildings from the Arsenal as well as the working wharf. As part of the modification of other areas of Raritan Center, a freshwater wetland mitigation area was created in the north-central portion of the study area. This freshwater wetlands area is approximately 16 acres in size and continues to be monitored to fulfill the requirements of the mitigation.

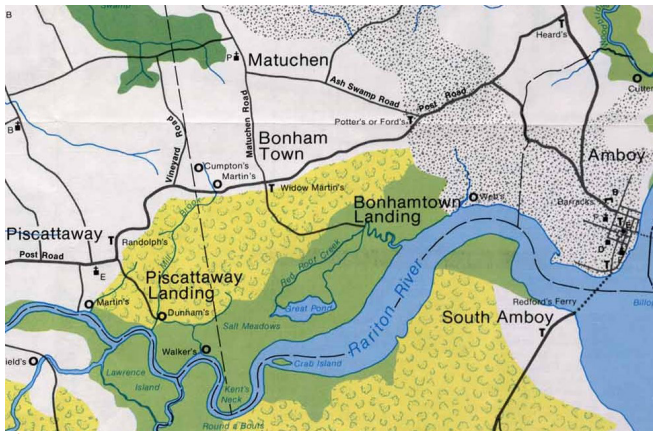


Figure 2*: Middlesex County Base Map during American Revolution*
Source: *mapmaker.rutgers.edu*

Figure 3*: Middlesex County 1850 Wall Map*
Source: *mapmaker.rutgers.edu*

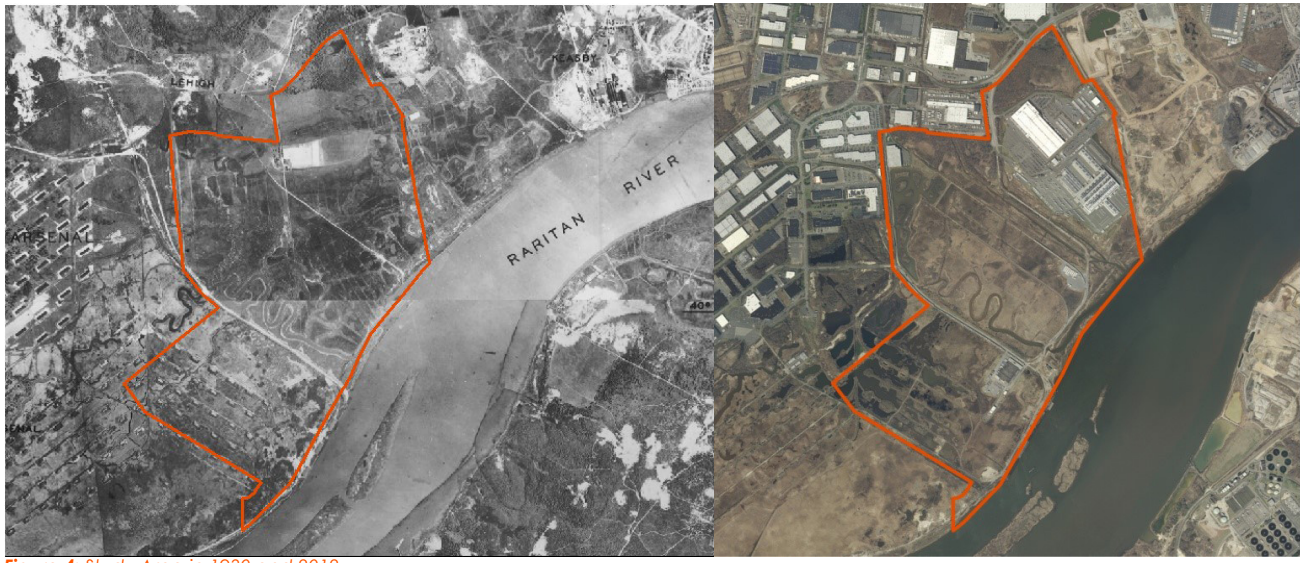


***Figure 4**: Study Area in 1930 and 2012*
***Source:** NJGIN WMS*

Immediately to the northeast of the study area along the Raritan River lies the site of a former chemical manufacturing plant operated by EPEC Polymers, Inc. Referred to as the EPEC site, remediation of the former chemical plant is complete and is undergoing redevelopment as the location of a power plant using piped natural gas, a nature preserve and a restored wetland. Planned redevelopment of this neighboring site includes a significant public access component, with public parking areas, a kayak launch and waterways, and walkways through the preserve and wetlands. Further to the east, lies another redeveloped former industrial site now occupied by Bayshore Recycling, a group of six recycling operations that accept construction debris and distribute the resulting products. As a group, the Bayshore companies are permitted by the NJDEP to accept over 10,000 tons per day of material. The Bayshore facility includes a private wharf on the Raritan River hosting a significant amount of daily barge traffic for receipt of debris and shipment of product.

To the northwest of the study area lie those parts of the former Raritan Arsenal now occupied by Middlesex County Community College, Thomas A. Edison Park, and EPA's Edison Environmental Center. Directly across the Raritan River from the study area is the former NL Industries industrial site which, with several neighboring parcels, is planned as the future site of a residential, office and commercial mixed-use community, including a large recreational marina. To the southwest of the study area along the Raritan River lies a vacant, partially wetland part of the former Raritan Arsenal, purchased by Summit Associates, and, further to the west, the river-edge Kent's Neck area of Edison where former landfills are slated for closure and a planned public access greenway along the River would approach Red Root Creek. Within the study area, along the River at the study area's western boundary, exists a sewer pumping station operated by the Middlesex County Utility Authority and, neighboring it to the west, the wharf area currently occupied by the operations of STC Industries, Inc.

***Figure 5**: Study Area Aerial including Neighboring Uses*
***Source:** NJGIN, NJ OIS*


EXISTING
CONDITIONS

The studio team investigated the conditions in the study area to determine the major site challenges and feasibility of various design alternatives. The analysis of the study area conditions addressed several issues including geology and soil, flora and fauna, existing land uses, topography, local zoning and transportation access. The concept plan rests on the findings of this analysis and an understanding of the major challenges and opportunities.

GEOLOGY AND SOIL

There are three soils, according to Natural Resources Conservation Service (NCRS), present on site: Pawcatuck-Transquaking complex, Atsion Sand, and Urban Land. Of the three, the Urban Land soils make up a small percentage of the overall site, limited to one area near the Wakefern facility and the northern edge of the site. For this reason, it was not considered to be relevant to this analysis.

Pawcatuck-Transquaking complex soils (0 to 2 percent slope, very frequently flooded) make up approximately 83% of the study area. These soils are very poorly drained and have depth to water table of 0. The frequency of flooding is characterized as very frequent, while the frequency of ponding is characterized as frequent. The United States Department of Agriculture (USDA) classifies this soil as hydric. Up to 14 inches of peat is typically found, representing significant organic material.

Atsion Sand soils (0 to 2 percent slope) are found in the dredge spoil deposit area in the northern area of the site. These soils are poorly drained and have a seasonal depth to water table of 0 – 12 inches. Both the frequency of flooding and the frequency of ponding are characterized as "none". The USDA classifies this soil as hydric. This is a sandy soil to a depth of 80 inches, below a 2 inch layer of organic material.

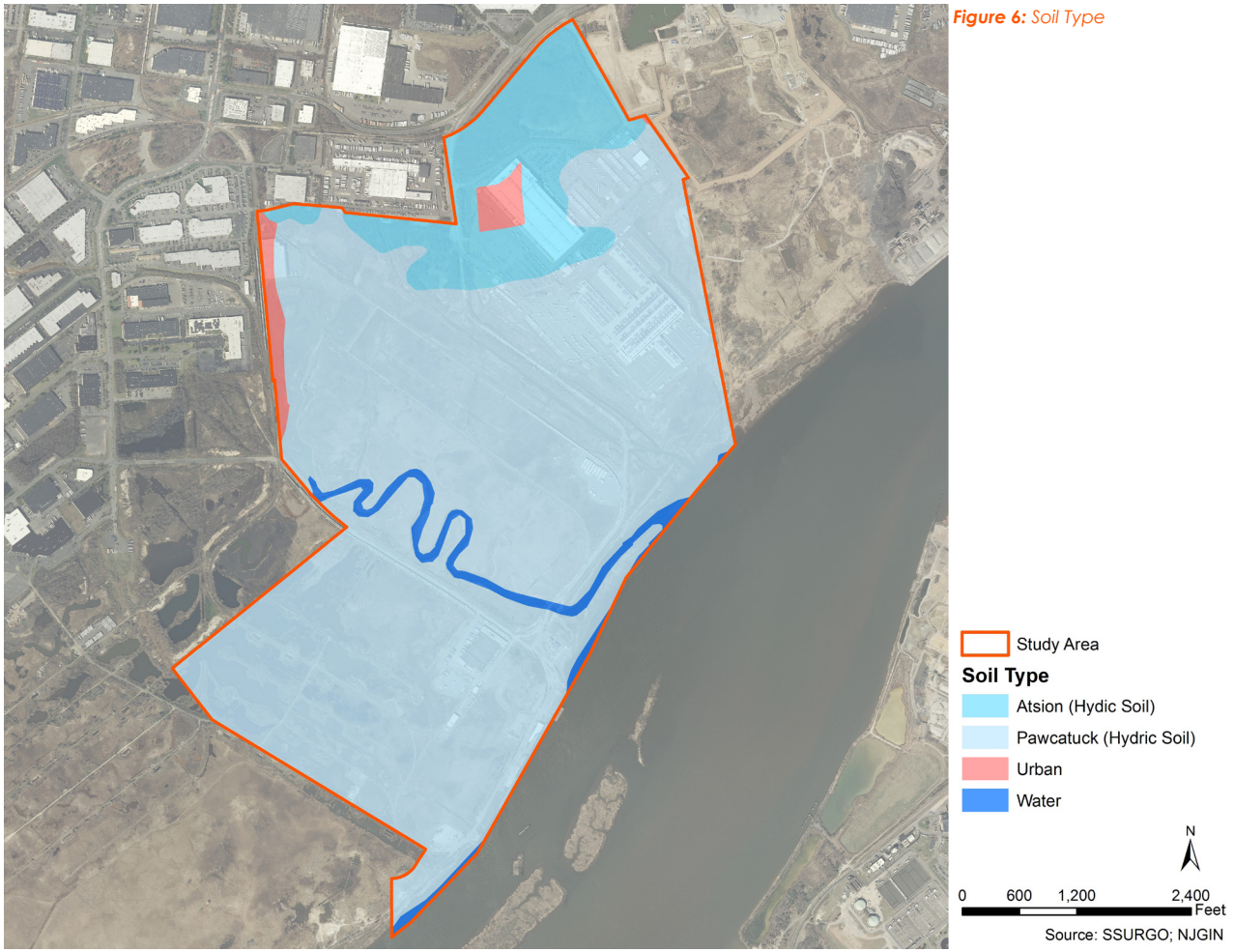


Figure 6: *Soil Type*

Hydric Soils

In any wetland study, soils classified as hydric are important. Hydric soils are one of three essential characteristics for identifying and delineating wetlands under both federal jurisdiction and the Freshwater Wetland Protection Act. Hydric Soils are defined by the USDA as "soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part." Both Pawcatuck-Transquaking complex and Atsion Sand are classified as hydric and together make up 96% of the study area.

Geology

According to the Schmid & Company Environmental Inventory, the study area is found on the coastal plain, near its junction with the piedmont formation. The study area is generally flat, with the only upland areas located adjacent to existing development. The bedrock is found at a depth of approximately 47 feet near Red Root Creek, limiting the development potential of the site. Additionally, recent alluvial deposits and the diabase sill found in the region limit the downward flow of water and potential groundwater recharge.

Soil Type	Total Area (acres)	% of Study Area
Atsion (hydric soil)	84.9	13%
Pawxatuck (hydric soil)	550.3	83%
Urban	13.1	2%
Water	18.2	3%
Total hydric soil	635.2	96%

Table 1: *Soil Type and Location*
Source: *Natural Resources Conservation Service (NCRS)*

Figure 7: *Phragmites and Great Egret*
Source: *Site Visit Photo - Mike Manzella and www.allaboutbirds.org*

FLORA AND FAUNA

Wetlands are critical habitats because of the shelter they provide to many species, including some that have declining populations. The Raritan Center area incorporates several critical habitats, including its shore, forested areas, old fields, freshwater wetlands, and tidal wetlands. The study area exemplifies the Piedmont plains that compose the Inner Coastal region that spans the state. Piedmont plains are composed of extensive grasslands, fragmented woodlands, and productive tidal marshes that are home to grassland birds such as the upland sandpiper. Nearby, the Atlantic Coastal community that begins in Monmouth County is home to nesting birds, including the blue heron and the great egret. The study area supports the large concentration of migrating birds and wintering waterfowl that reside along the Raritan River. Of concern is the phragmites community which forms a homogeneous habitat, along with other invasive species that result not only in a less diverse habitat but also one that is disruptive for nesting as well. The recent fire and clearing of phragmites offers an opportunity to diversify the grasses between mean and high water (NJ Division of Fish and Wildlife, 2012) (USACE, 2009).

LAND USE: LAND COVER

There are ten land use types in the study area according to the 2007 Land Use data from NJDEP. The biggest land use type is Water, accounting for 44% of the total site. Due to the technology that determines land classification, the moisture content may mischaracterize how much permanent standing water is actually covering land. Thus, some portion of wetland areas can often be classified as water, as is likely the case here. Industrial land makes up 13% of the study area, is concentrated the FedEx site. The land use statistics also indicate that 13% of the study area is dominated by phragmites.

Land Use Type	Total Area (acres)	% of Study Area
Industrial	88.7	13%
Stormwater Basin	6.5	1%
Former Military	24.1	4%
Transportation	6.5	1%
Other Urban or Built-Up Land	33.2	5%
Phragmites Dominate Urban Area	85.6	13%
Forest	46.8	7%
Wetlands	72.2	11%
Water	293.8	44%
Barren Land	9.2	1%
Total Land Area	**667**	

Table 2: *Land Use Area by Type*
Source: *NJDEP 2007 Land Use/Land Cover Dataset*

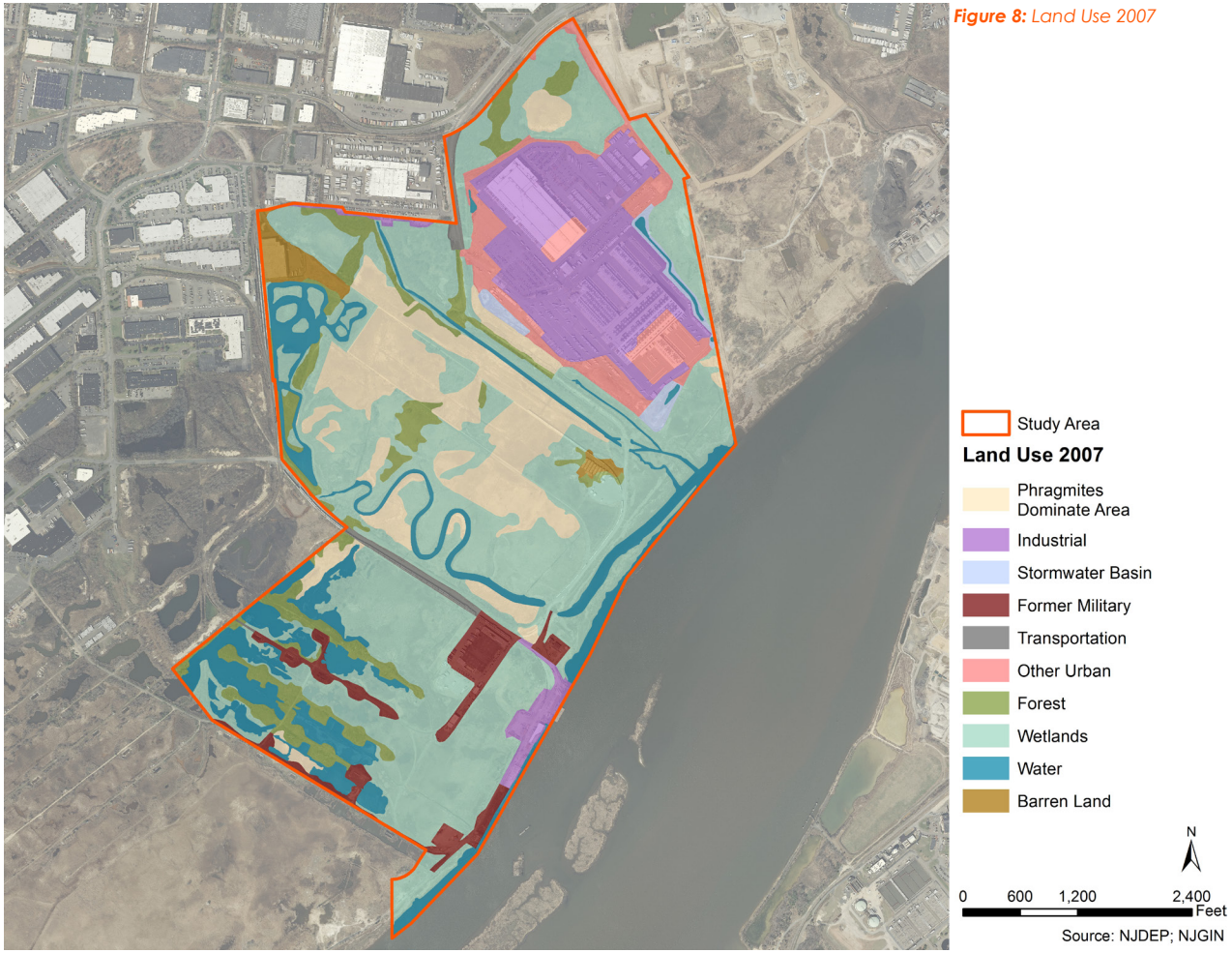


Figure 8: *Land Use 2007*

LAND USE: TYPES OF WETLANDS

According to wetlands data from the U.S. Fish and Wildlife Service (FWS), there are four types of wetlands on site: Estuarine and Marine Deepwater, Estuarine and Marine Wetland, Freshwater Emergent Wetland, and Freshwater Forested/Shrub Wetland. Among the four, Estuarine and Marine Wetland is the most common wetland type, accounting for 65% of the total wetland area and more than half of the total study area. Each of the other three types has a 10%-15% share of the total wetland area. There are four other types of wetlands around the site, including Freshwater Pond, Lake, Riverine and Other.

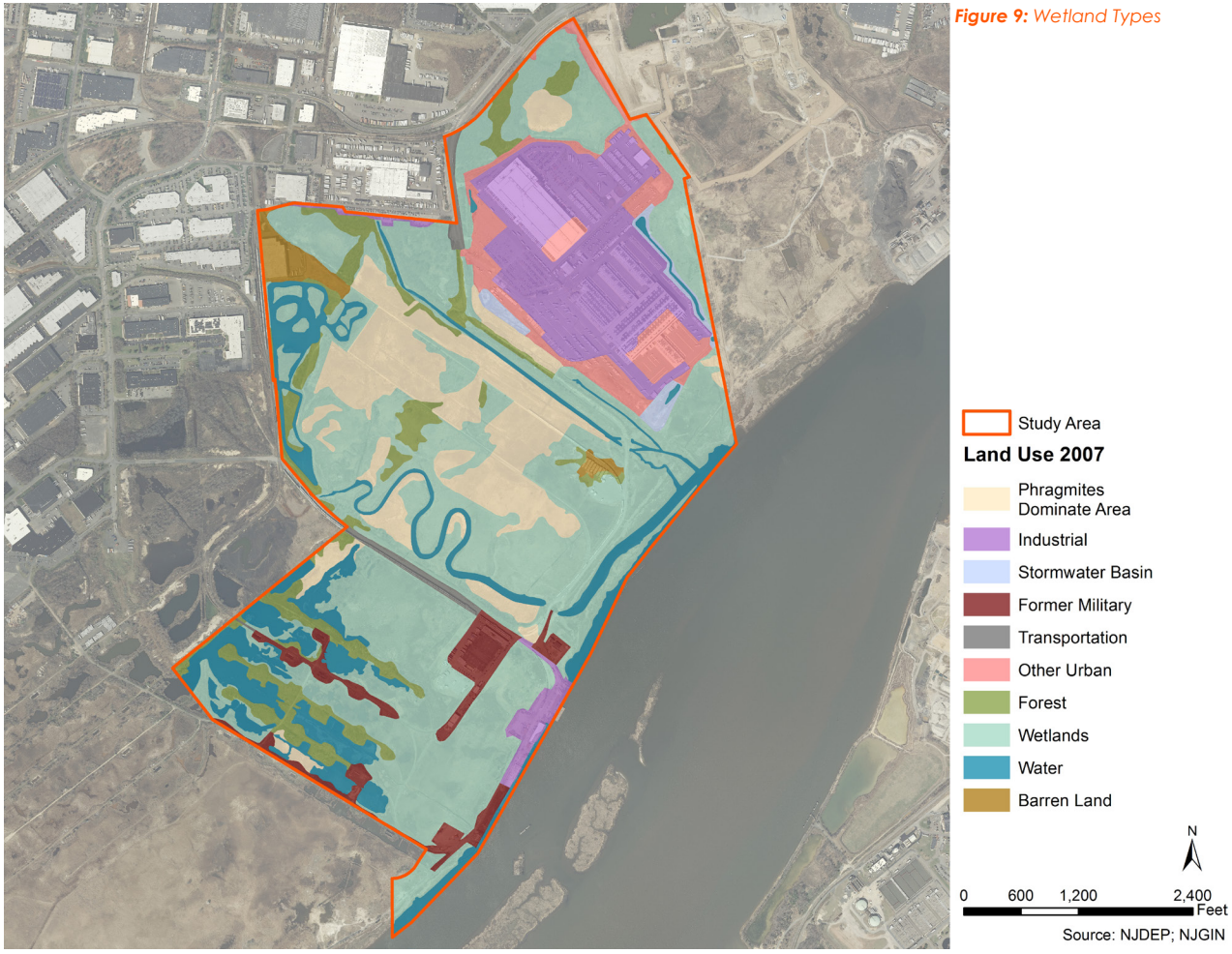


Figure 9: *Wetland Types*

Wetland Type	Total Area (acres)	% of Total Wetland Area
Estuarine and Marine Deepwater	56.3	10.17%
Estuarine and Marine Wetland	357.8	64.66%
Freshwater Emergent Wetland	78.8	14.24%
Freshwater Forested/Shrub Wetland	60.5	10.94%

Table 3: *Wetland Type*
Source: *U.S. Fish and Wildlife Service (FWS)*

LAND USE: IMPERVIOUS SURFACES

As with any developed industrial park, Raritan Center consists largely of impervious coverage, such as asphalt, concrete and roofs. The total impervious surface area within Raritan Center is 928.5 acres, or 39% of the Raritan Center total site area. Within the study area, the total impervious surface area is 135.8 acres, accounting for 20% of the study area. The impervious surface was mapped using 2007 Land Use/Land Cover data from NJDEP, with each land use polygon containing a percentage of impervious surface area. As a result of this impervious coverage, there is a significant amount of stormwater runoff that flows to the River through the study area. Typically, runoff from a highly impervious site such as Raritan Center can contribute to poor water quality and filtration or pre-treatment would help mitigate these impacts.

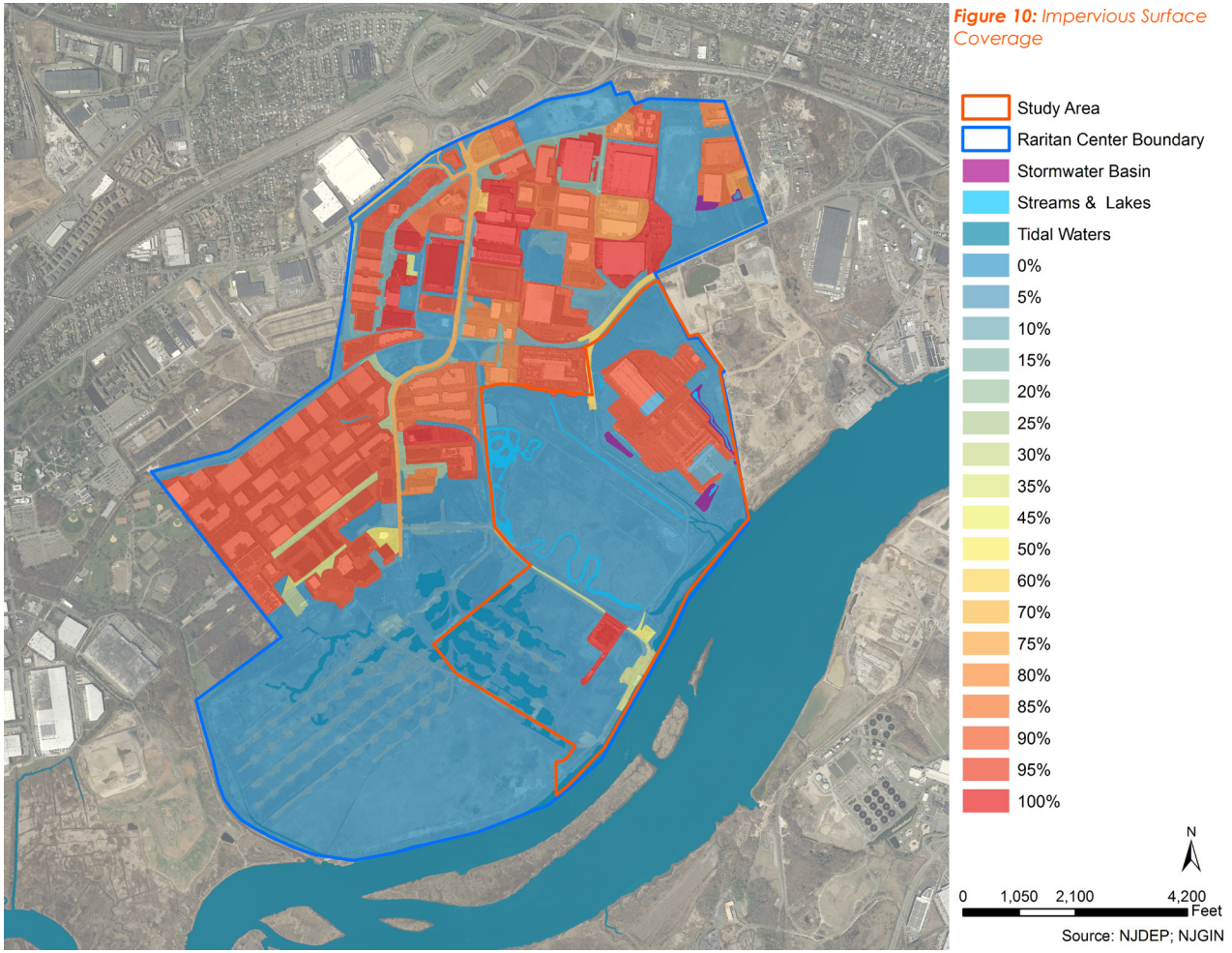


Figure 10: *Impervious Surface Coverage*

TOPOGRAPHY:

The topography of study area contributes to its historic function as wetlands and further direct this restoration plan. Using LiDAR data from the U.S. Geological Survey, a topographical map of the study area was created in Figure 11. There exists no significant variation in elevation through most of the site, but even the slightest of height change can provide substantial opportunity for water flow and vegetation change.

