HUDSON-RARITAN ESTUARY
ENVIRONMENTAL RESTORATION FEASIBILITY STUDY

LOWER HUDSON RIVER

STUDY AREA REPORT

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U.S. Army Corps
of Engineers
New York District

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I. INTRODUCTION

Background

1. The New York District of the Corps of Engineers (the District) is conducting a feasibility study for ecosystem restoration in the Hudson-Raritan Estuary (the Estuary) – the Hudson-Raritan Estuary Ecosystem Restoration Study, herein referred to as "HRE". The study area is delineated as the Port District, an area surrounding greater metropolitan New York City within an approximate 25-mile radius of the Statue of Liberty (Figure 1). However, for purposes of ecological continuity the actual study area may include additional portions of this system beyond the man-made Port District boundary.

2. The overall goal of the HRE is to restore ecological function and diversity that have been lost or degraded as a result of human activities. The HRE will rely on both existing and newly obtained natural resource data to identify areas to be restored or conditions that must be addressed to assure successful ecosystem restoration. The two primary components of the study are the preparation of a Comprehensive Restoration Implementation Plan (CRIP) and the implementation of restorations/enhancements at various locations