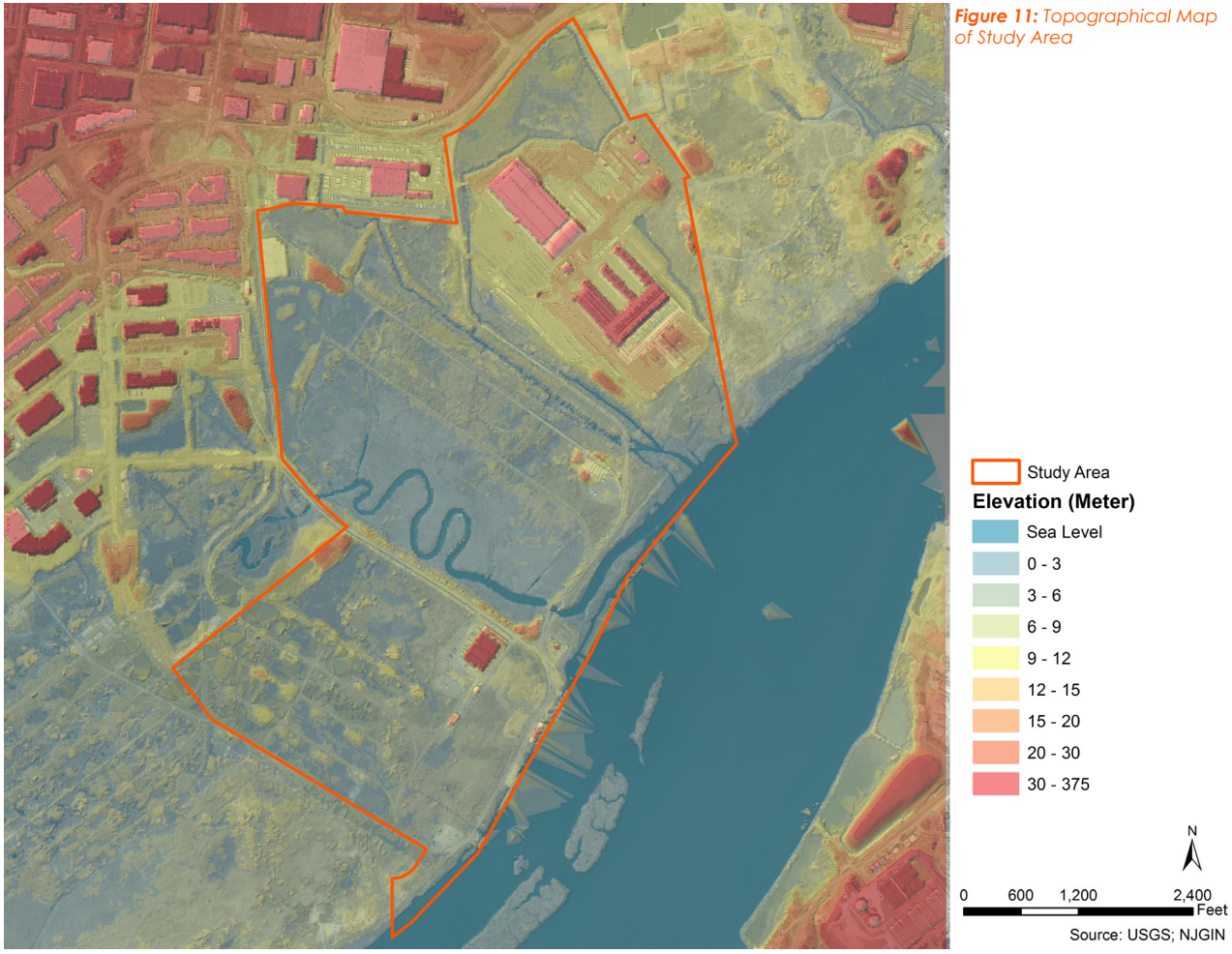


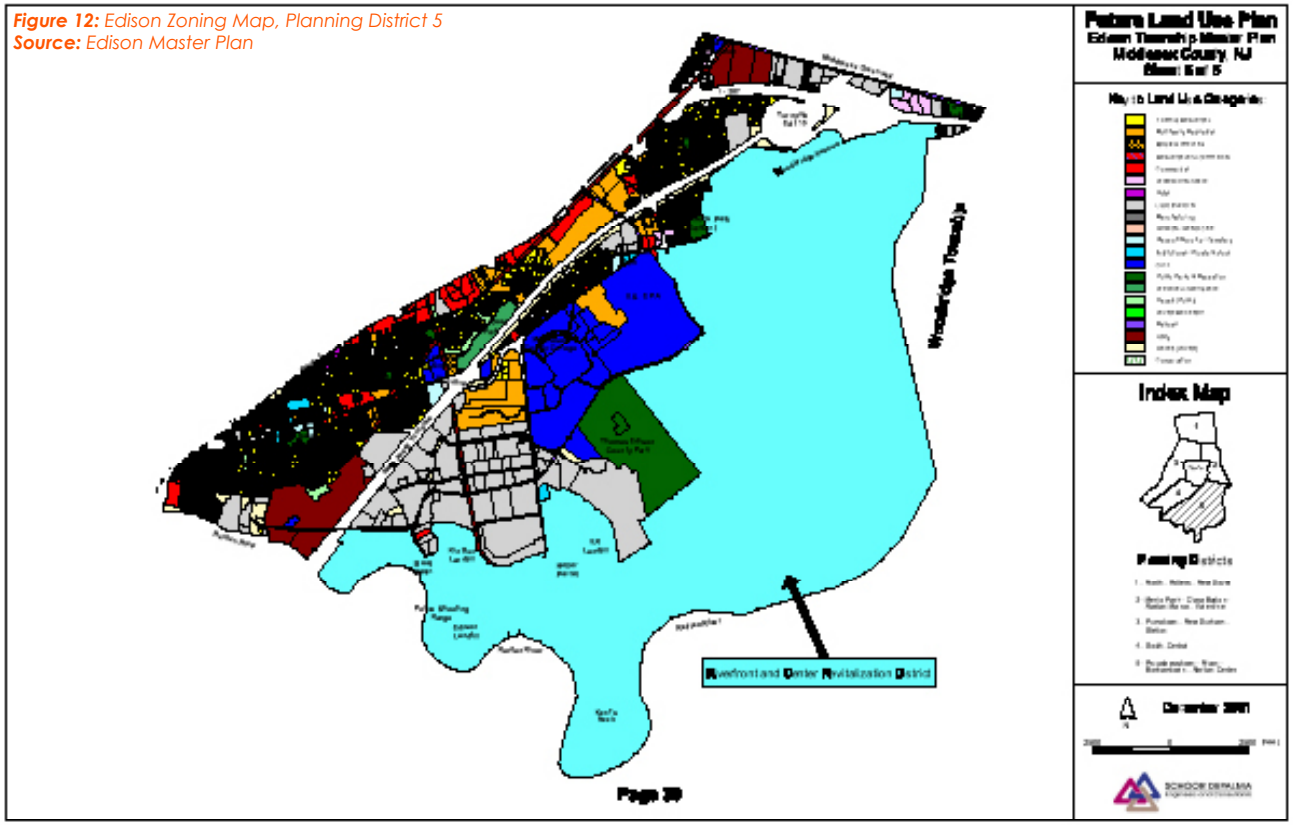
Figure 11: *Topographical Map of Study Area*

LOCAL ZONING

The study area straddles Edison and Woodbridge Townships, but are nonetheless zoned similarly. The majority of the site, within Edison Township's boundaries, is zoned as the "Raritan River Revitalization District" and recognized by the Township as both heavy and light industry (Edison, 2003). The Raritan River Revitalization District is one of several zones included in the Township's 5th Planning District, and as such has many provisions for mixed uses. Edison's Master Plan calls for permitted uses that include all of Raritan Center's existing uses, including but not limited to light industrial, warehousing, office space and hotels as well as multiple types of residential housing. Edison has also permitted uses on this site area to include those related to a seaport, "including but not limited to a marina, retail, educational, restaurants, and entertainment". Additionally, active and passive recreation were suggested as requirements in conjunction with waterfront development (Edison, 2003).

Edison Township's Master Plan identifies development of a seaport village along the Raritan River waterfront and requires that, "any future plans for this area must ensure significant public access to the waterfront" (28). In accordance with these goals there have been several successful plan proposals for the area including the Open Space Advisory Committee's 3-mile Bonhamtown Raritan River Trail which connects the former Raritan Arsenal from Thomas Edison County Park, opening the area for residents, Raritan Center employees and Middlesex County College students.

Figure 12: *Edison Zoning Map, Planning District 5*
Source: *Edison Master Plan*



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The Woodbridge Township portion of the study area lies within the Keasbey section of the township (Woodbridge, 2012). The eastern half of the study area within Woodbridge Township's boundary lies within the Keasbey/Port Reading 1996 redevelopment zone, the Keasbey Phase II redevelopment zone, as well as a Heavy Industrial zone. The Redevelopment Agency of the Township of Woodbridge (Woodbridge, 2014) is responsible for facilitating redevelopment of areas designated by the municipal council as "in need of redevelopment" based on the Agency's investigation and referral. One of several efforts includes a plan for an eco-industrial park at the EPEC site, which is "part of a strategy to revitalize the entire Keasbey area extending from Industrial Highway south to the Raritan River, north to the Edison border, and east to the City of Perth Amboy," overlapping the study area at Red Root Creek (Woodbridge Township Master Plan). The study area portion south of Riverside Drive is designated as multiple redevelopment areas that also encourage industrial uses similar to this eco-industrial park. In 2009, the Keasbey redevelopment zone was designated as a Brownfield Development Area. From the available maps, it appears that the study area portion of the Keasbey BDA has been redeveloped by the construction of the FedEx Corporation and Wakefern Food Corporation facilities. It does not appear that further redevelopment plans for this area are pending.

Figure 13: *Keasbey Redevelopment BDA Map*
Source: *Woodbridge Redevelopment Agency*

The Edison Master Plan (Edison, 2003) Conservation Element in Section 11.6 lists the municipality's planning strategies for fulfilling Edison's goals and objectives. These strategies include several that implicate the proposed restoration plan for the study area, such as to "protect the resource and recreational value of wetlands in Edison through development regulations," to "promote recreational opportunities and improve public access along the Raritan River waterfront provided such access and development does not degrade the function and value of this natural resource

system," "restrict or limit development adjacent to this environmentally sensitive area to water-dependent uses and other uses deemed compatible" and to "identify and protect the habitats of resident and migratory threatened and endangered species."

Three trails or greenways have been proposed to access public open space and/or the Raritan River through or near the study area (Edison, 2003; Middlesex, 2002). The western-most from the study area is the Raritan River Greenway, a planned six-mile bicycle and pedestrian accessible linear recreational area with a marina (Figure X. Draft Middlesex County Bicycle Pedestrian Plan, route NE 328). This Greenway follows the northern bank of the Raritan River from the Route 1 bridge to the area near Red Root Creek. North of the study area and Raritan Center runs the Middlesex Greenway (Figure X, route NE 304). The Middlesex Greenway currently runs 3.5 miles between Middlesex Avenue in Metuchen and Crows Mill Road in the Fords section of Woodbridge Township, along the abandoned Lehigh Valley Railroad right of way. Planned extensions of the Middlesex Greenway run west into Somerset County and east to Perth Amboy and Harbortown (Figure X, route NE 319). The Edison Township Planning Board has suggested a dedicated bicycle/pedestrian lane connection between route NE 328 and NE 304, along existing public rights-of-way. This proposed lane would connect the Raritan River waterfront area at the NE 328 route terminus to Dudash Park, an access point for the Middlesex Greenway lying just north of Route 440. It appears that, as proposed, the NE 328 to Dudash Park connection would cross in a south-west to north-east direction through the study area. Finally, the Bonhamtown-Raritan River Trail, is proposed as a 3-mile loop trail through the former Raritan Arsenal from Thomas Edison County Park. This trail was recommended by the Edison Open Space Advisory Committee and incorporated into the Edison Township Master Plan.

From a broader perspective, the current Edison Township Master Plan (Edison, 2003) classifies the Raritan Center and all of the undeveloped land lying between Route 1 and Metuchen to the west and the municipal boundary of Woodbridge to the east, and from the Raritan River waterfront north to the Lehigh Valley (Conrail) Railroad, as Planning District 5 ("PD 5"). Edison's vision for south-west to north-east direction through the study area. Finally, the Bonhamtown-Raritan River Trail, is proposed as a 3-mile loop trail through the former Raritan Arsenal from Thomas Edison County Park. This trail was recommended by the Edison Open Space Advisory Committee and incorporated into the Edison Township Master Plan.

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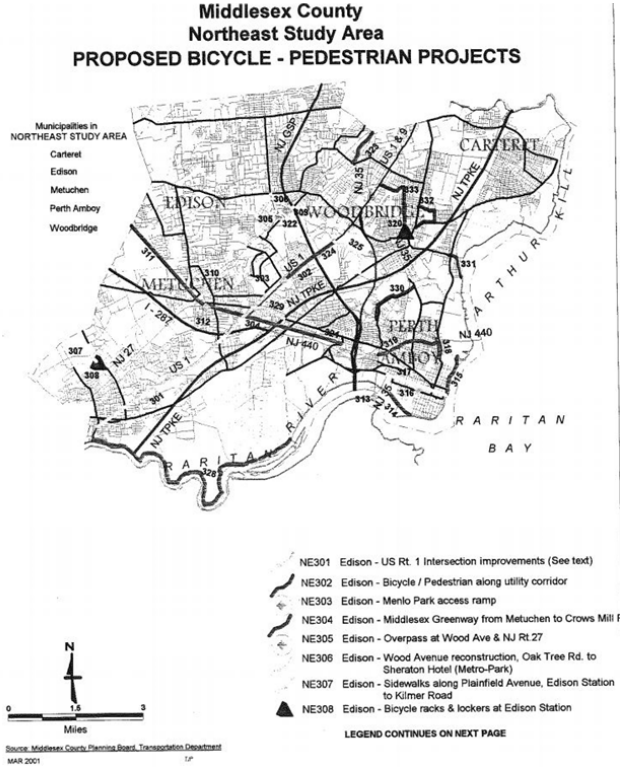

Figure 14: *Proposed Pedestrian and Bicycle Projects*
Source: *2002 Middlesex County Bicycle Pedestrian Plan*

waterfront, with a mix of uses including residential, retail, restaurant, significant acres of active and passive recreation, and multi-modal transportation, including commuter ferry service. As a starting point, the PD5 vision requires significant public access to the waterfront. A mixed use district labeled the Raritan River Revitalization District was described, to include light industrial, warehousing, office space and hotels as well as marina, retail, educational, restaurants, and entertainment. Standards for this area would permit by right multiple types of residential housing. The Master Plan refers to a 3-mile loop trail (apparently, the

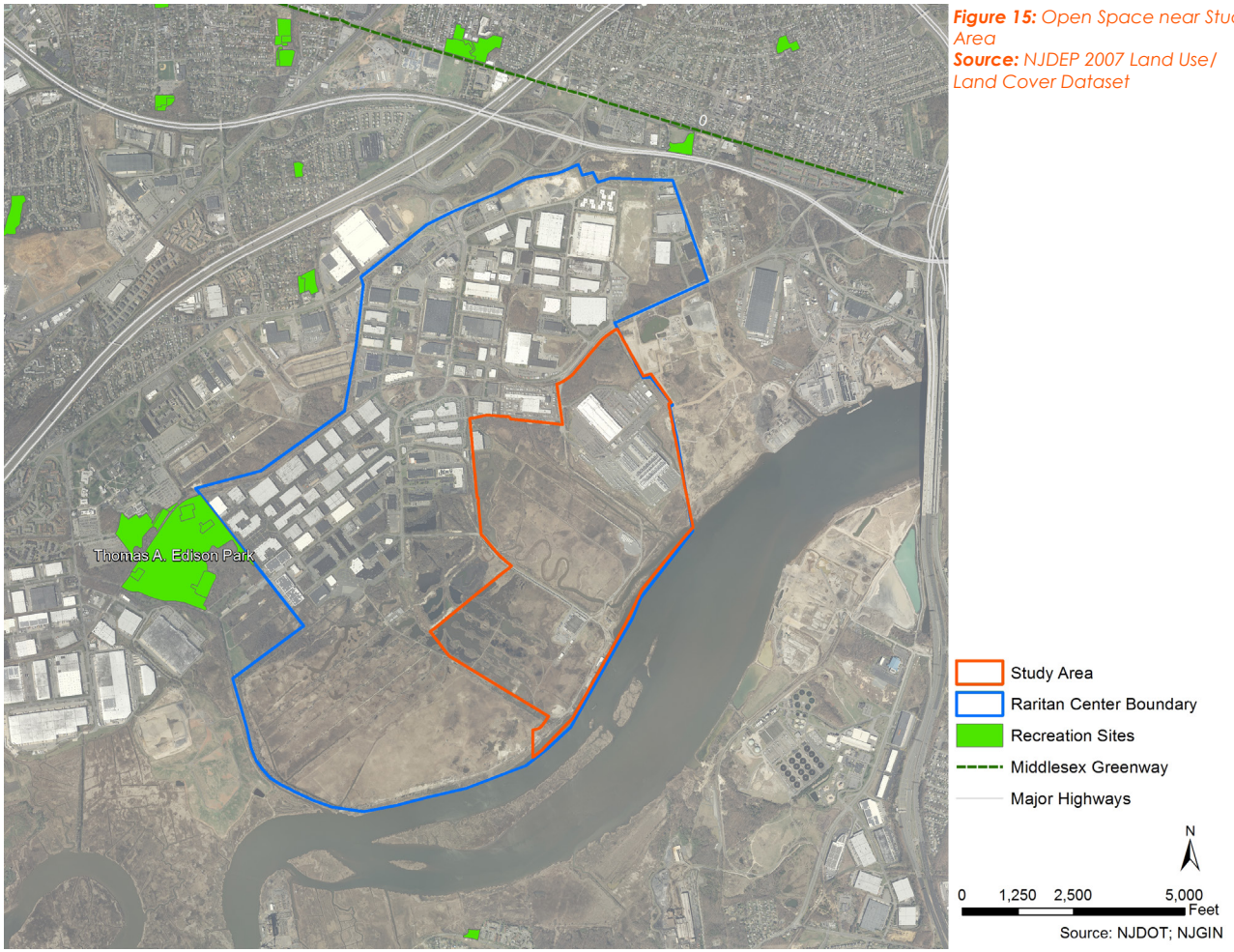

Figure 15: *Open Space near Study Area*
Source: *NJDEP 2007 Land Use/ Land Cover Dataset*

Bonhamtown- Raritan River Trail) running from the Thomas Edison County Park to the riverfront to serve residents, Raritan Center employees, and Middlesex County College students. The Master Plan also refers to Edison's Open Space Acquisition Plan as having identified a sizable portion of the riverfront as potential open space parcels.

Middlesex County and the Middlesex County Improvement Authority in the mid-1990's undertook a Raritan River Case Study (Middlesex, 1995; Woodbridge 2008) yielding four broad recommendations that imply goals in some measure harmonizing with the study area proposed restoration. These four recommendations, briefly summarized, were as follows: residential development at Raritan Center so that employees could live closer to work, a riverfront park to provide recreational opportunities and access to the river, efforts to expedite closure and/or remediation of landfills so that the riverfront park could be extended westward (west of the study area), and transit improvements linking the Center to New Brunswick, Perth Amboy and the bayshore communities of Monmouth County through a transit link between NJ Transit Coast line (Perth Amboy) and the NJ Transit Northeast Corridor line (Metropark or Metuchen).

TRANSPORTATION

There is no doubt that the land use and development of Raritan Center today can be attributed to the location of the site relative to major transportation infrastructure. The Raritan Center site, which contains the study area, sits at a crossroads of major national and state highways, has direct access to them, and is served by public passenger and freight transportation lines. Newark Liberty International Airport is located just 20 miles north of Raritan Center. Approximately 20,000 employees travel to and from the Center daily.

Roadway Access

The Raritan Center has excellent access to the New Jersey Turnpike, the Garden State Parkway, Route 287, Route 440, Route 1, Route 27, Route 9 and Route 35, all of which (save for the Parkway) are truck routes for the movement of goods. On and off-ramps for all of the major roadways are located directly off of either Woodbridge Avenue or Riverside Drive, the principal arterials feeding Raritan Center, shown in Figure 15. The main roadway for travel within the Center is Raritan Center Parkway, a four lane roadway bisecting the Center.

The Red Root Creek study area within the Center can be accessed via Sweetwater Road (formerly Olympic Drive), running along the western edge of the creek from Raritan Center Parkway and crossing the freight rail line to the waterfront. The study area can also be accessed via Cattail Way, running from Riverside Drive to the waterfront on the east side of the creek and a pair of north-south freight rail lines. A potential third access point to the study area could exist from Blue Heron Way, which also crosses the freight rail line and terminates behind a warehouse adjacent to an upland area just north of the creek.

Public Transportation

Raritan Center lies within five miles of five commuter train stations on the NJ TRANSIT system – three on the Northeast Corridor line (Edison, Metuchen and Metropark) and two on North Jersey Coast Line (Perth Amboy and Woodbridge). In addition, the Metropark station is served by Amtrak for regional connection to areas on the Northeast Corridor beyond New York City to the north and Philadelphia to the south.

Raritan Center is served by NJ TRANSIT bus line 813 which connects to points in Perth Amboy, Woodbridge, Metuchen and Edison. This bus line connects the Metuchen and Perth Amboy train stations to the site. Weekday service

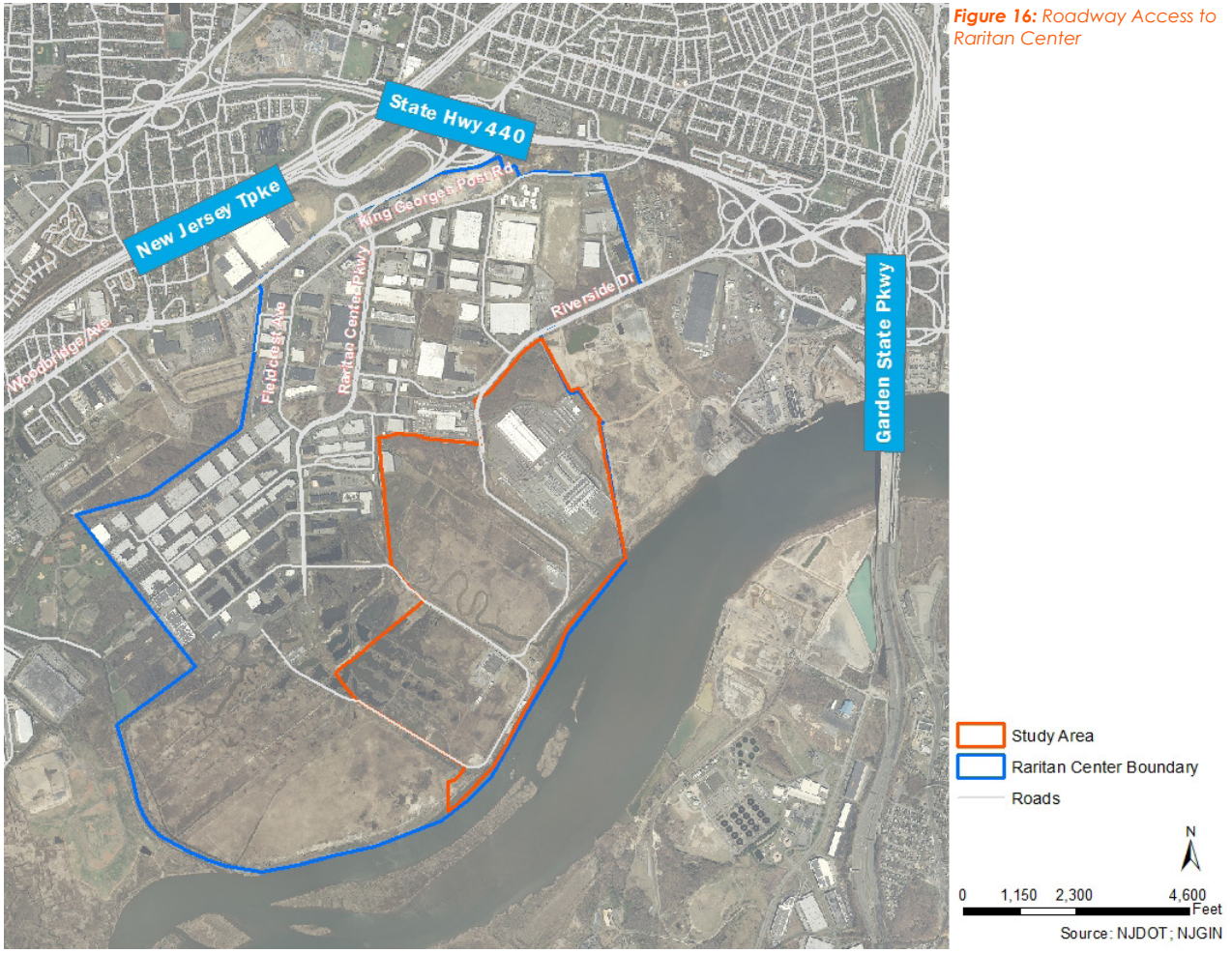

Figure 16: *Roadway Access to Raritan Center*

is provided every 20 to 30 minutes during the morning rush and on the hour after 9:00am. There is currently no weekend service for Raritan Center, but the bus line does stop at Middlesex County College on Saturdays. Despite adequate weekday service to the site, the condition of the bus stops located at the Center are mediocre at best. Many of the stops do not have bus shelters, only signs on the road marking the stops, and even those that do have shelters do not have sidewalks leading up to them, as there are largely no sidewalks within the Center.

Freight Movement

Historically, the Raritan Center site has been a major hub for movement of freight, particularly via heavy rail. During its former use as Raritan Arsenal, munitions were moved via freight rail to the ports north of the site for shipment to the European fronts during the World Wars. The Raritan Industrial freight line serves the Center and is being evaluated by the New Jersey Department of Transportation to connect to the Chemical Coast freight line for increased rail traffic. In addition to this main freight line running through the Center, there are many spurs and sidings throughout the site, including the study area, but many of these have been abandoned. The only active spur runs into the study area along Sweetwater Road, down to the working waterfront wharf and back up. Currently, that line is being utilized to bring raw material to the wharf for processing (pipe welding). In addition, this spur and two rail lines terminating in the study area to the east of the creek hold rail cars storing plastic pellets. The active use of these freight lines on the site effectively divides the study area into sections and challenges a comprehensive restoration of the wetlands and the provision of public access to the site.

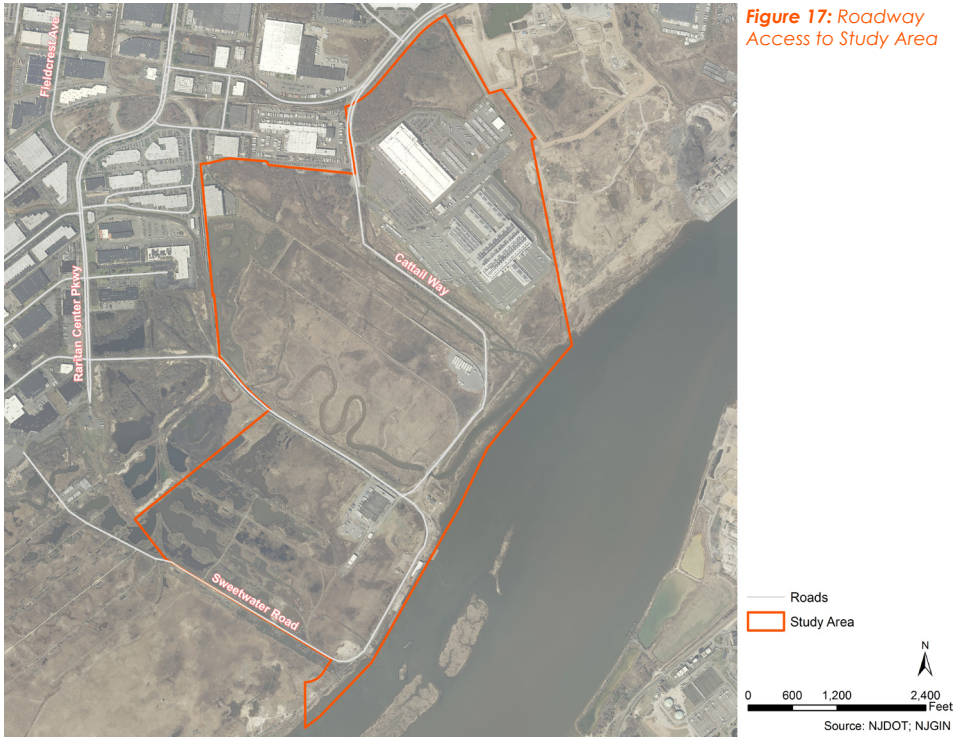

Figure 17: *Roadway Access to Study Area*

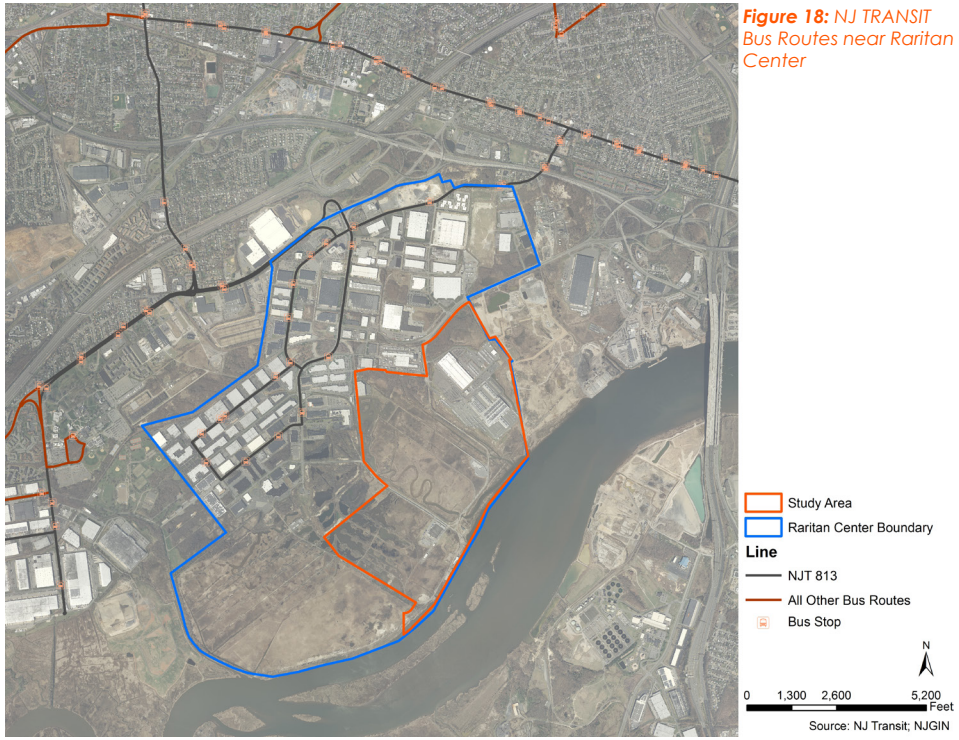

Figure 18: *NJ TRANSIT Bus Routes near Raritan Center*

Non-Motorized Access

As the Raritan Center site is oriented to freight rail and automobile and truck movement, there exist no pedestrian or bicycle facilities within the Center. There is an extensive amount of public right-of-way available within the current roadways for conversion to multi-modal use, but the prospect of this shift may be difficult due to the high volume of large trucks moving through the site. Middlesex County has adopted a Complete Streets policy, requiring all road upgrades to consider all road users; however, the townships of Edison and Woodbridge have not adopted such a policy. To provide major pedestrian and bicycle access through the surrounding area, the Middlesex Greenway runs just northeast of Raritan Center on an abandoned freight rail right-of-way, with plans to expand. In addition, there are plans to complete the East Coast Greenway route through Middlesex County. The exact route in this area has yet to be finalized, but there is a possibility it could run through the study area in the future.

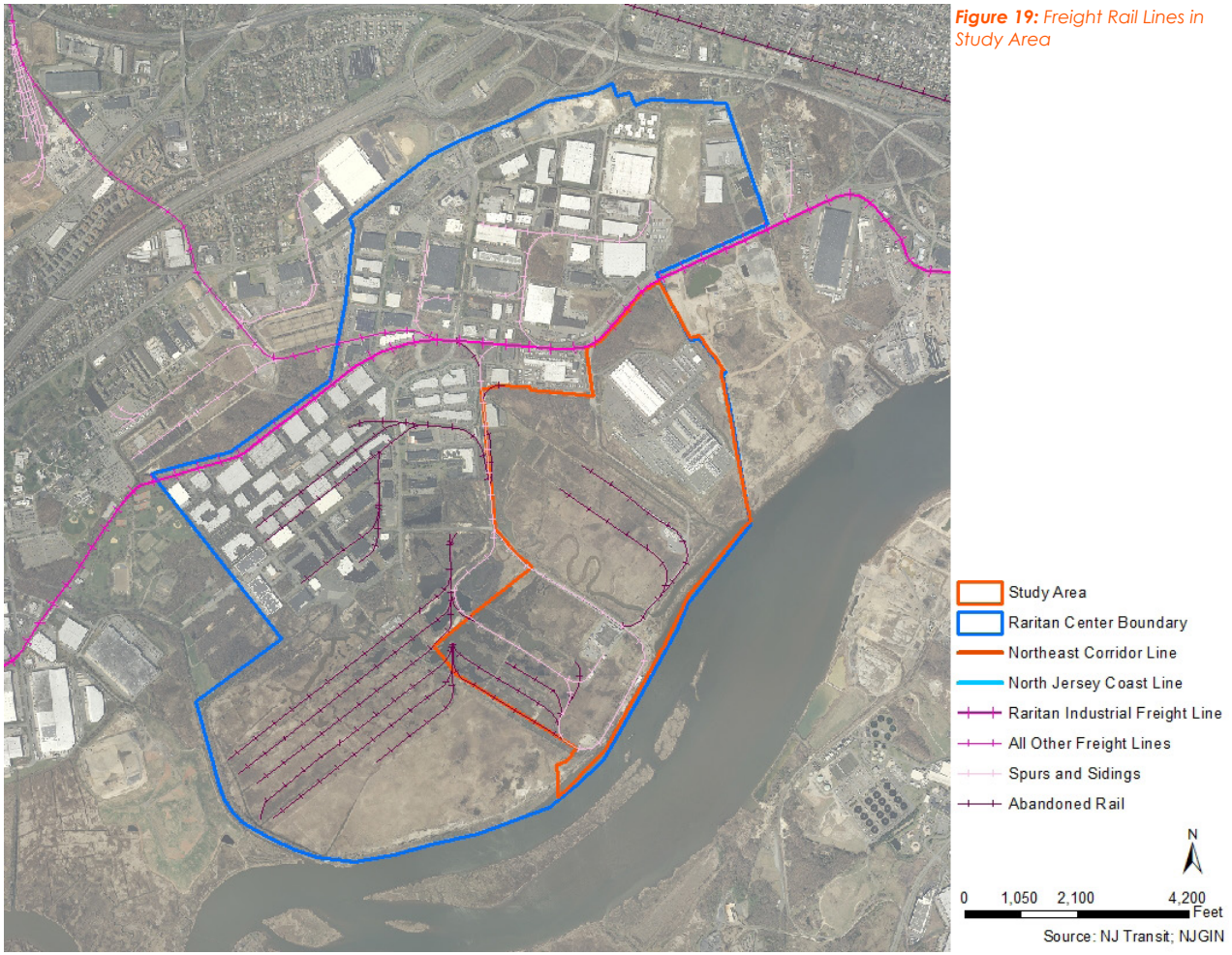

Figure 19: *Freight Rail Lines in Study Area*


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SITE
CHALLENGES

The studio team's analysis of existing conditions revealed several substantial challenges to restoration of the study area. These include multiple jurisdictions and stakeholders, competing uses, contamination and flooding and sea level rise concerns. Each of these are discussed in further detail in this section

STORM SURGE AND SEA LEVEL RISE

Superstorm Sandy's storm surge decimated the study area. The flood water carried several trailers from an overflow FedEx parking lot on the edge of the River inland across the study area, even moving one as far as the previously restored freshwater wetland. The pumping station for the Middlesex County Utility Authority at the River's edge within the study area was heavily inundated. Superstorm Sandy's extensive storm surge cannot be considered a one-time event.

As shown in Table 4, most of the site is within the Special Flood Hazard Area, also known as the "100-year floodplain." The latest Federal Emergency Management Agency (FEMA) Preliminary Flood Insurance Rate Maps (Preliminary FIRMs), released in January 2014, illustrate this vulnerability to our wetlands area and some of the neighboring buildings and infrastructure. These maps reflect an increased vulnerability from flooding as compared to existing maps, even though these new maps did not take Sandy into account. Small sections of the site abutting the Raritan River, including the wharf and adjacent working area, are in the coastal high hazard zone (the velocity, or VE zone, subject to waves of 3 feet or more in a 100 year storm event). The majority of the study area is within the Limit of Moderate Wave Action (LiMWA), meaning that it is subject to waves between 1.5 and 3 feet during a 100-year storm event. While these zones are not regulated to the same building standards as velocity zones, the damage from

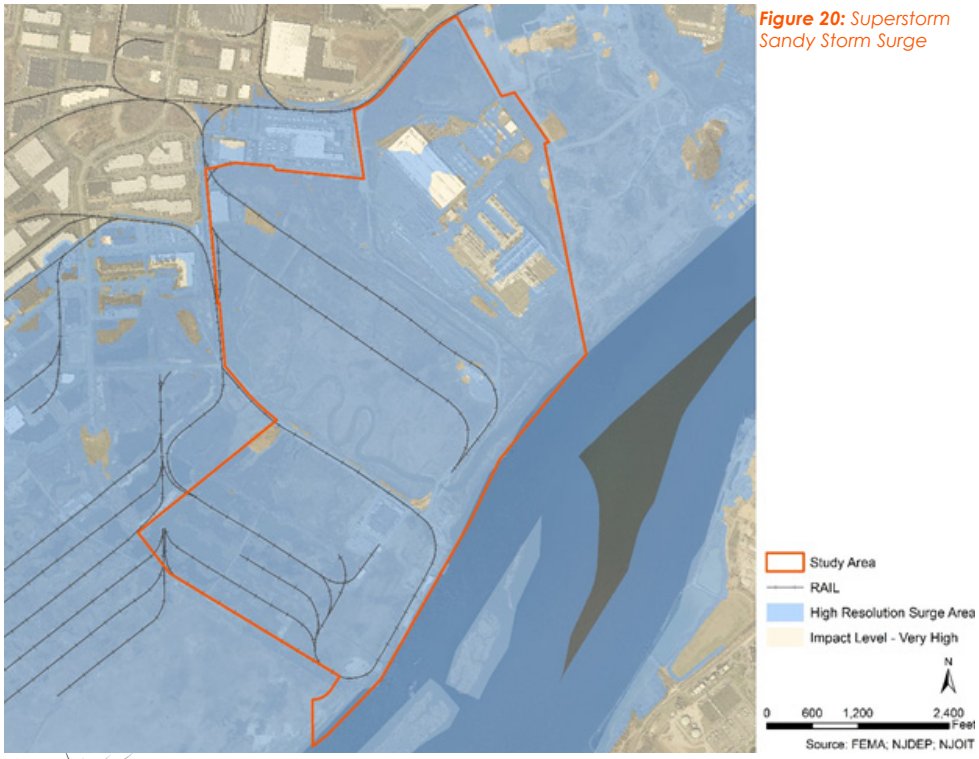


Figure 20: *Superstorm Sandy Storm Surge*

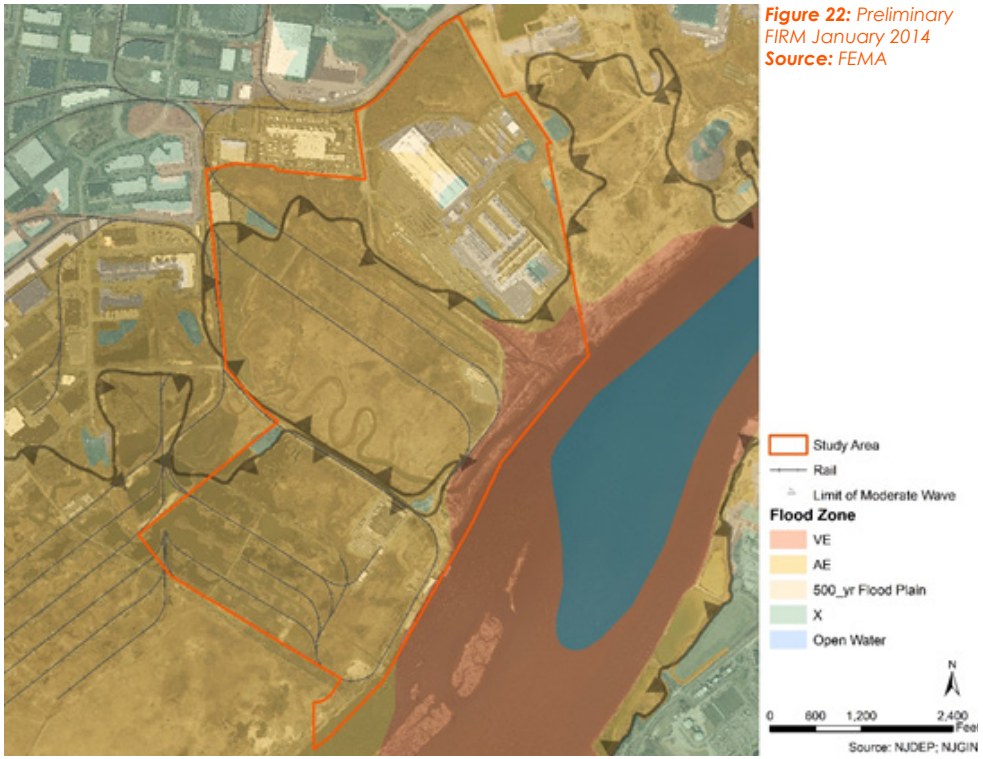


Figure 22: *Preliminary FIRM January 2014*
Source: *FEMA*

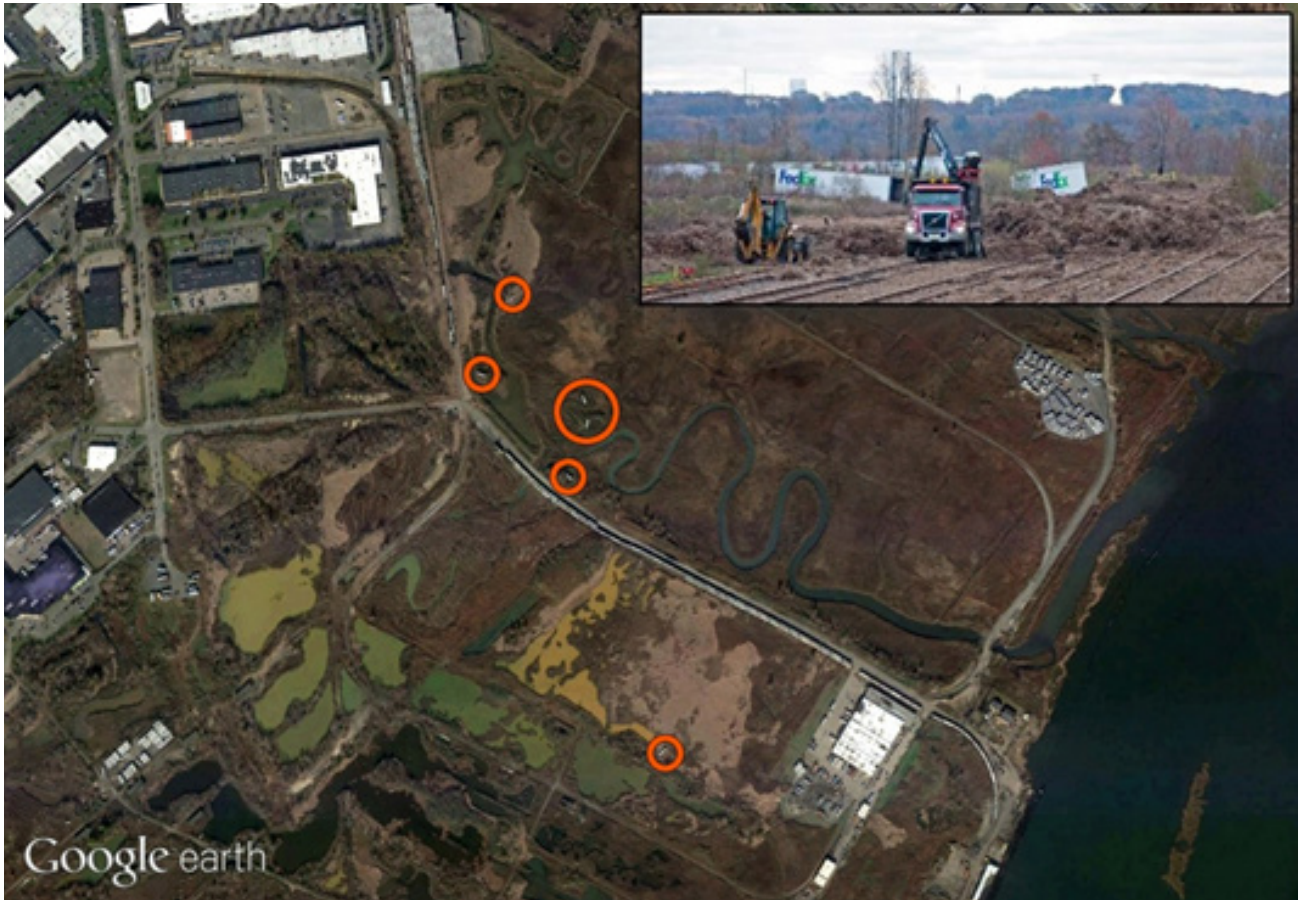


Figure 21: *Superstorm Sandy Aftermath Aerial*
Source: *Google Earth, November 2012*

Table 4: *Flood Zone Impact to Study Area*
Source: *FEMA Preliminary FIRM January 2014*

Flood Hazard Zone	Total Area (acres)	% of Total Flood Zone Area within Study Area
Shaded X Zone (500-Year Flood Hazard Zone)	33.6	5.00%
AE Zone (100-Year Flood Hazard Zone, not subject to 3-foot or greater waves)	577.1	86.50%
VE Zone (Velocity) (100-Year Flood Hazard Zone, subject to 3-foot or greater waves)	45.5	6.80%
Unshaded X Zone (outside 500-Year Flood Hazard Zone)	10.3	1.50%

such moderate wave action can be significant. For example, in similar area elsewhere, Sandy's storm surge did wash number of houses off of their foundations. Thus, the study area is highly vulnerable to both inundation and waves in large storm events. The key is proper mitigation to lessen storm surge impacts to the study area and even more importantly, to the surrounding infrastructure and buildings.(FEMA, 2014).

In this case, some of the adjacent developed Raritan Center area is also within the 100-year floodplain, though not within FEMA's mapped moderate wave action area. This means these properties are subject to flooding during major storm events but unlikely would experience damaging wave action. However, any flood or storm surge prediction maps do have inherent limitations. For one, the delineation between different zones is based on computer modeling and subject to human error. The nature of storms are that they vary in terms of actual and forecasted effects, difficult to predict with certainty. Therefore, wetland restoration and additional hardening measures are important in the protection of Raritan Center as a whole during future weather events.

The sea level rise maps for the study area show that a large part of the study area would be permanently underwater if sea level were to rise. Estimates of sea level rise by 2100 vary, but most predictions estimate a sea level rise of between one foot on the low end, and up six feet on the high end, with most predictions around two feet (IPCC 2007). Rising water is a concern for much of our site, and that would mean more salt water intrusion on the site.

The extent of sea level rise during normal tide cycles is not the only concern. Any increase in sea level during normal tide cycles means that that future storms would not have to be as intense as today's storms to equal or exceed past storm events. A two-foot sea level rise combined with a more common storm surge of two feet would impact roughly the same current land area as a present day four-foot storm surge event.

Some climate scientists also predict that there will be more intensive storm events in the future. Regardless of general storm intensity, as New Jersey learned from Hurricane Sandy, it only takes one severe storm event to permanently change the landscape of an area. The key for this site will be adapting to salt water and using the wetlands restoration to enhance the storm protection for Raritan Center from future storm events and sea level rise impacts.

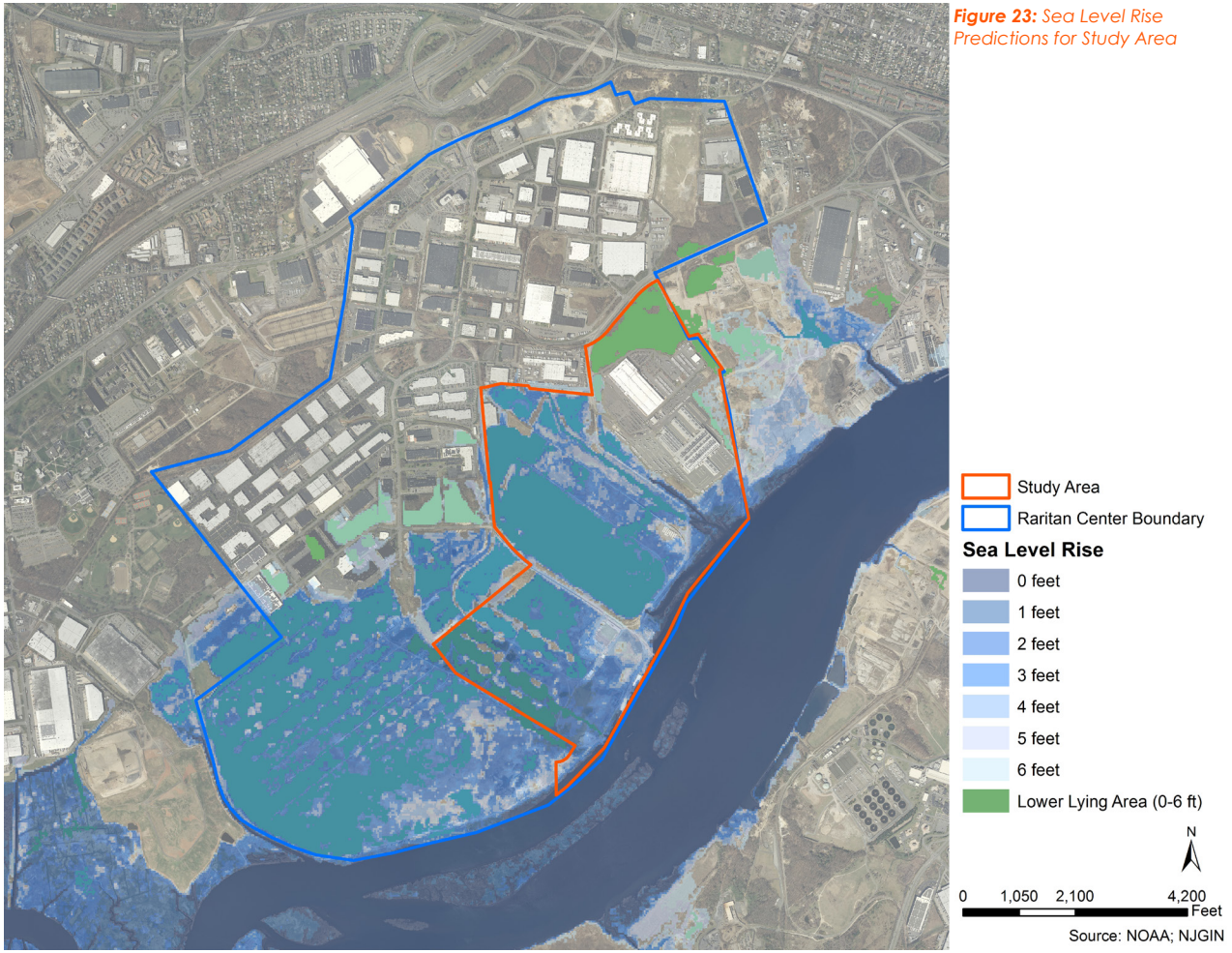


Figure 23: *Sea Level Rise Predictions for Study Area*

HISTORIC CONTAMINATION AND REMEDIATION EFFORTS

Historic Contamination

The Raritan Center is part of a wider region of New Jersey where there is a concentration of Known Contaminated Sites (KCS) regulated by the New Jersey Department of Environmental Protection (NJDEP). For instance, as depicted in Figure 23, within a five-mile radius of the Center there are a total of 421 KCS (NJDEP, 2013).

Within the Raritan Center boundary itself there are 11 NJDEP KCS. One of these sites, ID 84799, associated with Twin Bridge Incorporated, falls within the study area.

In addition to Site 84799 which rises to the criteria of being a NJDEP KCS, tests of the study area's soil, sediment, surface water and groundwater commissioned by USACE and FBC have detected widespread instances where contaminant levels exceed US Environmental Protection Agency (USEPA) standards or the 2009 NJDEP Soil Remediation standards for Residential Direct Contact, Non-Residential Direct Contact and Impact to Groundwater Soil Screening Levels (FBC, 2007; FBC, 2011). Contaminants tested for and present within the study area include Volatile Organic Compounds, Base Neutral Compounds, Petroleum Hydrocarbons, pesticides, and heavy metals such as Arsenic, Lead, Aluminum, Beryllium, Manganese, Mercury, Selenium, Silver, Arsenic, Antimony and Vanadium (FBC, 2011). As an example of the prevalence of contamination, a summary of soil samples that exceeded the 2009 NJDEP Soil Remediation Standards is provided below in Table 5.

Much of the contamination on the site is thought to be linked to its former use as the U.S. Army Raritan Arsenal from 1917 to 1963 as discussed above and to the historic filling of the site with contaminated Raritan River dredge spoils by USACE (FBC, 2011).

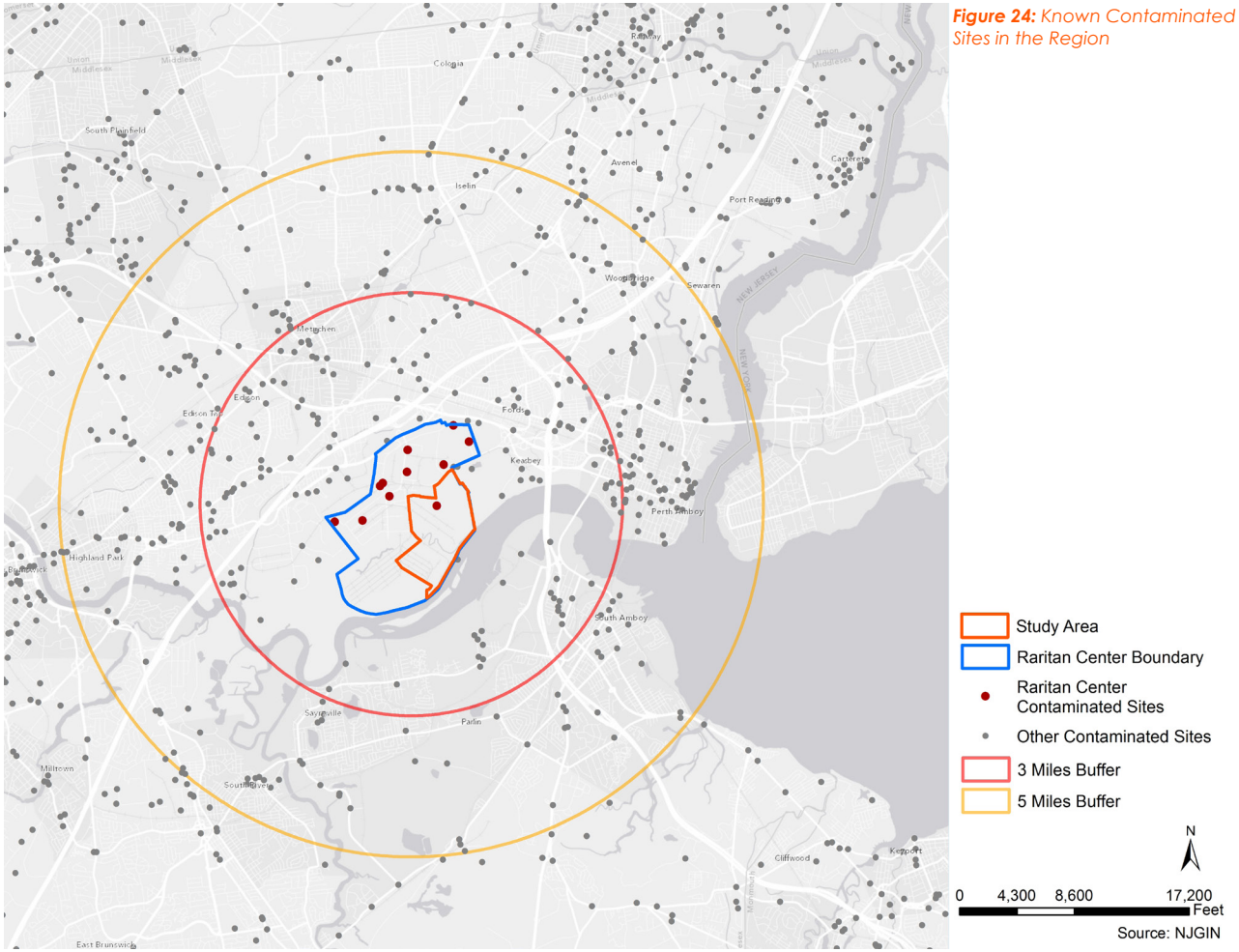


Figure 24: *Known Contaminated Sites in the Region*

Table 5: *Summary of Soil Samples Exceeding 2009 NJDEP Soil Remediation Standards*

Contaminant	Samples Tested	Samples That Exceeded 2009 NJDEP Standards	Percentage That Exceeded Standards
Volatile Organic Compounds	117	12	10.30%
Base Neutral Compounds	172	61	35.50%
Petroleum Hydrocarbons	32	4	12.50%
Pesticides	128	7	5.50%
Metals – Arsenic, Lead (n.b. other metals results not reported here)	170	65 (Arsenic), 3 (Lead)	38.2% (Arsenic), 2.3% (Lead)

Remediation Efforts

USACE has an extensive history of investigation and remediation at the study area dating back to an exploration for possible contaminated sites in 1961 when 16 separate areas of potential contamination were identified and a detailed decontamination plan for the Arsenal developed. The decontamination plan was carried out in 1962 and 1963 during which an additional area of contamination was identified (USACE, n.d). A map of all areas of concern identified by USACE is provided at Figure 24. As the figure shows, 10 areas fall partially or wholly within the study area including Area 4, Area 5, Areas 6, 6A and 6B, Area 11, Area 12, Area 13, Area 14 and Area 16. The former uses of these sites are noted in the figure legend.

Of significance to the wetlands restoration plan proposed is Area 5, the former Chemical/Mustard Disposal Area. As the record from a 1987 Environmental Inventory indicates, mustard gas has been one of the principal contaminants of concern at the former Arsenal. The results of a 1970 field investigation, however, revealed that the contamination level in Area 5 was not as high as previously thought based on the USACE's documentation from the 1960s which recommended the area for non-use. Nonetheless, according to Peter Visceglia of FBC, acting on principles of precaution, this site has been advised only for developments that would effectively cap the site (Visceglia, 2014).

Today the Corps continues its over 20-year-long investigation and cleanup of the site under the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS), a federal program that applies to former Department of Defense properties transferred to private ownership (USACE, 2013). As of October 2013, USACE is actively carrying out a Military Munitions Response Program investigation which will represent the first comprehensive investigation focused on the wetlands component of the former Arsenal, including the study area. The investigations are slated to be completed during the summer of 2014 and should "define the nature of munitions and explosives of concern, munitions constituents, and other hazardous and toxic waste; provide information to assess the risks and hazards to human health, safety, and the environment posed by munitions and other contaminants; provide the data needed to define remedial alternatives in the Feasibility Study; and provide information to support development of a Proposed Remedial Action Plan" (USACE, 2013).

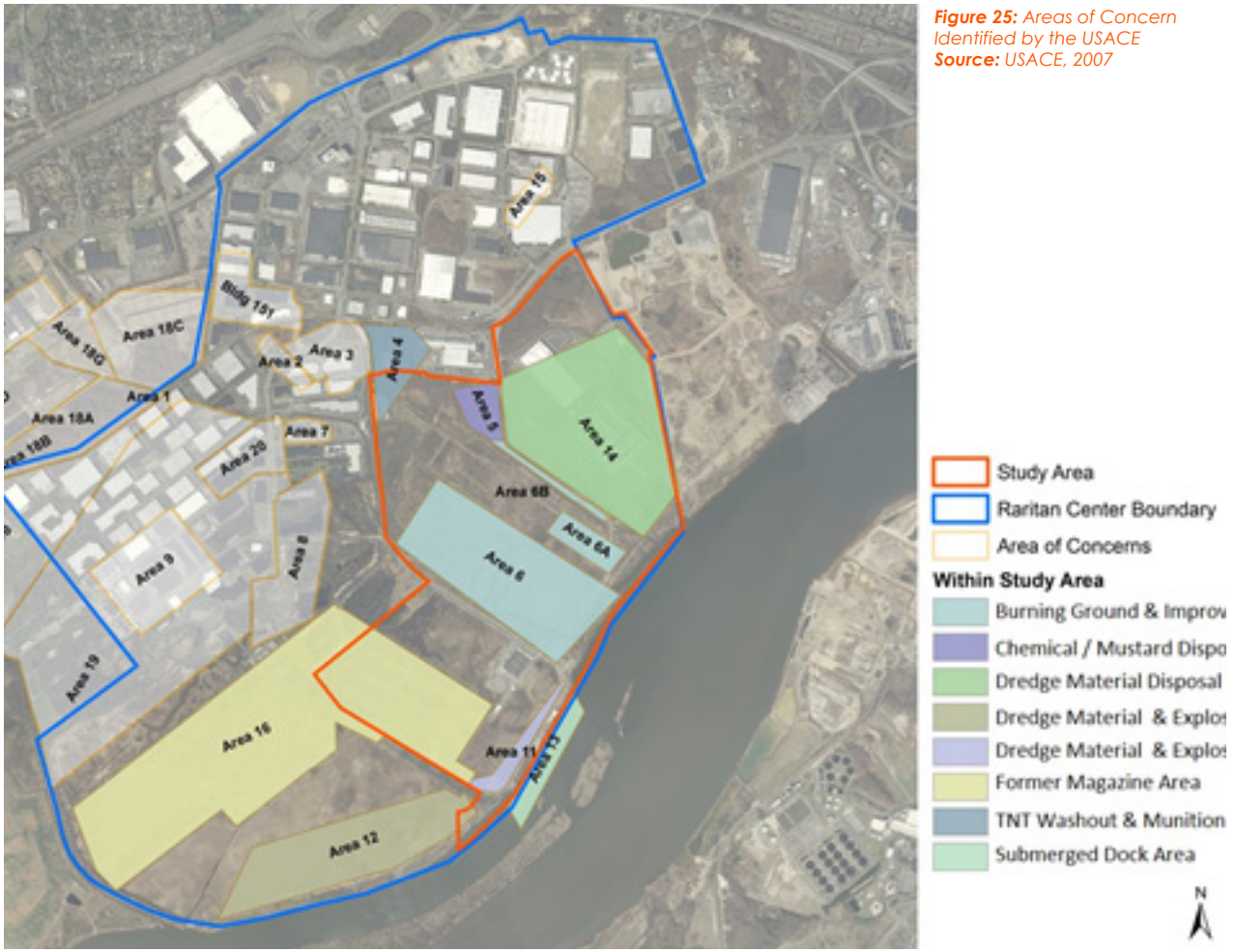


Figure 25: *Areas of Concern Identified by the USACE*
Source: *USACE, 2007*

Implications for Restoration

At higher concentrations and exposure levels, the contaminants present at the site are known to have potential harmful effects to wildlife and humans. Given this, USACE commissioned a Baseline Ecological Risk Assessment (BERA) of the site completed in March 2008 with the expressed purposes of determining whether existing levels of contamination in soils, sediments and surface waters at the former Arsenal pose ecological risks and whether any evidence of impacts to the Raritan River from the site is present (USACE, 2008). The report finds that the ecological implications of the onsite contamination are limited. Specifically it concludes that:

- In most places and cases there is little evidence of risk to either the aquatic or terrestrial habitats or species on the site from existing levels of contamination;
- There is no evidence that freshwater habitats are at ecological risk from contaminants, with the possible exception of risk from arsenic in the sediments of Area 19 (outside the study area);
- There is no evidence of significant impacts to fish, fiddler crabs and higher receptors in estuarine habitats, with a few possible exceptions;
- With a few exceptions (e.g. the case of aluminum, arsenic and selenium), piscivorous receptors such as great-blue heron, raccoon or mink are not at risk from contaminants detected in fish and fiddler crab prey in estuarine sediments;
- In terrestrial environments, there is risk to American robins foraging on invertebrates in Area 5 due to soil lead contamination (as indicated by hazard quotient modeling using Lowest Observed Adverse Effect Levels). While the results show other metals posing potential risks, the risks calculated did not exceed or barely exceeded risk calculated for the reference location; and
- There is no evidence of site impacts to the Raritan River.

The results of the BERA indicate that existing levels of onsite contaminants should not significantly undermine restoration efforts from an ecological perspective. Therefore, it is not evident that contamination at the site should be viewed as a barrier to wetland restoration or as a fatal impediment to meeting restoration goals, particularly considering the regional context where similar levels of contamination is not exceptional.

While not prohibiting the restoration effort, the presence of contamination should be recognized and addressed in the restoration plan and its implementation. From an ecological perspective, this means remediating or isolating the soils/sediments of Area 5 where the evidence suggests harmful effects to American robins. Isolation could be achieved by the already planned development of Area 5. Area 5, however, is not included in the conceptual plan for the study area in this report. The results of the ongoing USACE investigations on the site would be useful and should further inform the details of the restoration plan and its implementation. Implementation of the of the restoration plan should also consider potential liberation of contaminants with the proposed re-introduction of sea water to the site and take measures to mitigate such effects if necessary.

From a public access perspective, precautionary measures should be taken to ensure that forms of public access are guided and restrained to avoid direct forms of human contact with contaminated sediments, soils, and surface waters. These recommendations are supported by former recommendations for the site including those recently by JM Sorge Inc. (FBC, 2011).

BALANCE OF USES

The study area includes degraded wetlands, forested uplands, man-made berms supporting roadways and railroad tracks, truck and material staging areas and a commercial wharf. The study area lies within an urban area with high demand for lower impact and lower cost commercial freight transportation accompanied by a decades-long effort to restore public and educational access to the river and local, restored natural resources. The physical layout and location of the study area lend themselves to fulfilling all of these goals. Plans are underway for restoration of the wharf and enhancement of the railway service to facilitate a more active multimodal transportation hub. The wetlands restoration envisioned by this restoration plan, proposes limited public access via a nature center on the uplands and elevated boardwalks and lookouts in the wetlands. The restoration plan also proposes multiple distinct habitats to be formed within the sections created by the berms that divide the wetlands from the River and the

wetlands into various sections. Thus, the location, commercial history, and physical structure of the study area motivate its potentially competing future uses as multi-modal transport hub, restored wetland habitat and passive recreation area. The study area's commercial transport function will have to combine with its use for passive recreation and both of these uses must combine with restoration of tidal flow, restoration of habitat and reintroduction of plant and animal species. Harmonizing these potentially competing uses for successful achievement of divergent goals is an important part of the study area restoration plan.

STAKEHOLDER INVOLVEMENT

Because of its location, history and potential uses, the study area attracts a relatively greater number of stakeholders and degree of stakeholder attention. Government and private stakeholder interests may already have plans or goals that implicate the study area or its restoration efforts. This restoration plan recommends a careful vetting and stakeholder inclusion process that informs stakeholders, elicits their input, strives to balance competing viewpoints and aims to bond with potential partners.

The identified stakeholders can be roughly categorized into four groups: 1) those expressing plans for projects that would physically approach or overlay the study area; 2) those expressing a localized interest in an aspect of the restoration, such as wetlands or public access generally; 3) those whose physical proximity invokes a need for communication regarding planned operations or changes; and, 4) local or specialized media outlets.

Several of these stakeholders are interrelated, such that an approach to one implicates an approach to another. Oftentimes, these stakeholders envision similar – but partially conflicting – projects for the Raritan River or its waterfront. The projects may themselves be complementary or competitive and may or may not be in accordance with the proposed restoration of this study area. The recommendation for implementation of the study area concept plan is to update this plan as presented with information resulting from a dialogue with sponsoring organizations, in particular with those whose plans or goals could support eventual public-private, or non-profit/for-profit partnerships.

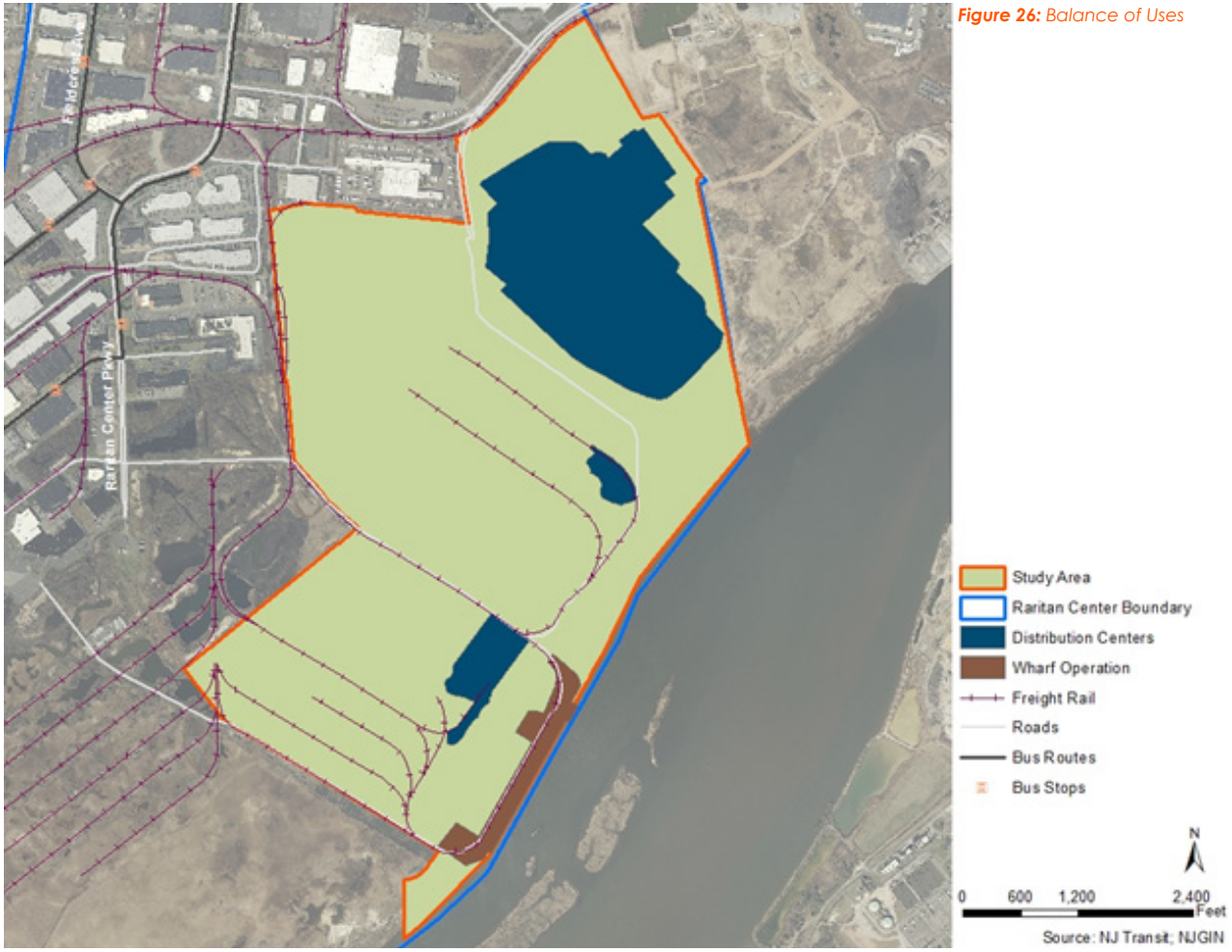


Figure 26: *Balance of Uses*

1) Stakeholders with plans that physically approach or overlay the study area

This is the largest group of stakeholders and comprises governmental and non-governmental entities. These stakeholders have published redevelopment plans for or near the study area or plans for active or passive recreation, including public access through the study area. Members of this group include:

- **Edison Township Planning Board and Edison Open Space Advisory Committee**

The committee drafted a plan for the former Arsenal site envisioning a seaport village with significant open space and public access to the Raritan River. In addition, the Conservation Element of Edison's Master Plan includes goals that implicate habitat restoration of and public access to the study area.

- **Edison Greenways Group, Inc.**

This is a private non-profit group funded by a grant from the New Jersey Conservation Foundation that worked with Edison Township and its Open Space Advisory Committee in creating plans that include public access trails through the study area. Three of its board members hold seats on the Open Space Advisory Committee.

- **Woodbridge Township Planning Board, Woodbridge Redevelopment Agency, and Brownfield Development Area Steering Committee, EPEC Polymers, Inc. and Competitive Power Ventures**

These entities are involved in remediation and redevelopment of the Keasbey Redevelopment Zone, including industrial redevelopment, wetlands restoration and waterfront park development on the neighboring EPEC Polymers, Inc. site. The eastern portion of the study area also falls within the Keasbey Redevelopment Zone.

- **Middlesex County Planning Board, Middlesex County Improvement Authority and Middlesex County Planning Department, Transportation Division**

Through their Raritan River Case Study (Middlesex, 1995; Woodbridge 2008), the County Planning Board and Improvement Authority have recommended residential development, public access, landfill remediation and public transportation improvements that could harmonize with the goals of the study area restoration. The Transportation Division of the County Planning Department authored the Middlesex County Bicycle Pedestrian Plan, with trails proposed near and through the study area.

2) Stakeholders with a localized interest in an aspect of the study area restoration, such as wetlands habitat restoration, remediation or public access

- **NY/NJ Baykeeper**

This private, non-profit corporation was founded in 1989, with assistance from the Hudson Riverkeeper organization and the American Littoral Society, as a "citizen-guardian" of the Hudson-Raritan Estuary. Its Raritan Riverkeeper program "pursues opportunities for land preservation and habitat restoration, and partners with other groups to advocate for the Raritan River's environmental importance, as well as its value as a recreational and cultural resource" (www.nynjbaykeeper.org). NY/NJ Baykeeper conducts several legal advocacy programs, the most relevant being its advocacy campaigns for public access and green infrastructure.

- **Edison Wetlands Association**

A private, non-profit organization founded in 1989 with an initial mission of promoting environmental cleanup and restoration of properties in Edison. Its mission has significantly expanded since then and it currently has several projects, including a Raritan River Project (www.BlueRaritan.org), a blog titled "Wild New Jersey", and a Brownfields to Greenfields project. Its Raritan River Project was founded in 1991 and conducts advocacy and communication campaigns on issues affecting clean-up and recreational use of the Raritan River. The Edison Wetlands Association participates in wetlands restoration at the EPEC Polymers, Inc. site.

- **Sustainable Raritan River Collaborative**

A joint project of Rutgers University staff and non-university affiliated environmentalists founded in 2009 to facilitate the collaborative work of a network of organizations and agencies in the Raritan River region to restore the Raritan River and "promote the integration of sound planning and a vision for the Raritan River region that balances social, economic and environmental

objectives" (www.raritan.rutgers.edu). The Collaborative is facilitated by Rutgers University as the Sustainable Raritan River Initiative.

- **NJ Audubon Society**

This private, non-profit entity currently uses the study area for bird watching expeditions on an occasional basis. The Society may find the concept plan's vision for restored habitat and enhanced bird watching facilities favorable.

- **US Army Corps of Engineers**

USACE has an interest in the study area in two primary ways. First, its Formerly Used Defense Sites program conducts investigation and remediation of areas within and around the study area that were contaminated through operations at the former Arsenal. Second, through the Rivers & Harbors Act and the Clean Water Act, USACE's jurisdiction may include the study area because it borders a navigable waterway.

- **New Jersey Department of Environmental Protection**

The NJDEP has permitting jurisdiction with respect to New Jersey wetlands.

- **The Port Authority of New York and New Jersey**

This quasi-governmental entity sponsors the Hudson Raritan Estuary Resources Program (HRERP) as part of its sustainability initiatives. Within a comprehensive plan for site acquisition decisions, the Port Authority has identified the Red Root Creek area as a priority acquisition and restoration site. The HRERP program is funded through the Port Authority's 10-year capital plan.

3) Stakeholders whose physical proximity invokes a need for communication regarding planned operations or changes

- **Middlesex County Utilities Authority**

This public entity operates a sewage pumping station at the foot of the study area on the bank of the River.

- **EPEC Polymers, Inc. and Cooperative Power Ventures**

These privately owned entities are the study area's immediate neighbors to the northeast, where a Keasbey Redevelopment Zone area has been remediated and is being redeveloped as part-industrial/part-restored-wetland and public open space, with public access to the River. The Woodbridge Redevelopment Agency and Brownfield Development Area Steering Committee cooperate in the redevelopment, as does the NJDEP's Brownfield Development Area Manager. The Edison Wetlands Association also participates in this endeavor.

- **STC Marine, LLC**

This private for-profit entity operates a pipe-assembly/pipe-welding operation at the wharf area and uses the wharf area to ship the assembled pipe by barge. This tenant would be surrounded by any restoration efforts and its motor-vehicle transport operations will cross through the study area on a frequent and regular basis.

- **Raritan Center tenants**

The distribution properties utilized by Wakefern and FedEx lie within the study area and these companies may have interest in contributing to the restoration effort. The tenant at 100 Blue Heron Way occupies the property closest to the study area's northern boundary. One of the study area conditions is the proximity of the employees of Raritan Center as a target audience for potential public access amenities.

4) Local or specialized media outlets, in addition to local newspapers

- **New Green Media (www.newgreenmedia.tv; info@newgreenmedia.tv)**

New Green Media is a blog related to Edison Wetlands Association and self-described as a "clearinghouse for green, sustainable, and environmental news across New Jersey."

- **News 12 New Jersey (news12nj@news12.com)**

New 12 NJ is a 24-hour local news service, exclusive to subscribers of Optimum Television, Xfinity, Time-Warner and Service Electric, that was launched in 1986. Its parent media company, News 12 Networks, is a regional news provider that has won 21 New York Emmy Awards, 42 New Jersey Society of Professional Journalists Awards and 6 Edward R. Murrow awards.

- **Wild New Jersey (www.wildnewjersey.tv)**

Wild New Jersey is a blog related to Edison Wetlands Association that reports on environmental issues as they relate to New Jersey's wildlife.

VISION FOR RED ROOT CREEK

Based on a comprehensive analysis of the current site conditions and perceived opportunities and constraints, seven distinct, yet integrated and mutually supportive restoration goals have been identified for the site. The goals span ecological, social and economic considerations typical of a sustainable planning framework and include:

1. Enhancing wetland ecosystem services provided to the Raritan Center, including storm surge protection, flood control and stormwater treatment
2. Enhancing the biological diversity and quality of the wetland system on a species and habitat level
3. Restoring the system to a state more resilient to sea level rise in the long term and storm surge events in the nearer term
4. Enabling long-term wetland research and monitoring opportunities on the site
5. Providing managed public access to the restored wetland for targeted audiences to promote awareness and enhance community and tenant relations
6. Capturing natural, societal, educational and economic value from the restored wetland
7. Creating a demonstration project that can be replicated elsewhere

The seven goals have directly guided the development of the concept plan presented on the following pages. Table 6 briefly introduces how the goals are expressed within the restoration plan to demonstrate the relationship between them.

Goal	Expression in Restoration Plan
Enhancing wetland ecosystem services provided to the Raritan Center, including storm surge protection, flood control and stormwater treatment	Hardening of wetland edges through increased vegetation or enhanced landforms
	Inclusion of green infrastructure throughout Raritan Center to reduce stormwater runoff
	Use of existing and additional freshwater wetland areas to retain and treat stormwater runoff
Enhancing the biological diversity and quality of the wetland system on a species and habitat level	Utilization of existing topographic variation and system of berms and water control devices to regulate water levels and create different habitat zones
	Encouragement of different vegetative communities in the various habitat zones
Restoring the system to a state more resilient to sea level rise in the long term and storm surge events in the nearer term	Restoration primarily via reintroduction of a tidal system except for the existing restored freshwater area and an additional stormwater wetland
Enabling long-term wetland research and monitoring opportunities on the site	Development of partnerships with local and regional colleges and universities and other research institutions/centers
Providing managed public access to the restored wetland for targeted audiences to promote awareness and enhance community and tenant relations	Development of a system of controlled boardwalks and lookout points in strategic locations that do not conflict with other site uses
	Partnerships with local schools, government agencies, community groups and environmental non-governmental organizations
	Provision of scheduled guided tours
Capturing natural, societal, educational and economic value from the restored wetland	Designed opportunities for restored wetland to provide enhanced ecosystem services to Raritan Center
	Designed ecotourism opportunities (through public access facilities)
	Designed greening and "eco-tenant" opportunities
Creating a demonstration project that can be replicated elsewhere	Recommendations for careful documentation and public availability of the plan implementation and ongoing monitoring/research results

Table 6: *Summary of Plan Goals and Expression in Concept Plan*

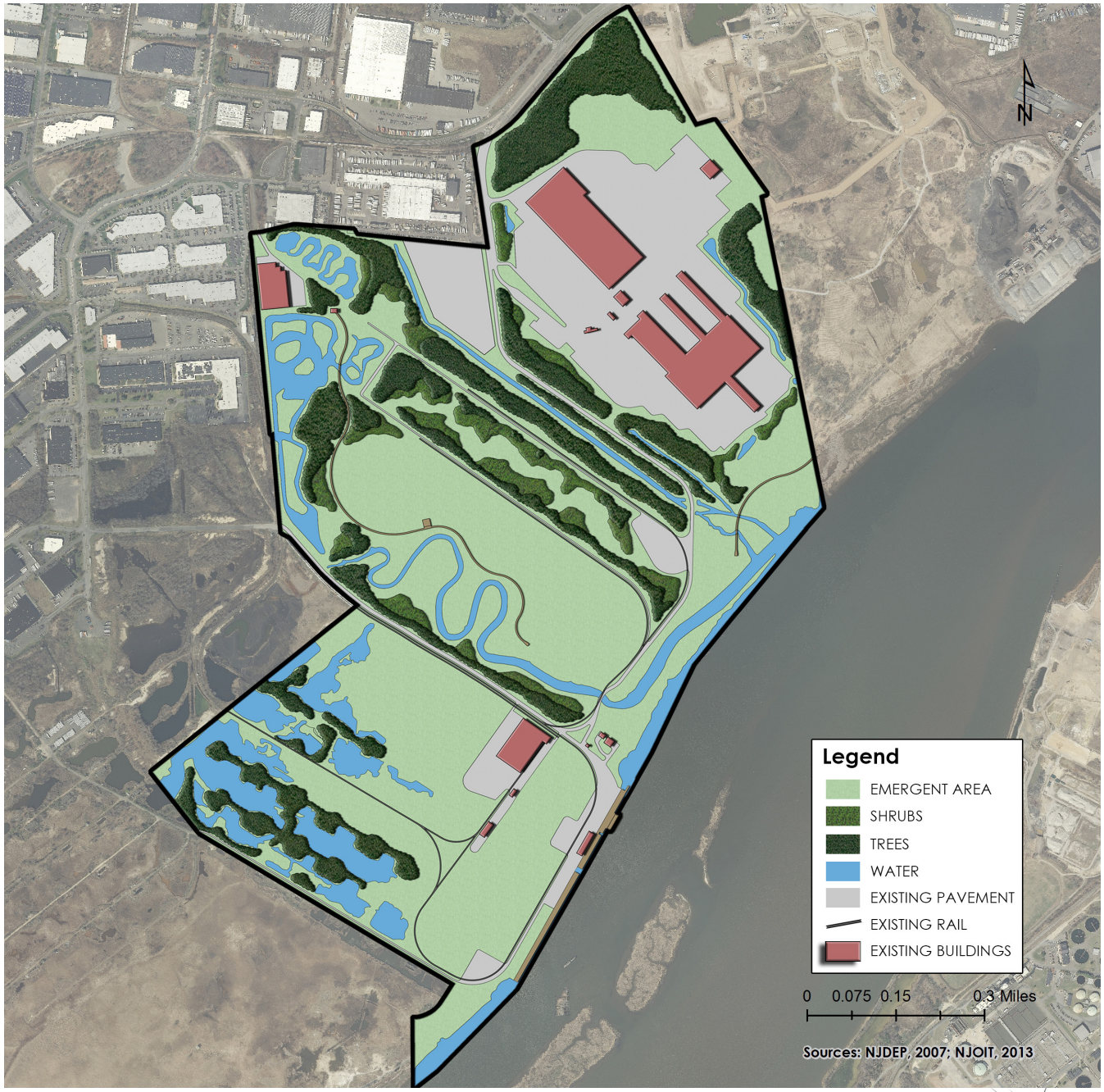
DESIGN CONCEPT

The design vision for the study area seeks to create a mosaic of high quality wetland habitats for native flora and fauna while providing an opportunity for managed public access. A fundamental element of the vision is to return the wetlands to their natural trajectory by restoring the majority of the site to tidal wetlands. This requires the removal of the tide gate to allow brackish water from the Raritan River to regularly interact with the wetlands on the site. Additionally, the internal culverts will be modified and used to manipulate water levels, increasing the diversity of our habitats.

The design vision for the study area seeks to create a mosaic of high quality wetland habitats for native flora and fauna while providing an opportunity for managed public access. A fundamental element of the vision is to return the wetlands to their natural trajectory by restoring the majority of the site to tidal wetlands. This requires the removal of the tide gate to allow brackish water from the Raritan River to regularly interact with the wetlands on the site. Additionally, the internal culverts will be modified and used to manipulate water levels, increasing the diversity of our habitats.

The removal of the tide gate is essential to a tidal restoration, but the design is sensitive to the vast investment in the development neighboring the tidal wetlands, and it includes increased vegetation and enhanced landforms that would increase the resiliency of the Raritan Center industrial park. Further hardening of edges and modification of berms and landforms could be undertaken to offer additional protection from flooding and storm surges.

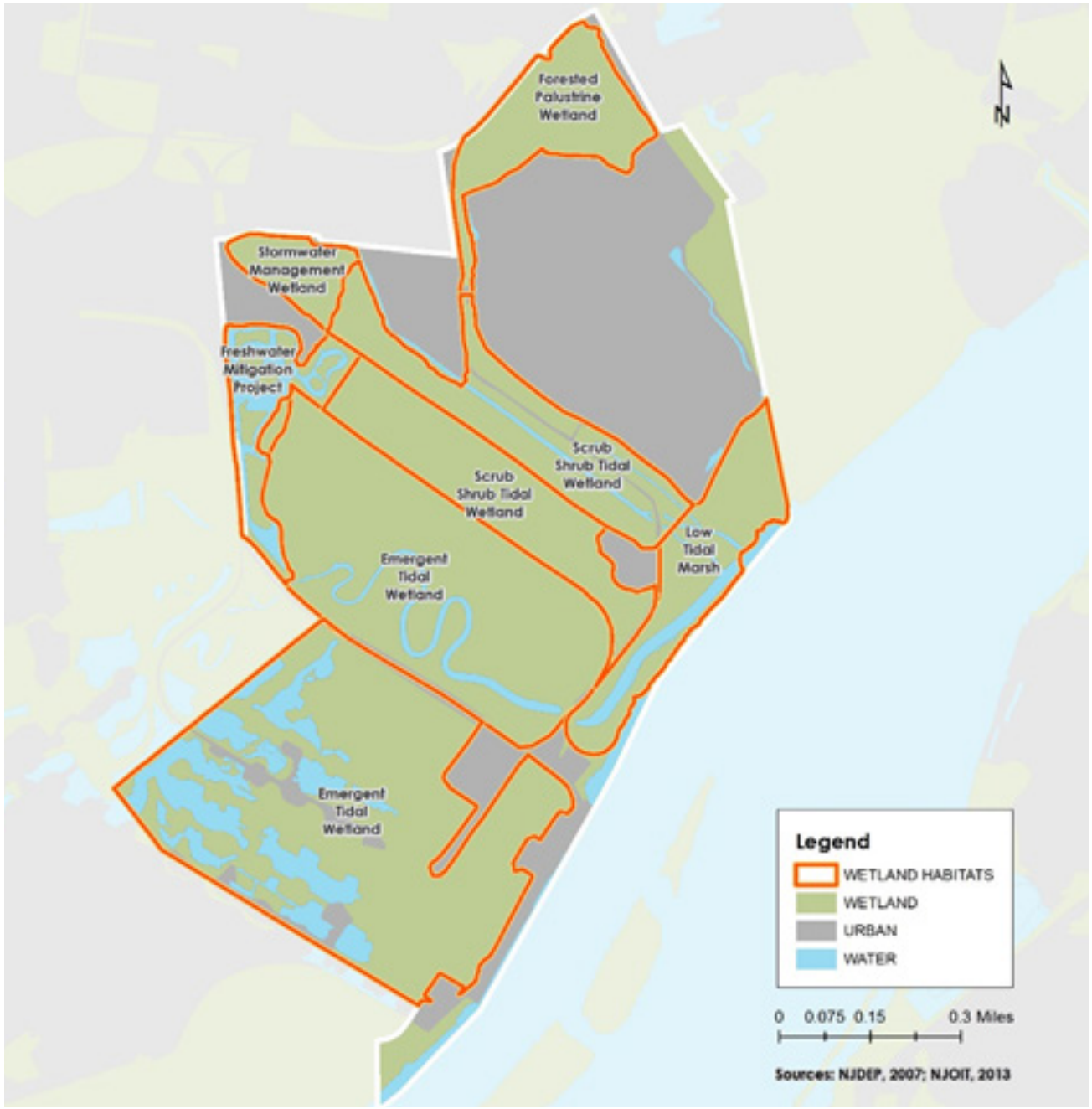
Figure 27: *Illustrative Aerial of Concept Design*



CREATING A MOSAIC OF HABITATS

Divisions caused by man-made and natural barriers within the study area present an ideal environment for a mosaic of distinct habitats, rather than one continuous and uniform wetland. For the most part, the study area's elevation is between sea level and 6 feet above sea level, but there are berms, uplands, and elevated roads and railroads that divide the site and allow for a low tidal marsh adjacent to the Raritan River, two habitats for emergent tidal wetlands, two scrub shrub tidal wetlands, a freshwater stormwater management wetland, a freshwater forested wetland, and the preservation of the existing freshwater wetland mitigation project.

Figure 28: *Concept Diagram*



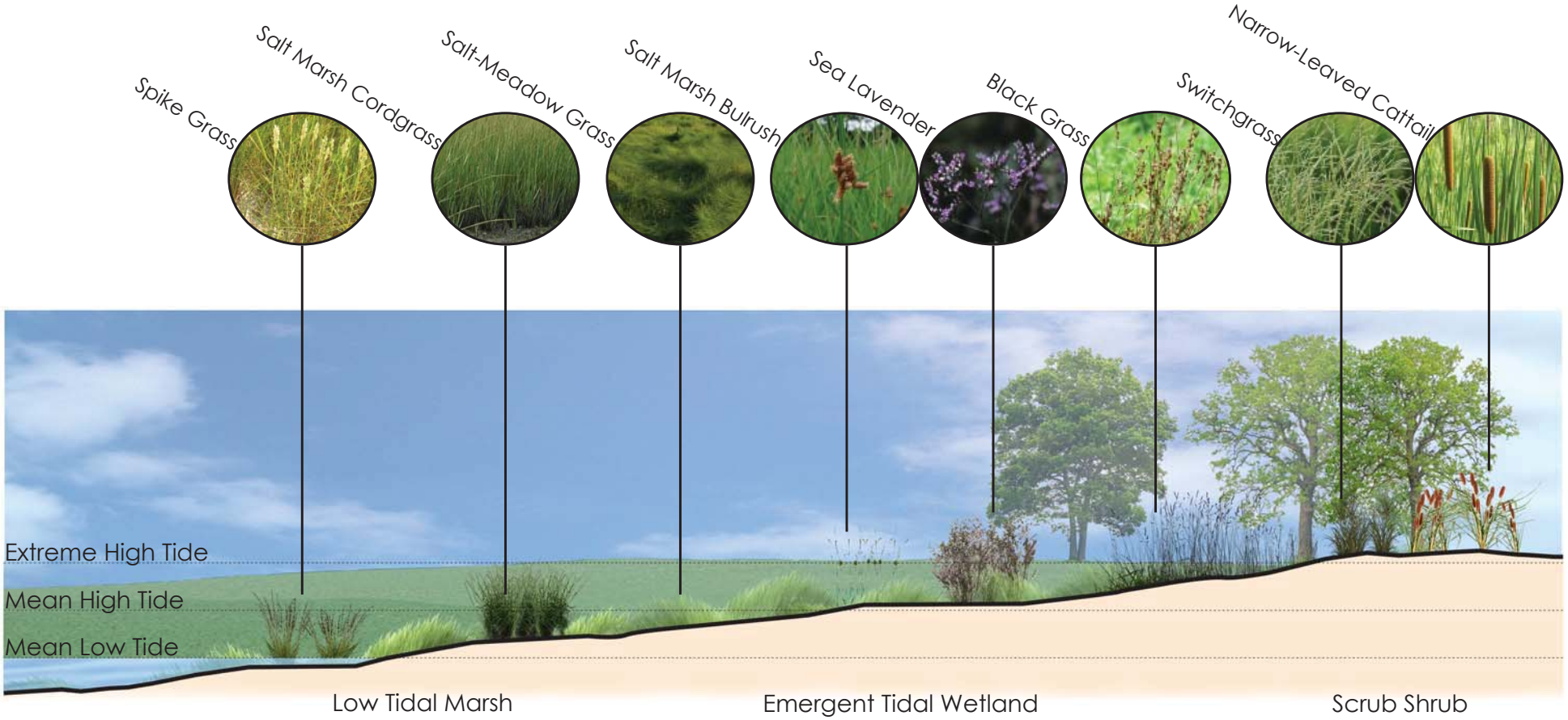


Figure 29: *Tidal Wetland Flora Cross-Section*

FRESHWATER WETLANDS

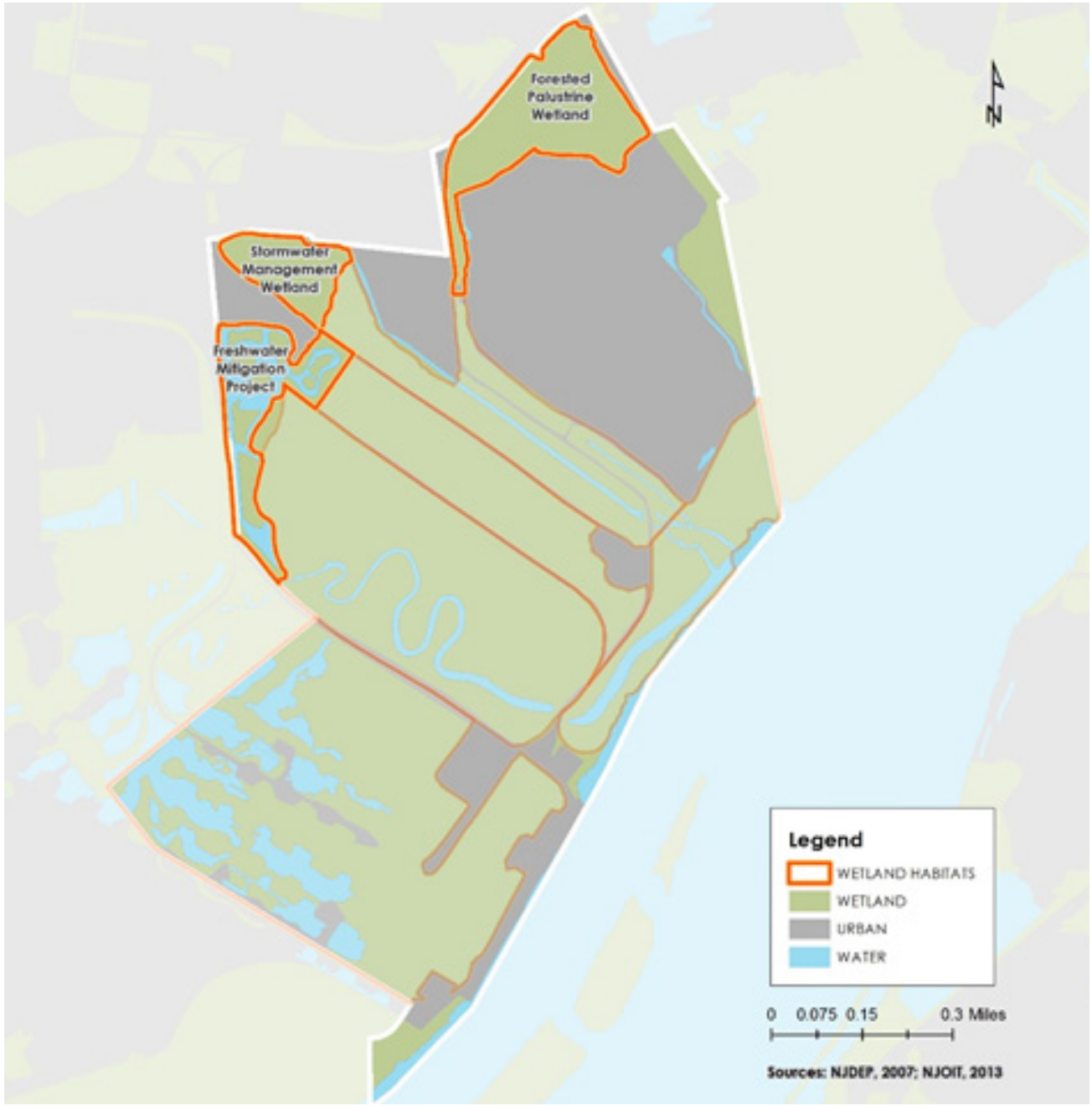
The sites that are the farthest inland and closest to the impacts of the existing development will remain as freshwater wetlands.

The freshwater wetland mitigation area was created to offset development impacts from the Raritan Center. It acts largely as a stormwater management wetland that collects and releases the adjacent development's stormwater into Red Root Creek, which flows into the Raritan River. The restoration plan recommends the preservation of this wetland, which is already isolated from adjacent wetland habitats by its surrounding uplands.

The concept design suggests the creation of an additional stormwater management wetland to the northeast of the freshwater wetland mitigation area to provide additional management and treatment for the Raritan Center's stormwater. This wetland would treat and then funnel water into Black Ditch, which also flows out into the Raritan River.

In the Northeast section of the study area, there is an existing Palustrine Forested Wetland. The concept design recommends that preservation and enhancement of these existing Palustrine Forested Wetlands.

Figure 30: *Freshwater Wetland Areas*



TIDAL WETLANDS

Closer to the river, the lower elevation and proximity to the brackish water of the Raritan River create an environment suitable for tidal wetlands. In the northern portion of the study area, bordering the Raritan River, there is a living shoreline that is subject to moving water, persistent flooding, and the highest level of salinity. It is categorized as a low tidal marsh, and while this plan would not substantially alter this habitat's identity, the establishment of a community of native emergent flora dominated by spartina alterniflora is recommended.

Figure 31: *Low Tidal Marsh*

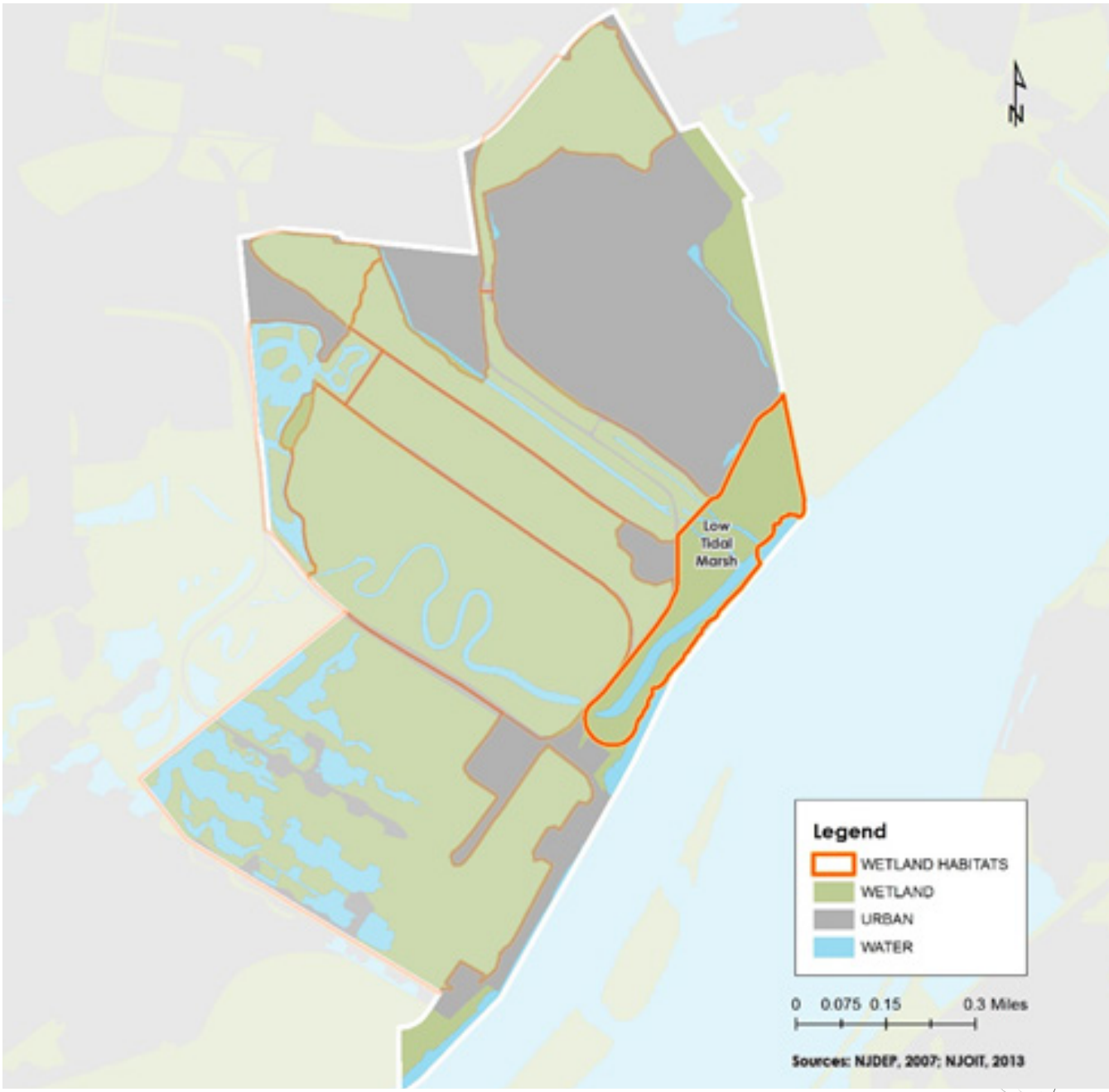


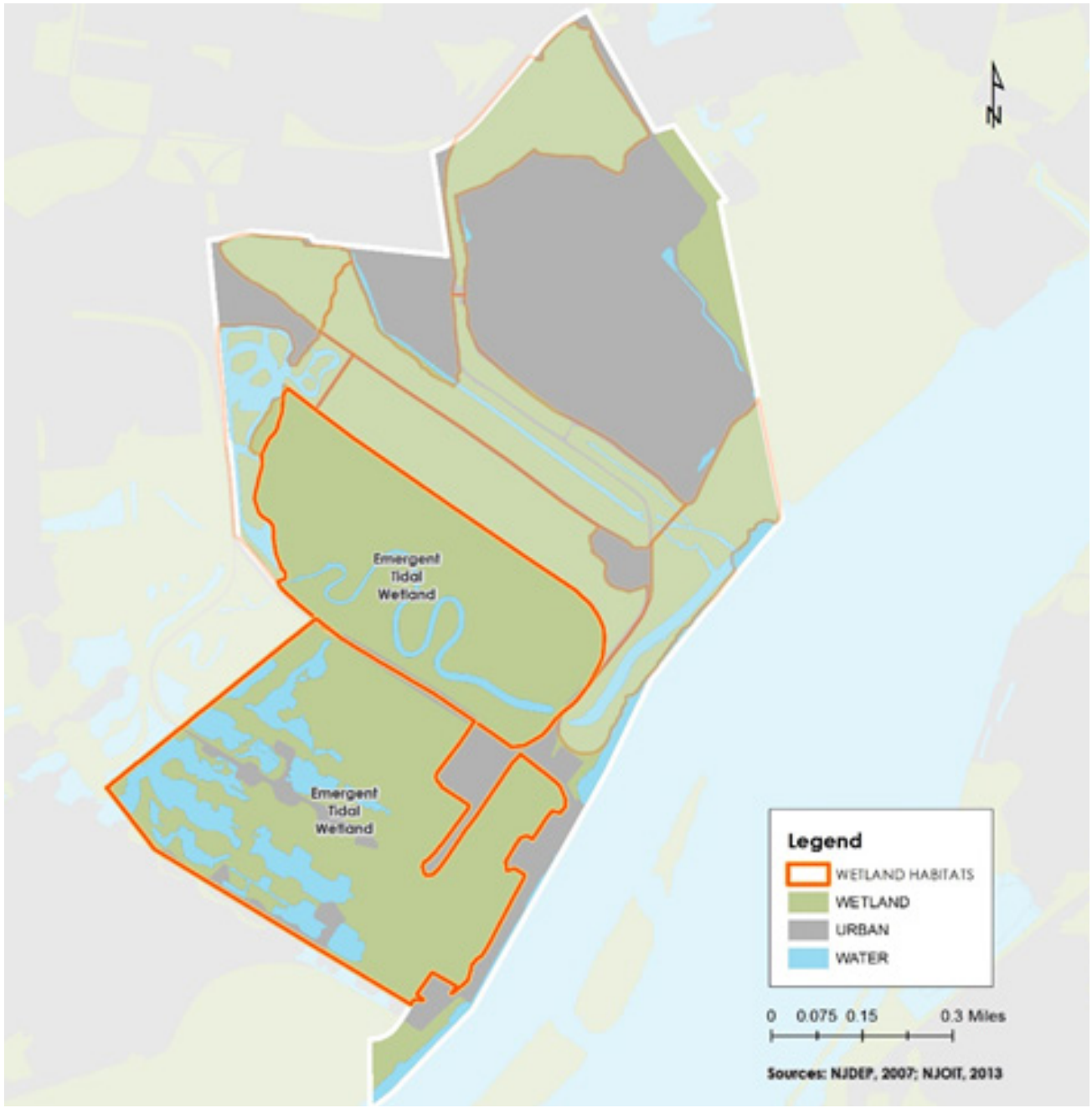
Figure 32: *Spartina Alterniflora*
Source: *www.nps.gov*

The next two areas farther inland are higher in elevation and are subject to a lower degree of flooding, making them suitable for emergent tidal wetlands dominated by erect, herbaceous (rather than woody) wetland plants. While the flora composition would most likely be dominated by spartina alterniflora, these habitats would have more potential to support species like glasswort and fleabane in addition to some denser shrubs that could take root on the uplands and berms.

Figure 34: *Glasswort*
Source: *www.commons.wikipedia.org*

Figure 35: *Fleabane*
Source: *www.newfs.s3.amazonaws.com*

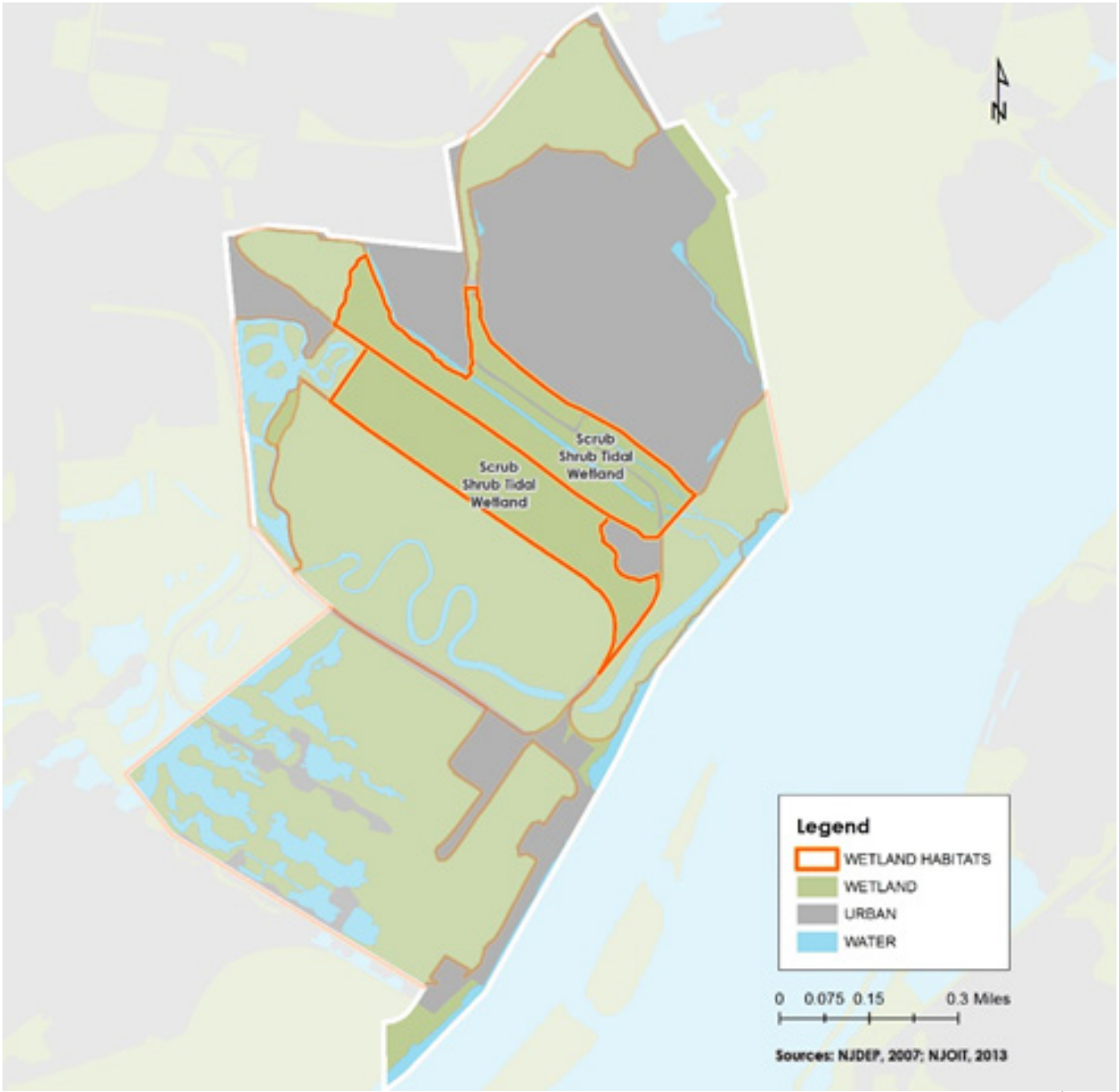
Figure 33: *Emergent Tidal Wetlands*



To the north of the Emergent Tidal Wetlands are two scrub shrub tidal wetlands. These areas are higher in elevation and can support larger communities of forbs and shrubs, in addition to native grasses. The northern scrub shrub wetland is slightly higher in elevation than the southern scrub shrub wetland and could support modest tree growth. Bayberry, Sea Myrtle, and Sea Lavender are a few examples of flora that could inhabit this area. Developing a dense understory layer in these scrub shrub wetlands will create a significant vegetative buffer between the entire study area and the FedEx/Wakefern development areas. This buffer will provide a visual separation between the two uses, increasing the aesthetic value within the study area. In addition, the buffer will also provide resiliency benefits for the developed areas, as the increased vegetation can buffer the development from wave action and flooding and provide erosion control.

Figure 37: *Sea Myrtle*

Figure 36: *Scrub Shrub Wetlands*



PUBLIC ACCESS AND AMENITIES

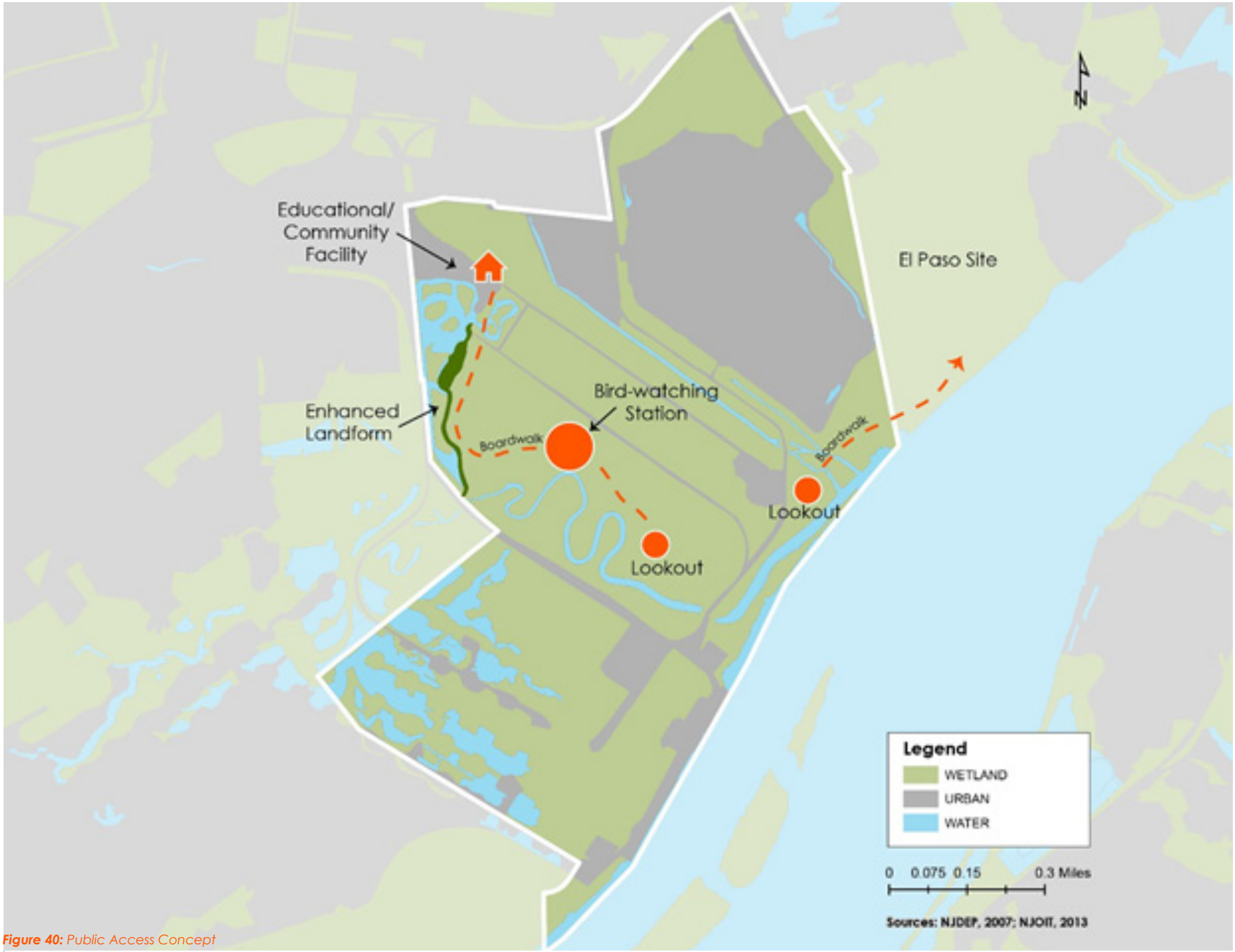


Figure 40: *Public Access Concept*

Education Center

Creating an on-site education center overlooking the wetlands would be an excellent way to connect the public with the restored wetlands. It could also serve as a gathering space for researchers and tenants and employees of the industrial park. This plan locates the center on an undeveloped upland near roads, parking and existing infrastructure that would allow the public to easily and safely view the wetland habitats while minimizing disturbance and cost. This space would connect directly to a boardwalk, which would guide public access further into the wetlands.

Figure 41: *Education Center Aerial*

Figure 42: *Education Center Reference Images*
Sources: *www.womansday.com, www.wetlandcenter.com, www.imamuseum.org*

Figure 47: *Bird-watching Station Aerial*

Figure 48: *Bird-watching Reference Images*
Sources: *www.toledoblade.com, www.cartinafinland.fi, www.nikdaum.com/news/dfw143.jpg*

Bird-Watching

As the study area is already a bird-watching destination used by multiple groups including the Audubon society, the restoration plan should enhance the bird-watching experience by creating a bird-watching station. Locating the station along the central boardwalk would be ideal, and a multi-level structure could provide opportunities to view wading, nesting and soaring birds. Bird-blinds could also be installed on the upland areas near the education center.

Boardwalks and Lookouts

The installation of boardwalks is essential to providing managed public access to the study area. Structurally, boardwalks solve some of the study area's issues of providing safe public access on a site with active rail lines and freight trucks, as it constrains the pedestrian route. In addition, the elevation of the boardwalk will make it resilient to storm surges and flooding. Interpretive signage can be located along the railings.

This plan recommends two separate boardwalks—one connecting the study area to the neighboring EPEC restoration site to the north, and the other running through the study area along the red root creek. Due to active rail lines, it is impossible at this time to connect the boardwalk in a continuous loop, but the points of termination on each boardwalk will offer unique vistas of the Raritan River and the restored wetlands. These lookouts provide additional opportunities for the installation of high-visibility, educational signage.

Figure 43: *Boardwalk Aerial*

Figure 44: *Boardwalk Reference Images*
Sources: *www.ballardnaturecenter.org, www.americantrails.org, www.rhorii.com*

Figure 45: *Lookout Aerial*

Figure 46: *Lookout Reference Images*
Sources: *www.flickr.com, www.panoramio.org, www.asla.org*

HAZARD MITIGATION

Freshwater Wetland Protection

The plan for hardening begins with strengthening and enhancing the existing berm protecting the previously restored freshwater wetland area in the north-central portion of the study area. As Superstorm Sandy has shown, the existing berm provides insufficient protection to this wetland, with salt water intrusion damaging the freshwater system. Thus, it is recommended to further stabilize and enhance the berm, with one possible solution being the driving in of sheet metal pilings seaward of the restored wetlands, providing additional erosion stabilization and another means to reduce potential wave action impact. Next, a higher berm could possibly be built up over and around the sheet metal pilings, to a level higher than the 500-year storm elevation. An additional hardening recommendation would be to consider additional sheet piling and berms or simply more robust vegetation around the perimeter of the study area as a provision of extra protection from future storm events.

Building Adaptation Measures

Additional steps can be taken to prevent damage to Raritan Center facilities and surrounding areas. The emergency plan for Raritan Center and the individual buildings should include procedures to be implemented prior to a major storm's landfall. These plans should include moving any equipment that can be moved, such as trailers and rail cars, from the most vulnerable areas of Raritan Center, as well as elevating key equipment and inventory in vulnerable buildings, and securing objects that cannot be moved.

The utilities in such vulnerable buildings should be raised as high as possible during future building renovations. Outlets should not be close to the floor in the ground level of potentially vulnerable buildings, nor should HVAC systems and other mechanical equipment be located on the ground. An additional prudent measure would be to take inventory of current wall surface types and investigate alternatives as concrete typically performs well after coming in contact with flood waters, while drywall needs to be replaced. Flood barriers can be installed onto vulnerable buildings in another attempt to reduce flood impacts. Relatively minor steps such as these can make a significant difference in a building's ability to withstand a major flooding event versus the transverse of a major catastrophe that causes a loss in productivity and rental income.

THE GREENING OF RARITAN CENTER

In addition to increasing resiliency of the wetland and Raritan Center facilities, FBC can adopt various green engineering strategies as one measure to rebrand Raritan Center as an eco-business park. Such "green business parks" reduce environmental impacts, maximize asset value, and ensure occupant satisfaction. Table 7 identifies recommended strategies to realize environmental, economic, and social benefits. The first recommendation would be to focus on strategies to create more efficiency throughout the site when building or retrofitting to lower operating costs with resource efficiency in energy, materials, and water. This could attract tenants seeking healthier and cleaner indoor environmental quality. The second green office park strategy is the integration of nature into the center by adopting low impact development (LID), commonly referred to green infrastructure, which improves water quality, reduces costly flooding events, and provides or restores habitat areas for flora and fauna. At the community level, green infrastructure provides cooperative education and volunteer opportunities that can improve community relations, demonstrate FBC's commitment to sustainability, and increase its reputation as stewards of environment. Lastly, the connectivity approach seeks to derive benefits from co-location and industrial symbiosis opportunities that can enhance the inter-industry or intra-industry cooperation. Lastly, there are additional strategies that could be adopted focusing on increasing and optimizing physical connectivity in order to provide healthy, affordable, modal options (pedestrian, bicycle, transit and auto) for users of the Raritan Center and visitors.

FBC can use these concepts and strategies to create a sustainable workplace, demonstrate commitment to sustainability and increase FBC's reputation while reducing operating costs, energy use, and environmental impacts. The criteria used for identifying benefits to FBC and its tenants from greening the site and restoring the wetland environment is the US Green Building Council's Leadership in Energy & Environmental Design (LEED) categories broken down into; sustainable sites, water efficiency, energy & atmosphere, materials & resources, and indoor air quality. The application of green office park concepts provides multiple opportunities to reduce environmental impacts while capturing both economic and social benefits at the FBC.

	Efficient Site	Integration with Nature	Connectivity
Building	Retrofit existing buildings, Build new high performance buildings, Obtain LEED certification	Green Sites	Co-location, Industrial Symbiosis
Infrastructure	Install renewable energy (on-site renewable resources), Incorporate co-generation	Green Infrastructure	Boulevard Streets, Bike/Walking Trails
Community Program	Implement zero-waste program, waste exchange program	Cooperative Education; Volunteer & Community Program, Open Space Preservation	Car & Bike Sharing, Shared commuting, Shared Shipping, Intra-park Transportation

Table 7: *Recommended Strategies Matrix for Greening Raritan Center*

Sustainable Site

Within LEED's sustainable site category recommendations, FBC can encourage the use of public transportation and take advantage of the neighboring Edison Park and a wetland boardwalk walking trail to promote a healthy lifestyle by enabling walking and biking. The environmental, economic, and social benefits are reducing carbon emissions with fewer vehicle miles traveled, reduced expense for vehicle maintenance and repair, and improved health from walking and biking.

Water Efficiency

The smart use of water to increase efficiency can be achieved through various initiatives such as installing a high efficient fixtures in restrooms and kitchens, water-efficient irrigation systems, water reuse/recycling systems in the areas of Raritan Center that are already developed. Information about these systems can be disseminated through tenant informational and educational programs to increase awareness of the water management plan and educate tenants on smart water use practice. The environmental, economic, and social benefits are reduced water usage, reduced water bills, less pollution to the wetland area due to reduced stormwater runoff and improved knowledge on efficient use of water both inside and outside Raritan Center.

Green Lease Fundamentals

To complement the environmental stewardship that FBC is demonstrating with its effort to restore wetlands and habitat within Raritan Center, it can also adopt green provisions within its standard leasing agreements to implement sustainability and resiliency goals throughout the entire site. These provisions could focus on incentivizing energy and water conservation within the bricks and mortar of each building but also the continued operations, maintenance and management of such structures by way of differing utility charges, metering and monitoring activity and other environmental controls (i.e., temperature ranges).

To better illustrate how FBC can adopt such green features, one example from each of the three approaches is provided below in greater detail.

Efficient Site Approach

A 250,000 square feet Oatey Distribution Center in Cleveland, Ohio is not a typical warehouse. It has been retrofitted with many green features that reduce operating cost, improve environment and provide high quality indoor environment to occupants of the building (NAIOP, 2005). The building that occupies 60% of a 10-acre site incorporates a stormwater pollution prevention plan that protects adjacent wetlands. It is also working with the Wildlife Habitat Council to increase the wildlife on wetland and adopt an educational resource center. To improve its air quality, it uses low VOC adhesives, paints, and carpets, and installed a building automation system that monitors and controls carbon dioxide, temperature and humidity levels. To improve water efficiency, gray water collection and reuse green strategies were adopted that reduced demand for process municipal water by more than 50 percent. Photovoltaic panels are used to power automated access gates and a building automation system monitors and reduces energy consumption by about 40%.

Integration with Nature Approach

Strategies that integrate nature at Raritan Center include adopting LID and green infrastructure, which in turn can bring opportunities for a cooperative education experience, volunteer and community activities, and an open space preservation program. Although both of these strategies are often used interchangeably, there is a subtle difference between the two. LID is an approach to land development practice that reduces impacts on water resources through the use of stormwater management practices that infiltrate, evapotranspirate, or harvest and use stormwater where it falls at the site-level (EPA, 2013); whereas, green infrastructure generally encompasses a broader area of a community or watershed. It refers to an "interconnected network of green space that conserves natural systems and provides assorted benefits to human populations" (Rutgers, 2013). Forests, meadows and floodplains are examples of natural green infrastructure and green roofs, rain gardens and rainwater cisterns are examples of man-made green infrastructure (EPA, 2013). Both LID and green infrastructure can reduce costs by reducing energy needs by insulating surfaces in cooler months and providing evaporative cooling in hotter months. Also, rainwater harvesting provides a local source of water preventing the use of potable water which requires an energy intensive treatment process. Other benefits are improved human health by reduction of flooding incidences and combined sewer overflows (CSO), improved aesthetics, better air quality, and increased property values.

Table 8 summarizes the results of studies that compared construction costs using LID vs. conventional stormwater controls for commercial developments that demonstrates how small increases in capital upfront are recouped through life cycle savings in the long-term.

Table 8: *Examples of Cost Savings from Installation of LID in Commercial Developments*
Source: *EcoNorthwest (2009) www.econw.com*

Location	Description	LID Cost Savings
270 Corporate Office Park Germantown, MD	12.8-acre site redesigned to eliminate pipe and pond stormwater system, reduce impervious surface, added bioretention islands, swales, and grid pavers.	$27,900 $2,180/acre
Light Industrial Parking Lot Portland, OR	2-acre site incorporated bioswales into the design, and reduced piping and catch basin infrastructure.	$11,247 $5,623/acre
Office Warehouse Lexana, KS	Reduced impervious surfaces, reduced storm sewer and catch basins, reduced land cost, added bioswales and native plantings.	$317,483

Connectivity

Connectivity approach seeks to derive benefits from co-location or inter-industry or intra-industry cooperation. The concept involves a network of firms that exchange or share resources (materials, water, energy, infrastructure, natural habitat and information) to improve economic performance while improving the environment. It results in reduced costs for disposal while gaining value from the "waste" and shared infrastructure. Also, connectivity approach at the infrastructure level aims to increase access and mobility by providing clean and affordable transportation options. It can be achieved by providing bicycle racks, employee shower/changing facilities, covered bus shelters or waiting areas, pleasant, safe and accessible walkways, and preferred parking for carpools. At the community program level, launching a car & bike sharing, shared commuting & shipping, and intra-park transportation can encourage transportation alternatives for employees and visitors while reducing transportation costs and emissions.

The case study below illustrates savings and profits of establishing an eco-business park.

Case Study - *Kalundborg, Denmark*

Industrial symbiosis refers to a special relationship where outputs of one industrial process is used as inputs of another process, a metaphor of mutual beneficial relationship among creatures. One of the well-known industrial symbiosis comes from Kalundborg, Denmark, where a web of energy, water, wastes and information exchange occurs among industrial firms, agricultural farmland, local administration and residents. The motivation of clustering various industries at Kalundborg was attributed to cost reduction and by-product exchange. Gradually, environmental and economic benefits were generated. For example, the use of the excess heat from Asnaes Power Station for household heating has eliminated the need for about 3,500 oil-burning domestic heating systems. Since the first connection arose in 1973, 16 contracts had been negotiated by 1994. The extent of the material and energy exchanges in 1995 was about 3 million tonnes a year, an equivalent of US $10 million a year. The core tenants are: oil refinery, coal-fired power station, pharmaceutical, and biotechnical industry. Throughout decades' trial and error, Kalundborg has evolved to an ecological urbanized area that integrate industrial, commercial and residential sectors, an ideal situation as described in New Urbanism.


VALUE
CAPTURE

An integral part of the concept plan is to recognize and understand the additional benefits flowing from restoring the natural resources of the study area to showcase FBC's restoration initiative and demonstrate the natural, societal, educational and economic benefits of wetland and habitat restoration for the surrounding area. This valuation of natural capital is identified by many environmentally conscious organizations as the recognition of the services and goods from nature that are essential for human life (Natural Capital Project, 2013).

There are many ways in which valuation can be done. Experts generally have used two approaches for valuing natural capital. The first is to focus on ecosystem services that benefit people based upon their behavior and choices and thus to estimate values of ecosystem services broken down by use (i.e. recreation and drinking water) and nonuse (general existence of species and wilderness) services. The second approach looks at ecosystem services that benefit natural, ecological systems (Dunford, 2007).

Valuation can also be done on an acreage basis as was done by New Jersey Department of Environmental Protection in 2007 when they conducted a study that valued the natural capital within the entire state of New Jersey. This process values not only ecosystem services as functions of nature that can be enjoyed by and benefit humans, flora and fauna, but also ecosystem goods, which are tangible commodities such as agricultural goods (NJDEP, 2007).

One can also attempt to value natural capital by avoided cost method as done in a report for Delaware Department of Natural Resources and Environmental Control. Although it is difficult to measure the value of something that prevents total damage or catastrophe, that is the thinking behind this method to quantify increased damage if wetlands were not restored and continued to decrease and the effects on the value of surrounding residential and commercial properties over time (Industrial Economics, Incorporated, 2011).

The concept of valuing natural capital, although not completely new, is only recently beginning to take hold among scientists, ecologists, economists, local leaders and decision makers as well as business owners and major corporations. There is a significant partnership between Stanford University, The Nature Conservancy and the World Wildlife Fund entitled the Natural Capital Project that is attempting to make this type of valuation and assessment ubiquitous within decision making for resource as well as land-use decisions. These participants have developed software sophisticated enough to model and subsequently assign costs and benefits to natural capital (Daily et al., 2009).

Because the wetland restoration design for the study area is at concept plan stage and because assigning actual dollar values to ecosystem services is still in its infancy across multiple industries, the value assessment for the study area restoration focused on ecosystem services specific to Raritan Center and sought to better explain the benefits of each service in hopes that this particular effort will spread across many sites within the Raritan Basin and instill a better understanding that is necessary for a successful decision making framework to be put in place on how ecosystem services can help to nurture human and natural well-being.

The importance of going through this value capture exercise and identifying these ecosystem services is important because:

- It makes the potential values of ecosystem services more apparent.
- It sets up a framework for further and continued analysis and research.
- It stimulates debate and gives weight to ecosystem services in policy decisions.
- It can begin to reshape the way land development can improve the collective environment instead of producing further environmental problems.

The value capture assessment executed in this plan was completed by way of a **three-pronged approach** that involved:

- Identifying and quantifying the ecosystem services or benefits from all of the natural features of the Red Root Creek area to not only Raritan Center and its employees, but also the townships of Edison and Woodbridge as well as the State and various stakeholders.
- Identifying and quantifying eco-goods which are the products derived from the continued stewardship of natural systems in the Red Root Creek area.
- Added Indirect Bonus: Identifying and quantifying opportunities for eco-tenant value capture.

Ecosystem service examples from Red Root Creek include:

Sediment removal

The dense vegetation and microtopography of wetlands slows and holds the flow of water, allowing suspended sediment to settle out. This service is vital to areas with large impervious surfaces, like the RBC.

Water filtration

Wetland vegetation and soils are able to capture and remove many water pollutants, including nitrates, phosphates and heavy metals.

Nutrient cycling and movement

Nutrient cycling can occur within and between different types and elevations of wetlands by way of pooling nutrients by way of water flow or transfer from wildlife movement within wetlands such as birds, crabs and other animals. The microbes present within wetlands recycle nutrients and exchange nitrogen with the atmosphere. Water quality is also protected further downstream from various kinds of vegetation that can also reduce nitrogen from entering streams (OzCoasts, 2013).

Pollination of crops and natural vegetation / Dispersal of seeds

Certain plants rely on various animals for fertilization and regeneration. Wetlands provide a safe habitat for both flora and fauna to continue this cycle which provides tremendous benefits to human life as well in that food crops, which are extremely prevalent in the State of New Jersey, depend on pollinators and seed dispersal.

Purification of air by dilution of air pollutants

Anaerobic conditions in wetland soils significantly slow the rate of decomposition of submerged organic matter. This process reduces the release of carbon dioxide, allowing the large amounts carbon to be stored within the soil.

Protection from floods and storm surge

Wetland soils and vegetation act as a sponge in wet weather events and protect nearby land with the ability to absorb large amounts of both wave energy and water.

Ecotourism examples:

- Existence of an array of wild species (i.e., birding tourism such as Audubon Society bird watching)
- Recreational opportunities (i.e., guided access along boardwalks through the wetlands and along the waterfront)
- Educational Partnership opportunities (i.e., further research opportunities involving monitoring and maintenance of wetlands once restoration is complete)

ECO-TENANT OPPORTUNITIES

Today's educated tenants seek high quality working environments that provide economic, environmental and social benefits. Today's businesses are putting more and more time and effort into becoming more sustainable, locating or relocating in more green settings and hiring and retaining a workforce for their missions that is looking for these socially and environmentally responsible qualities in an employer. This is one indirect benefit of wetland and habitat restoration that can result in physical as well as financial benefits to Raritan Center.

In summary, future tenants could very well be willing to spend more money in rents for their spaces in Raritan Center in connection with their added ability to achieve these sustainable goals and benefits.

FUNDING + IMPLEMENTATION

REGULATORY APPROVALS

Wetlands are protected by Federal and State legislature and authorities, so any restoration plan must pass through permitting processes at multiple levels of government. As the study area borders a navigable waterway, USACE will have jurisdiction over the site within 1,000 feet of the Raritan River. For areas of the site further inland, the restoration plan will need to go through state permitting through the New Jersey Department of Environmental Protection (NJDEP).

The type of wetland plays a role in determining the permits necessary on the state level. For the study area, the FWS categorizes all wetlands in the study area except those far inland as estuarine and marine, while the NJDEP's wetland inventory categorizes the wetlands bordering the Raritan River and the wetlands in the western portion of the study area as saline marsh, and the wetlands bordering Red Root Creek as herbaceous with the Cowardin classification of PEM1C (non-tidal, palustrine, emergent wetland containing vegetation that is persistent throughout the year with seasonal flooding). A USACE study of the area conducted in 1986 found a mixture of tidal and freshwater habitats on the site.

Federal Permitting

The federal role in regulating wetlands comes from the Clean Water Act, which requires Section 404 permits to disturb natural wetlands. The USACE evaluates and issues permits, which are subject to review by the Environmental Protection Agency (EPA). Restoration projects fall under the USACE's Nationwide Permit (NWP) No. 27, which authorizes "activities in waters of the United States associated with the restoration, enhancement, and establishment of tidal and non-tidal wetlands and riparian areas…provided that those activities result in net increases in aquatic resource functions and services" (USACE, 2012, p. 14). Though the permit does not authorize the conversion of one aquatic habitat type to another, it does not consider a change of plant communities due to restoration as aquatic habitat conversion, so the habitat alterations suggested by this report would fall under the authority of this permit (for example transforming phragmites dominated habitat to spartina dominated habitat). Provided that there are net increases in aquatic resource functions and services, no compensatory mitigation is required. This permit can also be used to establish a mitigation bank or an in-lieu fee project, though reversion would be prohibited in these instances.

NJ State Permitting

Coastal Wetlands Permit

On the state level, Coastal General Permit 29 is the permit that applies to habitat restoration. This permit authorizes "habitat creation, restoration, enhancement and living shoreline activities sponsored or substantially funded by a Federal or State agency or other entity" (N.J.A.C. 7:7-7.29).

For this coastal general permit, the sole purpose of the activities on site must be restoration creation or enhancement, and there must be a sponsor participating or funding the activities who endorses the restoration in writing. Activities that this permit authorizes include altering hydrology, breaching a structure to allow an influx of water, placing habitat improvement structures, regrading, cutting or burning to manage nuisance flora, and establishing a living shoreline. To qualify for this permit, the project must:

- Be part of a plan for restoration, creation, or enhancement of the habitat and water quality functions and values of wetlands.
- Be consistent with the requirements of the Wetlands Act of 1970, the Coastal Area Facility Review Act, and the Coastal Zone Management Rules;
- Improve or maintain the values and functions of the ecosystem
- Have a reasonable likelihood of success

Freshwater Wetlands Permit

General Permit 16 would be necessary to authorize habitat creation and enhancement activities in freshwater wetlands. Like the coastal general permit, this requires the participation of a sponsor who endorses the project in writing. It also authorizes plans approved or created by the NJDEP's Division of Fish and Wildlife, the Partners for Fish and Wildlife program (U.S. Fish and Wildlife Service), the U.S. Department of Agriculture's Natural Resource Conservation Service, the NJDEP's Office of Natural Resource Damages, the USACE, other Federal or State Agencies, and charitable conservancies. To be considered for the permit, the project must be part of a comprehensive plan for restoration, sponsored by an appropriate entity, and aligned with the goals of the Freshwater Wetlands Protection Act. It must also improve the values and function of the ecosystem and have a reasonable likelihood of success (N.J.A.C. 7:7A-15).

NJDEP's freshwater wetland permitting also provides a permit that authorizes the creation of a boardwalk. General Permit 17 authorizes the construction of a trail or boardwalk no wider than 6 feet for use by pedestrians, bicycles and other non-motorized methods of transportation (N.J.A.C. 7:7A-17). However, provided that the construction meets all requirements of General Permit 17, it can be authorized through General Permit 16 and no additional permit will be necessary.

Additional General Permits

General Permit 1: Maintenance and Repair or Existing Features – N.J.A.C. 7:7A-5.1

Authorizes the repair, rehabilitation, replacement, maintenance or reconstruction of a previously authorized currently serviceable structure, fill, roadway, utility line, active irrigation or drainage ditch, or stormwater management facility lawfully existing prior to July 1, 1988 or permitted under N.J.A.C 7:7A-5.1. Qualifying for authorization under general permit 1 requires that the structure, fill, roadway, utility, ditch or facility has not and will not be put to any use other than as specified in any permit that authorized its original construction. Activities under general permit 1 prohibits the expansion, widening, or deepening the authorized feature. Furthermore, the permittee shall not deviate from the plans of the original activity with the exception of minor deviations in the materials or construction techniques that are necessary to make repairs, rehabilitation, or replacements (provided that such changes do not disturb additional freshwater wetlands or State open waters upon projection completion).

General Permit 11: Outfalls and Intake Structures – N.J.A.C. 7:7A-5.11

Authorizes activities in freshwater wetlands, transition areas, and State open waters that are necessary for the construction of a stormwater outfall structure, an outfall structure that discharges other than stormwater into State open waters and covered by a valid NJ Pollution Discharge Elimination System (NJPDES) permit, a Department approved intake structure located in a State open water, a lawfully operated well not connected to a public water system, conveyance structure (e.g. pipes and headwalls, and energy dissipation structure (e.g. rip-rap, gabion baskets, scour holes, etc.) that are associated with an outfall or intake structure.

General Permit 17: Trails and boardwalks – N.J.A.C. 7:7A-5.17

Authorizes the construction of trails and boardwalks for the use of pedestrians and bicyclist. This permit does not, however, include any other recreational construction of any "covered or enclosed structure" such as gazebos or rain shelters. The total area that may be disturbed under this permit is not to exceed a quarter of an acre. The trail of boardwalk shall be no wider than six feet.

General Permit 20: Bank Stabilization Permit – N.J.A.C. 7:7A-5.20

Authorizes the activities necessary to stabilize the bank of a water body for the purpose of preventing or reducing soil erosion that include the placement of gabions, rip-rap, or geotextiles along a stream bank. Applicants are directed to use vegetative or bioengineering stabilization methods unless site conditions require alternative methods in accordance with the Standards for Soil Erosion and Sediment Control in New Jersey (N.J.A.C. 2:90).

Freshwater Wetlands letter of interpretation line verification:	$600 + $84/acre
General Permit:	$600 +$48/acre
Flood Hazard Area Control Act permit:	$4,000
(1) Waterfront Development general permit:	$600
Application fee for a transition area waiver over one acre:	$600 +$48/acre affected

Additional Individual Permits

Waterfront Development Permit – N.J.A.C. 7:7-10

This permit regulates any projects involving the development of a waterfront that is near or upon any tidal or navigable waterway in the State. The pertinent activities cited in this permit include the alteration of any structure and the excavation of waterfront land, pilings, dredging or the removing or sand or other materials from lands under the all tidal waters, and limited upland construction within 500 feet of tidal flowed waters. Furthermore, this permit becomes particularly important with respect to public access since this program was developed with this goal in mind (NJ Department of Environmental Protection, 2010):

Table 9: *Waterfront Development Permit Fees*

Construction Cost	Fees
$0 to $50,000	$3,500 + 1.2% of construction costs
$50,001 to $100,000	$4,100 + 2.4% of construction costs
$100,001 to $200,000	$5,300 + 3% of construction costs
$200,001 to $350,000	$8,300 + 3.6% of construction costs
> $350,000	$13,700 + 2.4% of construction costs

Flood Hazard Area Permit (formerly the Stream Encroachment Permit) – N.J.A.C. 7:13:

Establishes stringent standards for development in flood hazard areas that are adjacent to surface waters. The following is an outline of various cost associated with obtaining an individual Flood Hazard Area Permit based on the specific projects elements as seen in Table 10.

Dam Modification/Construction Permit – N.J.A.C. 7:20-1-4 through 1.7

Authorizes permittees to construction a dam under the following conditions:

(1) The permittee commences within a year from the permit date

(2) The permittee completes within two years unless otherwise approved by NJDEP.

(3) A New Jersey licensed professional engineer prepares the plans and specifications in addition to supervising construction inspections.

There is no fee for filing an application for a Dam Modification/Construction Permit.

Water Lowering Permit

Authorizes the partial or complete lowering of a body of water while ensuring the protection of aquatic animals or vegetation, which requires a two dollar application fee (NJ Department of Environmental Protection, Division of Fish and Wildlife, 2013).

Project Element	Qualifier	Fee
The stabilization, reestablishment, or protection of a bank	Review of necessary hydrologic and/or hydraulic calculations	$3,000 + $300/each100-foot segment of channel (or a portion thereof)
	Review of hydrologic and/or hydrologic calculations that are not necessary	$1,000
Construction of a bridge, culvert, footbridge, low dam, or other water control structures (including up to 200 feet of channel modification if necessary for the placement of the water control structure)	Review of necessary hydrologic and/or hydraulic calculations	$4,000
	Review of hydrological and/or hydraulic calculations necessary for a bridge or culvert that provides access to one private residence (which is not being constructed as part of a larger residential subdivision)	$2,000
	Review of hydrological and or calculations that are not necessary	$1,000
Channel Modification	Review of necessary hydrologic and/or hydraulic calculations	$3,000 + $300/each 100-foot segment of channel (or a portion thereof)
	Review of hydrologic and/or hydraulic calculations that are not necessary	$1,000
Retaining Wall	Extending 4 feet or more above ground	$4,000
	Extending less than 4 feet above ground	$1,000
Stormwater Discharge Structure	Each stormwater discharge structure (including conduit and outlet protection and/or conveyance channel)	$1,000

Table 10: *Flood Hazard Area Permit*
Source: *Incorporation of the Drainage Design Manual into the Design Manual—Roadway as Section 10, Drainage Design and Revisions*

CAPITAL COST OF WETLAND RESTORATION

Due to the conceptual nature of this plan and the uncertainty of design specifics, this report does not attempt to estimate exact costs. In general, wetland restoration cost depends on (1) what is being restored, (2) the extent of damage on the site, (3) the desired pace of restoration, and (4) how robust and permanent the repairs need to be. Figures gathered from various sources reflect that restoration project costs can range from five dollars per acre to $1.5 million per acre, with large-scale projects proving to be relatively low in cost in comparison with small-scale projects. The problems of estimating cost may be overcome by grouping wetlands and wetland restoration projects according to structural characteristics that affect restoration cost, and by adjusting the baseline cost estimates for each group using simple indicators of site conditions. Site conditions to consider include soil hydrological conditions, topography, urban versus rural environment, on-site or off-site disposal of spoil, and whether union or non-union labor will be employed.

A study conducted in 1993 by the University of Maryland, with financing from the EPA and Department of Energy, attempted to evaluate wetland restoration projects in which nine wetland categories were developed on the basis of wetland characteristics. These categories were designed to provide an economic and statistical basis for improving wetland mitigation policy in addition to determining how a wetland restoration might contribute to the achievement of wetland, floodplain and watershed goals. Cost of restoration data was collected and examined for approximately 1,000 separate projects. A detailed cost analysis was performed for roughly ten percent of the total projects examined, with outside cost data accounting for the remaining 90 percent. The elements that were identified for standardizing cost included location, site characteristics, wetland type, and project objective. Data on the average cost per acre, as shown in Table 11, revealed that, of the nine wetland categories, salt marsh and tidal freshwater wetlands provided the third and sixth lowest average per acre restoration expense (King & Bohlen, 1994).

Table 11: *Average Cost per Acre for Wetland Restoration*

Relative Cost Rank	Wetland Project Category	Unit Cost (2014 dollars)
1	Agricultural Conversion	$1,624.78
2	Mangroves	$29,246.08
3	Salt Marshes	$29,262.32
4	Aquatic Bed (tidal or nontidal communities of permanently or nearly permanently submerged plants)	$31,683.25
5	Freshwater Mixed (nontidal projects in which both forested and emergent vegetation is produced)	$41,106.98
6	Tidal Freshwater	$68,240.84
7	Emergent Freshwater (nontidal projects establishing emergent wetlands)	$79,126.88
8	Complex (incorporating three or more wetlands types in single project)	$92,125.14
9	Forested Freshwater (nontidal projects establishing forested wetlands)	$126,570.52

Note: All figures have been adjusted using the Consumer Price Index (CPI) Inflation Calculator available through the Bureau Labor Statistics

LOCAL APPROVAL

The local zoning ordinances enforced by Edison and Woodbridge Townships concerning the study area do not seem to cause reason for alarm because its continuity with the efforts previously-mentioned. More importantly, the environmentally-sensitive attributes on the site area which would have otherwise conflicted with ideas similar to the proposal explained in this report, have generally been mitigated by the ordinances included in both Townships' zoning. For example, much caution is given to flood hazard and natural area protection, but granted that flood hazard design elevations are delineated on development plans, the party proposing seems to have reasonable leniency for its project. Even still, as relevant to the study area plans, the following have been identified in the zoning ordinances as "permitted uses" in flood fringe portions: "Recreation: golf courses, improved courts and playing fields, swimming areas, boat launching ramps, picnic and camping, and open space uses such as hiking trails" (Edison Township, New Jersey, Township Code § 15.40.010, G (1999). Since the study area and parcels immediately around it are also zoned for "revitalization" or "redevelopment" it can also be reasonably assumed that there would be no interference on the uses of adjacent properties.

Obtaining a permit for work on this site will, of course, require the regular process of completing the permit application and submitting construction and plot plans to both municipalities. Several criteria that this plan must be sure to meet, include, but are not limited to demonstrating minimally-invasive plans on flood fringe areas, natural features, and riparian zones. Both Townships require that the proposal provide documentation to allow the approving authority to evaluate whether the proposal has:

- an inherent low flood damage potential
- does not obstruct flood flows or increase flood heights and/or velocities
- does not affect adversely the water-carrying capacity of any delineated or non-delineated floodway and/or channel
- does not increase local runoff and erosion
- does not unduly stress the natural environment of the floodplain or degrade the quality of surface water or the quality of ground waters
- does not require channel modification or relocation
- does not require fill or the erection of structures
- does not include the storage of equipment and materials

Ordinances referring to natural feature preservation also require that "no structure [be] built within one hundred feet of… [a] body of water within any drainage or conservation easement, and [that] no fence shall be constructed on a conservation easement" (Edison Township, New Jersey, Township Code § 15.40.030 (1999).

As part of Stormwater Pollution prevention Plans to protect riparian zones, it is also required that riparian zones be 150 feet-wide along both sides of water that contains "documented habitat for a threatened or endangered species of plant or animal, which is critically dependent on the surface water body for survival…" (Edison Township, New Jersey, Township Code, Ord. No. O-1770-2011 § II (1999), as is true here. Another relevant land ordinance requirement for non-structural stormwater management strategy include designs that, "help to prevent accumulation of trash and debris in drainage systems", and features that help to prevent and/or contain spills or other harmful accumulations of pollutants at industrial or commercial developments" (Edison Township, New Jersey, Township Code, Ord. No. O.1611-2008 § 9; Ord. No. O.1692-2009 § II (1999).

Finally, to help mitigate the permitting and approval phases, Edison Township, in an attempt to promote the protection of wetlands and open space, offers alternatives such as deed restriction programs, density transfers, and easement purchases for areas like the study area at hand. Both Woodbridge and Edison have demonstrated their attempt to respond responsibly to the New Jersey Division of Fish and Wildlife's Endangered and Nongame Species project map that identified the wetlands area between the Raritan Center and the Raritan River as 1 of the 2 critical wildlife habitats in Edison. Not only have both Townships responded positively to environmental issues concerning the study area, but research concerning their zoning ordinances suggest that they have also acted proactively by minimizing potential conflict for third party entities that wish to execute proposals for public access and environmental mediation.

RELATIONSHIP TO THE HUDSON-RARITAN ESTUARY COMPREHENSIVE RESTORATION PLAN

The Raritan Center was identified as restoration opportunity number 549 in the Hudson-Raritan Estuary (HRE) Comprehensive Restoration Plan (CRP). The CRP is a collaborative, living document intended to guide and coordinate restoration efforts in the estuary, which includes the area within a 25 mile radius of the Statue of Liberty. The HRE planning area is separated into 8 planning regions, and the study area of this report falls within the CRP's Lower Raritan River planning region.

The study area was singled out by the CRP for its potential for coastal wetland creation and restoration. Coastal wetlands are one of the plan's 11 target ecosystem characteristics, and the CRP "aims to create and restore coastal wetlands, at a rate exceeding the annual loss or degradation of wetlands in the HRE planning region, to produce a net gain in acreage" (Hudson-Raritan Estuary Comprehensive Restoration Plan, 2009, p.37). The plan's target is to increase coastal wetlands in the HRE's planning area by 1,200 acres by 2015 and by 15,200 acres by 2050. Restoring more than 300 acres of wetlands in the study area to tidal wetlands would significantly further this goal.

The CRP's analysis and inclusion of the study area demonstrates that the restoration of this site aligns with a larger regional plan and that the benefits of a coastal wetland restoration will be valuable in improving the health of the Hudson-Raritan Estuary as a whole. The plan's endorsement of the study area as a restoration opportunity should be used as an asset to garner both support and funding in the restoration process.

POTENTIAL FUNDING MECHANISMS

There are several avenues through which Raritan Center could investigate potential funding for the restoration of the study area wetland and habitat. Funds are appropriated at all levels of government through various programs focusing on restoration, development and management of wetlands and wildlife habitat. To set the stage of funds available from the federal level and in light of recent devastation of much of the area surrounding Raritan Center due to Superstorm Sandy in 2012, it is important to note the magnitude of funding made available for restoration through Federal Sandy Aid. Of the $60.4 billion emergency funding approved by Congress, EPA received $577 million which goes directly to states for wetland restoration and ecosystem enhancement, the Small Business Administration received $765 million in aid for low-interest loans to provide technical assistance to individuals and business owners related to long term resiliency, and the U.S. Department of Commerce received $310 million of Federal Sandy Aid for actions such as preparedness and resiliency, forecasting and modeling mitigation efforts, but also activities that provide protection through natural ecosystems, such as wetlands restoration (Gurian, 2013).

Obviously, much of the Federal Sandy Aid has been allocated, and will continue to go, directly to state agencies and non-profits which will not be beneficial in the case of Raritan Center, but this report does identify some potential funding mechanisms that are still applicable to the study area by way of trickle down funding from Federal Sandy Aid for technical assistance to private landowners as well as other various agencies and programs to which FBC can apply for financial assistance in order to realize this restoration effort.

U.S. Fish and Wildlife Service (FWS)

The Partners for Fish and Wildlife (PFW) program is likely the best option for funding restoration of the study area and fulfillment of the concept plan presented by this Report. The PFW program, established in 1987, focuses on conservation and management of Federal Trust species such as migratory birds, inter-jurisdictional fish, threatened and endangered species and certain marine mammals. Since its inception, the program has successfully restored over one million acres of wetland habitat. The PFW program assists private landowners with wetland restoration projects. Since it is a federally funded program, an Environmental Impact Statement will be required. Technical and financial assistance is provided to the landowner, including locally-based biologists to plan, implement and monitor the restoration projects. The program's staff also assist with identification of additional funding sources and acquisition of necessary permits (U.S. Fish and Wildlife Service, 2011). To begin participation in the program, the landowner simply needs to contact the state coordinator. The private landowner voluntarily enters into a 10-year cooperative agreement with acknowledgement

that reimbursement will be given after project completion. PFW program contracts are structured to provide goods and services, but usually not cash, averaging $5,000 worth of services per contract. Contracts can approved and work may begin very quickly following initial meetings. The program has been offered every year since the early 1990's for New Jersey projects (Freiday 2014).

Tidal Wetland Mitigation Banking

Wetland mitigation banks are market-based approaches to wetland restoration established by federal regulations allowing for a public or private entity to restore wetlands. A mitigation bank sponsor, authorized by the NJDEP and USACE, purchases land to create the bank. The bank sells credits to developers who have altered or impacted other wetland areas. The purchaser (developer) must obtain two times the amount of wetland area impacted. Mitigation is required when permanent loss of greater than 0.1 acres of freshwater wetlands occurs or if the applicant fails to demonstrate that "all activities have been designed to avoid and minimize impacts to wetlands."

In the watershed where the study area is located (WMA 9), the approved wetland mitigation banks are (NJDEP, 2014):

- Port Reading Bank, with a portion of 8.47 credits available for tidal wetland creation and enhancement activities;
- Cranbury Wetland Mitigation Bank, with 38.14 mitigation credits available for freshwater wetland creation, restoration and enhancement;
- Wyckoff's Mills Wetland Mitigation Bank, with 86.91 mitigation credits for freshwater wetland creation, and wetland/transition area enhancement activities.

One possibility for funding restoration at the Red Root Creek study area may be to partner with an existing wetland mitigation bank to add to the total credits available for purchase. The existing banks contain only freshwater wetlands credits and there may exist a strong market for tidal wetlands credits. The money acquired with the sale of credits can then help to fund restoration of the Red Root Creek site.

National Coastal Wetlands Conservation Grant Program

A second round of funding has been approved for the Hudson Raritan Estuary Resources Program (HRERP) by the Port Authority of NY/NJ. The program is part of the agency's sustainability initiatives allocated in its 10-year capital plan. The HRERP funding is split between New York and New Jersey to acquire land which provide open space, ecological habitat, public access and storm resiliency along coastal waterfronts (NY/NJ Baykeeper, 2014). The Red Root Creek site was listed as one of the priority acquisition and restoration sites by the New York – New Jersey Harbor Estuary Program comprehensive plan, which the Port Authority utilizes for site acquisition decisions (Habitat Working Group, 2014).

The Corporate Wetlands Restoration Partnership (CWRP) was established in 2000 to preserve and protect coastal ecosystems all across the United States. This partnership utilizes corporate contributions through the Coastal America Foundation, a unique collaboration of federal, state and local agencies to fund restoration, protection, enhancement and preservation projects. The types of activities which have received funding include dam removals, habitat maintenance, removal of invasive species and research and monitoring (CWRP, 2014). The state chapters of the CWRP recruit contributors and select projects to be supported. The New Jersey state chapter, established in 2003, does require a federal partner for all projects, such as FWS and provides funding up to $25,000 (NJ CWRP, 2014).

OTHER POTENTIAL SOURCES

Section 404 grant – Mitigation or in lieu fee

When a developer impacts wetlands, a mitigation must be undertaken or a pre-determined in lieu fee payment must be made to perform the actual mitigation of wetlands elsewhere, under section 404 of the Clean Water Act. An in lieu fee (ILF) program conducts activities such as habitat restoration, creation, enhancement, or preservation of wetlands, streams or threatened or endangered species. Unlike mitigation banks,

ILFs may perform various restoration and enhancement activities throughout a watershed rather than at one particular site. Much like mitigation banks, agreements are established, but the mitigated sites are not always constructed prior to the environmental impacts taking place. Instead, projects are undertaken once sufficient funds are received by the ILF program. Federal regulations require that ILF programs be administered by government or nonprofit entities only. Like mitigation banks, all risk is transferred to the ILF sponsors. The sponsors ensure mitigation credits will be available when needed, lowering project cost and risk (US DOT FHWA, 2014).

Wetlands Mitigation Fund (NJDEP)

In New Jersey, money is donated to the Wetlands Mitigation Fund when freshwater wetland is impacted in order to fund a mitigation project. The amount of the contribution is dependent upon the size of the impact and whether it resulted from an individual or general wetlands permit. All proposed contributions and the distribution of funds is up to the discretion of the Wetlands Mitigation Council (Mitigation Options, NJDEP, 2014). These funds are available only for freshwater wetlands restoration; however, a grant may be allowed for a part of a planned restoration as freshwater wetlands, thus opening up the possibility of funds dedicated to the proposed stormwater management/freshwater wetland portion of the study area (Aspinwall, NJDEP, 2014).

Natural Resource Damage Settlements (NJDEP)

The Office of Natural Resources Restoration (ONRR) at the NJDEP, in conjunction with the Green Acres program and NJ Attorney General's Office, pursues natural resource damage claims and restoration settlements for natural resource damages. The ONRR engages in restoration projects with nonprofit or local government partners, such as acquisition of land for aquifer recharge, restoration of appropriate habitat and rehabilitation or creation of wetlands. In some cases, restoration of the natural resource is not done on site, but rather at another site within the same watershed management area. In most cases, establishment of a conservation easement on the rehabilitated land is required as part of the settlement (Program Overview, NJDEP, 2003).

Section 206 Program (USACE)

This program, run by USACE, provides assistance for restoring aquatic habitat, including floodplain habitat under the Water Resources Development Act of 1996. A study undertaken by USACE investigates alternative solutions to identify a restoration plan for implementation. The local sponsor is obligated to share 50 percent of feasibility costs after the first $100,000 in federal expenditures and 35 percent of implementation costs if a feasible plan is identified (US Army Corps of Engineers, 2014).

Section 1135 Program

This program is also run by USACE for the purpose of restoring wetlands and floodplain habitat previously impacted by a USACE project under the Water Resources Development Act of 1996. Following a detailed investigation for technical feasibility, environmental acceptability and cost-effectiveness, the project is accepted for construction. The maximum federal expenditure is $5 million and costs are shared 75% federal, 25% non-federal. The non-federal sponsor must assume maintenance and operation of the site upon completion. In-kind contributions are permitted to reduce overall cost (USACE, 2014).

North American Waterfowl Management Program (FWS)

Funds available from FWS are awarded for conserving wetlands for migratory birds and other wildlife under the Migratory Bird Joint Ventures program. The funding is available to private landowners for the protection, restoration and enhancement of wetland and upland ecosystems for the conservation of migratory birds. Normally phased over a one to five-year period, these joint venture grants average $225,000 per award and do not require a non-federal match (Migratory Bird Joint Ventures).

Federal Aid in Wildlife Restoration (FWS)

Additional funding is provided by the FWS for the purpose of restoring wild birds and mammals by acquisition, development and management of habitat. The program is funded by an excise tax on the purchase of firearms, ammunitions and archery equipment. Grant funds are disbursed to states covering up to 75% of project costs ("Wildlife Restoration Program - Overview", 2013).

North American Wetlands Conservation Fund (FWS)

The U.S. Fish and Wildlife Service disburses funding from the North American Wetlands Conservation Fund (NAWCA-14-USSTANDARD-623). The eligibility is open to any kind of entity. The program is a competitive, matching grants program that supports public-private partnerships carrying out projects in the United States that further the goals of the North American Wetlands Conservation Act, requiring long-term protection, restoration, enhancement and/or establishment of wetlands and associated upland habitats for the benefit of all wetlands-associated migratory birds (NAWCA, 2014). The New Jersey Department of Environmental Protection (NJDEP) acquires lands in floodplains for recreation and conservation purposes through its Blue Acres program. The landowner offers land for sale to the State in order to preserve the buffer or protection of other lands (NJDEP Green Acres Program, 2014).

Five Star Wetland Restoration Grants

The Five Star Restoration Program provides grant funding in the amount of $10,000 to $40,000 to support community-based wetland, riparian and coastal habitat restoration projects. Project partners must number at least five and grant matching is recommended at a ratio of about 1:1. The grantees must provide environmental education and training through projects that restore wetlands and streams and are accessible to the community. The program is composed of a partnership among the National Association of Counties (NACo), the National Fish and Wildlife Foundation (NFWF), the EPA, the Wildlife Habitat Council (WHC) and corporate sponsors Southern Company and Pacific Gas and Electric (PG&E) (Five Star Restoration, US EPA, 2014).

Clean Water Act Nonpoint Source Grant (Section 319h Grant) (EPA)

The purpose of this Environmental Protection Agency program is to implement its approved nonpoint source management programs. State agencies are eligible for funding, which then disburse grants to local entities. Municipal and county planning departments, water quality management planning agencies, state and regional entities, state government agencies, universities and colleges and other local nonprofit organizations are eligible to receive the funding. In the past, New Jersey has used this funding solely for watershed-based plans, however this may be changing for the latest round of funding (NJDEP, 2011).

Coastal and Marine Habitat Restoration (NOAA)

The National Oceanic and Atmospheric Administration (NOAA) program for Coastal and Marine Habitat Restoration funds coastal habitat restoration projects that aid in recovering listed species and rebuilding sustainable fish populations or their prey. The projects are funded primarily through cooperative agreements. Awards are typically in the range of $500,000 to $5,000,000 over three years. Eligible applicants include universities, non-profit organizations, for-profit organizations and governments (Coastal and Marine Habitat Restoration, NOAA, 2014).

DEVELOPING PARTNERSHIPS

The study area restoration provides opportunities for educational, maintenance, monitoring and research partnerships that could provide substantial benefits to surrounding residents, community groups and the scientific community while at the same time delivering benefits to Raritan Center, including enhanced community relations.

Education, Maintenance and Monitoring

In terms of education, partnerships can be formed with a number of different groups to take advantage of the public access facilities. Example groups include local schools and universities, local public agencies with environmental and park functions, environmental non-governmental organizations and other community groups such as churches, local Boys and Girls Clubs, Girl and Boy Scout Groups, and Rotary Clubs.

In addition, there is a great opportunity to partner with the neighboring Keasbey Redevelopment (EPEC Polymers, Inc.) site where wetland restoration is underway with public access and education as major components (Township of Woodbridge, 2011). The Red Root Creek restoration concept plan includes a public access connection to the EPEC site, allowing for synergies in education programming and sharing of public access facilities.

Ideally, education partnerships should begin during the restoration period, thus providing opportunities for partners to be involved in the restoration process itself. For example, local

Organization Name	Location
Alliance for New Jersey Environmental Education	Bernardsville, NJ
American Littoral Society	Highlands, NJ
Association of New Jersey Environmental Commissions	Mendham, NJ
Edison Wetlands Association	Edison, NJ
Lawrence Brook Watershed Partnership	Milltown, NJ
New Jersey Academy for Aquatic Sciences	Camden, NJ
New Jersey Audubon Society	Bernardsville, NJ
New Jersey Friends of Clearwater	Red Bank, NJ
New Jersey School of Conservation	Branchville, NJ
New York/New Jersey Baykeeper (Raritan Riverkeeper)	Keyport, NJ
NY-NJ Harbor and Estuary Program	New York, NY
Raritan Headwaters Association	Bedminster, NJ
Stony Brook-Millstone Watershed Association	Pennington, NJ
Sustainable Raritan River Initiative	New Brunswick, NJ
The Nature Conservancy (New Jersey)	Chester, NJ
Metropolitan Waterfront Alliance	New York, NY

Table 12: *Potential Environmental NGO Partners*

high-school or middle-school students may be engaged in growing some of the wetland plants needed for the restoration offsite and engaged in the actual planting onsite. A similar model is on-going for the neighboring Keasbey site where the municipality is involving local schools in the restoration process as a part of their outreach and education goals (Lefsky, M., personal communication, February 2014). There are existing successful examples of such student participation in wetland restoration, one being the Stormwater Ecological Enhancement Project (SEEP) at the University of Florida campus (Clark, M., Associate Professor, Wetland Ecology, UF, personal communication, October 16 and 18, 2012; NATL).

Once the restoration is complete, partners can serve as the primary providers of scheduled guided tours and may also provide valuable volunteer routine maintenance and monitoring assistance such as trash removal, weeding, species counts and water quality monitoring.

Research

The study area provides an excellent opportunity to study scientific questions of high current and future interest with attached policy implications, including those related to best wetland restoration practices and sea level rise adaptation. The variety of habitat zones proposed adds to the richness of research questions that can be addressed and research designs feasible, such as multiple comparison sites.

There are a number of research universities and other institutes within New Jersey and the surrounding region with an environmental focus that may be interested in establishing long term monitoring and research sites within the restored area. Prime examples of potential research partners locally and regionally are listed in Table 13.

The scientific community could benefit by securing access to long term study sites; while the Center, in addition to contributing to the body of scientific knowledge, could enhance its reputation by association with these renowned institutions and their various publications. Such partnerships also could contribute to the "green" branding of the Center. Partnerships would ideally include a provision that research findings and publications be made publicly available.

Institution Name	Location
Middlesex County College	Edison, NJ
Montclair State University	Montclair, NJ
New Jersey Institute of Technology	Newark, NJ
Rutgers University, Institute of Marine and Coastal Sciences and Center for Urban Environmental Sustainability	New Brunswick, NJ
Stevens Institute of Technology	Hoboken NJ
Monmouth University	West Long Branch, NJ
Stockton State College	Stockton, NJ
Brooklyn College	Brooklyn, NY
Cary Institute of Ecosystem Studies	Millbrook, NY
City University of New York	New York, NY
Cornell University	Ithaca, NY
Hudson River Foundation	New York, NY
Hunter College	New York, NY
Manhattan College	Riverdale, NY
Queens College	Queens, NY
State University of New York – College of Environmental Science and Forestry	Syracuse, NY
State University of New York at Stony Brook	Stony Brook, NY
Duke Marine Lab	Beaufort, NC
Virginia Institute of Marine Science	Gloucester Point, VA
Woods Hole Marine Biological Laboratory	Cape Cod, MA

Table 13: *Potential Research Partners*

Creating a Demonstration Project

An important goal of this restoration is to create a demonstration project that can be replicated elsewhere. Making detailed information available about the entire process would reduce informational barriers that can thwart restoration efforts. Such information sharing

the details necessary for other restoration projects in the watershed to synergize with the Red Root Creek restoration.

It is suggested that an information package be prepared describing the study area restoration process, from planning to post-implementation stages, in the form of an electronic toolkit. The NJDEP and other proposed partners could serve as repositories for the toolkit to enhance its availability to interested parties. The package could include this plan as well as practical information about the implementation process. Materials in the toolkit could include:

1) Implementation Process, a record of the implementation process and lessons learned, techniques for phragmites removal, seawater reintroduction, habitat creation and species re-introduction, permitting experience, implementation timeframe, restoration costs educational and research partners; and,

2) Restoration Performance, measures of habitat quality, species abundance and diversity, and ecosystem services values at various phases of the restoration process, timeframe for recovery of new habitat and species establishment, results of ongoing onsite monitoring, research and educational activities.

NEXT STEPS

The next steps to be taken in order to implement the concept plan were derived from the experience of the studio team, discussions with FBC and its consultants and various other stakeholders.

Refine and engineer conceptual design. Extensive surveys of the site should be conducted, including biological, hydrological and topographical studies. Engineering of water levels and control devices will be essential to ensuring the vitality of the wetlands. Plan the layout and phasing of the site to meet the goals of restoration and public access. Design details of public access amenities, enhanced landforms (hardening) and planting plan need to be developed. A cost estimate and contingency plan for the restoration can be developed at this point which will aid in the pursuit of funding mechanisms.

Distill an adaptive management plan. This plan addresses invasion of opportunistic species, impacts from human activities, and storm surge events while supporting the ecosystem's return to its historic trajectory. It includes actions for controlling invasive species and the protection of targeted desired species. The restoration is merely the beginning of an ongoing process for returning native species. The plan should allow for at least five years of monitoring and maintenance to allow a stable root base to develop for the desired native species.

Establish an operations and maintenance plan. A well-written and funded plan for appropriate monitoring and evaluation is critical for successful restoration.

Coordinate with USACE remediation efforts. The restoration process should continue to foster a cooperative relationship with the USACE and respond to remediation efforts. Consistent and open dialogue should continue.

Identify funding sources. The restoration team should first connect with the Partners for Fish and Wildlife program to begin dialogue about funding and permitting. Establishing contact with other potential funders and partners is necessary to select optimal programs and begin the application process. Further discussion with mitigation bankers is encouraged to better understand the potential opportunity of establishing a wetland mitigation bank.

Align with stakeholders. To develop cooperative relationships with local stakeholders, a progressive series of informative outreach initiatives and meetings is recommended. The study area has an opportunity to collaborate with activity on neighboring sites. For example, with respect to EPEC Polymers, Inc. and Cooperative Power Ventures, the study area concept plan includes a boardwalk connection to this neighboring site's public walkway. In addition, STC Marine, LLC and Middlesex County Utilities Authority's pumping station will be surrounded by the study area restoration efforts and access to those facilities will cross through the study area. Cooperative communications with these entities would benefit the restoration process. The Raritan Center tenant at 100 Blue Heron Way occupies the property closest to the study area's proposed education center and boardwalk access point. The concept plan envisions visitors to the education center or boardwalk would use the parking lot at this location. An agreement concerning access to this facility could be reached with the tenant.

More generally, the greening of Raritan Center envisions changes that may be of interest to Raritan Center's tenants. In addition, the concept plan envisions the employees of Raritan Center as a target audience for the study area's public access amenities. The participation of tenants and their employees is strongly recommended to ensure a successful program.

Obtain necessary permits. Developing of a coordinated and properly-timed application process is essential to the success of the implementation of the restoration project.

Develop partnerships. Educational, maintenance, monitoring and research partnerships will require coordination with the institutions and organizations previously identified. Stakeholder meetings could bring to light potential opportunities for partnering on specific initiatives or projects.

Restoring the Red Root Creek wetland is an important ecological and social endeavor that addresses the goals and aspirations of local communities and interest groups. Returning the wetland to its natural trajectory will protect investments already made while enhancing coastal resiliency and providing vital habitat for native flora and fauna. Managed public access is a key component and will yield significant benefits to the community. This restoration can serve as a prototype for balancing ecological value and economic goals. The Red Root Creek Restoration Plan provides a vision of what could be, outlines measures to achieve it, quantifies the potential benefits and offers a strategy for implementation and funding.

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APPENDIX A: TEAM BIOGRAPHIES

Victoria Airgood is a degree candidate in the Master of City and Regional Planning program focusing on international development and regional planning, with research interests in agricultural sector investment in transitioning and developing countries and economic history in declining American urban areas. Ms. Airgood also is a licensed commercial litigation attorney and New Jersey Superior Court roster mediator. She earned her law degree at Rutgers School of Law, Newark, an MA in experimental psychology from the University of Arizona and her BA degree in psychology from Barnard College. Part of her mediation training and experience was through the AFSC's "Alternatives to Violence Program" at the Federal Minimum Security Prison, Fort Dix. Ms. Airgood served as legal specialist for alternative dispute resolution and commercial law liaison to the Bulgarian Government through the ABA's Central and East European Law Initiative, stationed in Sofia, Bulgaria. Through this service, she developed her interest in economic transition and agricultural investment. Early in her career, Ms. Airgood taught introductory psychology and statistics at University of Maryland, European Division, West Berlin, Germany, and studied psychology and economic migration briefly at Freie Universitaet, Berlin. While there, Ms. Airgood became interested in the law as a context of social behavior and chose to pursue a law degree. Presently, Ms. Airgood is on temporary assignment for trial preparation of an environmental mass tort action. In the future, Ms. Airgood hopes to combine her education and experience through mediating conflicting interests in land use, natural resource preservation and economic development decisions.

Kelly Beggs is a Master's Degree candidate at the Bloustein School for Planning and Public Policy at Rutgers University. At Rutgers, she has specialized in environmental and physical planning, and her interest is in planning resilient, green and healthy cities. She currently holds a GIS internship at the Open Space Institute, a land conservation organization in New York City, and her previous experience includes a role as program assistant in planning the first-ever New Brunswick Ciclovia, as well as higher education communications and public relations.

Andrew Bomberger is a research assistant for the Alan M. Voorhees Transportation Center while also pursuing a Master of City and Regional Planning degree, both at the Bloustein School at Rutgers. After receiving a Bachelor of Landscape Architecture degree from Penn State University, Andrew spent time in the land development and landscape design fields, working on projects ranging from large commercial centers to residential estates. Realizing the impact of planning on design and development decisions, Andrew decided to return to school to study physical and environmental planning. Andrew combines a design-oriented background with a passion for integrating natural systems into our communities, increasing resiliency while also providing significant economic benefit. Andrew composed maps for Dr. Judy Shaw's upcoming book, The Raritan River: Our Landscape, Our Legacy, and currently edits the NJ Walks and Bikes blog.

Angela Burnett is a Master of City and Regional Planning degree candidate at the Edward J. Bloustein School of Planning and Public Policy with a dual focus in Environmental and Physical Planning and Housing and Real Estate. Angela's primary goal as a planner is to promote sustainable communities that balance environmental, social and economic goals. Prior to her present studies Angela received her Bachelor's degree in Environmental Studies and Sustainable Development from Brandeis University and worked in the conservation and environmental management field for 5 years. Working with The Ocean Project, an international NGO, Angela focused on supporting a global network of zoos, aquariums and museums in enhancing their educational messaging. From there Angela served with the Government of the Virgin Islands (British) as the Territory's Climate Change Officer. In this role Angela designed and implemented public education programing, conducted a vulnerability and capacity assessment, formulated and authored the Territory's Climate Change Adaptation Policy, and developed the draft framework for a local Climate Change Trust Fund. Angela was also involved in a number of other local environmental management initiatives including managing stakeholder consultations to develop the Territory's first Beach Management Plan and initiating a Green Pledge Program.

Michael Catania, Studio Co-instructor, is the Executive Director of Duke Farms Foundation. Duke Farms, serves as a model of sustainability and environmental stewardship on 2,700 acres in Hillsborough, NJ. Michael founded Conservation Resources Inc., a nonprofit conservation group that provided financial and technical assistance to the conservation community in New Jersey. Previously, he served as Deputy Commissioner of the NJ Department of Environmental Protection, Executive Director of The Nature Conservancy of NJ, President of the Schiff Natural Lands Trust, and he has been the Chair

of the NJ Natural Lands Trust for more than 12 years. Michael holds a BA in Political Science from Livingston College, an MA in Political Science from Rutgers University, as well as a JD from Rutgers School of Law in Camden.

Jing Chen is a Master of City and Regional Planning student with a concentration of Geographic Information Systems at Edward J. Bloustein School of Planning and Public Policy at Rutgers, the State University of New Jersey. As a geographer and urban planner by training, he is interested in the application of geographical information techniques (including remote sensing, geographic information systems and spatial analysis) for planning and urban sustainable development. Before joining this studio team, Jing had worked at Rutgers Center for Green Building and Beijing Forestry University for several research projects related to eco-industrial development, eco-environmental engineering and GIS. Jing has earned a bachelor's degree in geography from Beijing Forestry University in China (2012) where his academic focus was on ecosystem services and resource management. He is also a student member of American Planning Association, Association of American Geographers and International Society for Industrial Ecology.

Jenna Choe is pursuing a Master in City and Regional Planning and Policy from the Edward J. Bloustein School at Rutgers. She earned her bachelors degree in Economics at Stony Brook University. She developed her interest in planning and policy while working on various projects from affordable housing for low-income people to community development at the San Francisco Redevelopment Agency. Recently, she interned at the United Nations NY Headquarter Office within the Communications and Outreach Department of the Sustainable Division, analyzing and assisting the Major Groups participation in the Rio+20 follow-up process. Over last summer, she interned at the United Nations Office of Sustainable Division in Korea, assisting with development of a knowledge sharing portal and international capacity development courses involving civil servants from 40 developing countries. In the future, she plans to continue to learn more and work in the field that creates safe and attractive places for people to live, work and play.

Jiayi Ding is a second year Master of City and Regional Planning student at Edward J. Bloustein School of Planning and Public Policy at Rutgers, The State University of New Jersey. Her concentration is environmental and physical planning, with a Geospatial Information Science (GIS) Certificate. To prepare for a career in real-world uses of GIS, Jiayi has studied ArcGIS in five graduate level courses and used it in a variety of projects, such as disaster recovery and site selection. She is also experienced with visualization tools such as AutoCAD, SketchUP, and Adobe Creative Suite. She is dedicated to applying GIS to describe how the world looks and to analyze how the world works. Jiayi also has a bachelor degree in Mechanical Engineering where she developed strong abilities of logic and data analysis.

Allison Fahey is a second year Master of City and Regional Planning candidate at the Bloustein School at Rutgers. She received a BA in Communication and Culture with a minor in Tourism Management at Indiana University–Bloomington where she developed an interest in urban planning to design walkable and bikeable cities that provide a sense of place and community. Allison joined the Bloustein School's MCRP program while working with Louis Berger's business development team, using her communications skills to develop materials for proposals, qualification packages and client presentations. She has received an up-close-and-personal view of the technical side of how urban planning can create livable and sustainable communities through design, rehabilitation and improvement of built and natural environments. Allison was one of four Berger/Bloustein Summer Fellows in 2013 during which she worked in Paris alongside Louis Berger staff improving their program management methodology (project scheduling, budget follow-up and information-sharing among others) based on her previous experience with U.S. transportation projects. Allison's concentration at Bloustein is Environmental and Physical Planning with a focus on land use, the balance between preservation and development, green infrastructure implementation for stormwater management and river restoration and economic impact analysis and valuation of the natural environment.

Yuling Gao is a graduate student at the Edward J. Bloustein School of Planning and Public Policy at Rutgers, The State University of New Jersey. She will complete a Master of City and Regional Planning (M.C.R.P) degree in May 2014 with a concentration in Environment Planning and a certificate in Geospatial Information Science. She also strengthens her real estate financial knowledge and urban design skills while learning at Bloustein. Currently, Yuling works as a graduate research assistant at the School of Environmental and Biological Sciences, Rutgers. She has participated in the project "Land Development on Water Resources of the Pinelands Region" for New Jersey Future, developing statistical analysis and creating relevant maps for the public water infrastructure systems in the Pinelands Region in New Jersey;

and has also assisted in another project, "Elevating the Importance of Upgrading New Jersey's Urban Water Systems", analyzing combined sewer outflow area and creating relevant maps for 21 New Jersey cities.

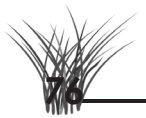
Chenille Gumbs had been a coordinator for several waterway cleanup initiatives with local grass roots organizations in New Brunswick, NJ. In this capacity she has organized many individual and group volunteers by exploring new strategies to educate, excite, and involve local community members of all ages in environmental issues and methods of action. As a member of the Red Root Creek Wetlands and Habitat Restoration Studio at the Edward J. Bloustein School of Planning & Public Policy, Rutgers University she has explored the land use policies for Edison and Woodbridge Townships in New Jersey, as they relate to public immersion into wildlife habitat; focusing on the effectiveness of such policies with creative but prudent third party proposals for these areas. Chenille earned her Bachelor of Arts at Rutgers University, and will complete her Master of City and Regional Planning in May 2014, with a concentration in Environmental and Physical Design.

Sara Malone, Studio Co-Instructor, is a Professional Research Manager in the Environmental Analysis and Communications (EAC) Group of the Edward J. Bloustein School of Planning and Public Policy at Rutgers, the State University of New Jersey where she works with the Sustainable Raritan River Initiative and the New Jersey Healthy Homes Initiative. Prior to joining the EAC Group, Sara was Director of Finance and Human Resources for Rainier Investment Management, Inc., a Seattle based privately held investment firm managing separate accounts, collective trusts and the Rainier Funds. She has a background in regional planning, project management, accounting, and human resources management and has training in ecological restoration and landscape design. Ms. Malone holds a Bachelor of Science from the University of Massachusetts/Boston and she received a Master of Environmental Studies from the University of Pennsylvania in 2012 where her academic focus was on ecology, wetlands restoration, and damaged lands reuse. She is a member of the Franklin Township Shade Tree Commission in Somerset County.

Michael Manzella is a graduate student at the Edward J. Bloustein School of Planning and Public Policy at Rutgers, The State University of New Jersey. He will complete a Masters of City and Regional Planning (M.C.R.P.) degree in May 2014 with a concentration in Transportation Policy and Planning. Michael has been a graduate research assistant at the Rutgers Center for Green Building while at the Bloustein School, developing life-cycle cost-benefit analyses of energy efficient measures in residential home buildings for the State of New Jersey and assisting with various other energy efficiency studies. He also had an internship experience at NJ TRANSIT in the summer of 2013 in the Transit Friendly Land Use Planning and Development group of the Capital Planning department at the agency, furthering the efforts of the Together North Jersey Regional Sustainable Transportation Plan, which is funded by the U.S. Department of Housing and Urban Development. Previous to pursuing graduate studies in Planning, Michael had been employed as a Project Engineer at the aerospace and defense firm Hamilton Sundstrand (now UTC Aerospace Systems), a subsidiary of United Technologies. He holds a Bachelor of Engineering in Engineering Management (2009) from Stevens Institute of Technology in Hoboken, NJ. Michael is also a member of the Zoning Board of Adjustment in the City of New Brunswick, NJ and holds certification as a LEED Green Associate.

Alexander McClean is a graduate student at the Edward J. Bloustein School of Planning and Public Policy at Rutgers, The State University of New Jersey. He will be completing his Masters in City and Regional Planning (M.C.R.P) degree in May of 2014 with a concentration in Water Management Planning. He has worked for the Department of Human Ecology as a research assistant on a publication for New Jersey Future entitled "Elevating the Importance of Upgrading New Jersey's Urban Water Systems: Water Infrastructure in 21 New Jersey Cities." His analysis focused on the legal framework behind New Jersey's Pollution Discharge Elimination System (NJPDES) that is used to regulate the State's combined sewer system (CSS) infrastructure, mitigation strategies, and current public safety risks.

Alison McKenna, a first-year Masters of City and Regional Planning student in the Environmental Planning concentration in the Bloustein School at Rutgers, is a Certified Floodplain Manager (CFM). She is a nearly lifelong resident of the Jersey Shore, having grown up two blocks from the ocean and a block from the Shrewsbury River in Monmouth Beach. Alison's home was destroyed in Hurricane Sandy, and she later volunteered in both Ortley Beach and Union Beach after the storm. These experiences have shaped her desire to pursue a career in coastal resiliency planning and hazard mitigation. Alison received a Bachelor of Science degree in Economics from Carnegie Mellon University in Pittsburgh, PA and later graduated from Fairleigh Dickinson University



with a Masters in Public Administration. Her professional experience includes positions with FEMA, the statistical unit of the NJ Department of Labor and Workforce Development, and the IT industry. An avid triathlete and runner, Alison enjoys spending her free time training by the various water bodies of the Jersey Shore.

Iskra Petrova is an architectural designer in a small New York firm, currently going for her masters in City and Regional Planning from Rutgers University. As part of her graduate curriculum she has acquired many new skills that have contributed to her knowledge of the various fields and topics of urban planning. She has been an active member in the Red Root Creek: Wetland Restoration studio this semester. She has contributed to class discussions, research, and aided in the composition of the report. She has used her previously acquired graphical skills to better illustrate the studio's vision for Red Root Creek. The scope of this studio and report has familiarized Iskra with the complex regulations that are involved with restoring a wetland, especially due to the conflicting heavy industrial current use of the site, along with a long history of contamination.

Sara Wenger is a graduate student at the Edward J. Bloustein School of Planning and Public Policy at Rutgers, The State University of New Jersey. She will complete a Masters of City and Regional Planning (M.C.R.P.) degree in May 2014 with a concentration in Environmental Planning and Geospatial Science. Upon graduation, she will join Eastgate Regional Council of Governments, a metropolitan planning organization in northeast Ohio. She has been a graduate assistant at Rutgers and has interned with both local and county governments as well as volunteered at Congressman Frank Pallone's New Brunswick office. Prior to her graduate studies, she was employed in Washington D.C. as an Outreach Associate for information and communications technology for environmental and agricultural development. She holds a Bachelor of Arts and a Bachelor of Philosophy in Interdisciplinary Studies from Miami University in Oxford, Ohio. As part of her interdisciplinary studies work, she monitored water quality in the Miami Valley. She holds certification as a LEED Green Associate.

Xiaozhou Zhang is a student of the Edward J. Bloustein School of Planning and Public Policy at Rutgers University pursuing a Masters of City and Regional Planning degree with concentrations in GIS and Physical Planning. Xiaozhou has worked in many GIS projects, focusing on mapping and spatial analysis. She has broad experience collecting, analyzing, visualizing and presenting data. Previously, Xiaozhou graduated Summa Cum Laude from Wuhan University with a Master of Engineering in Surveying and Mapping and a Bachelor of Science in Geographic Information System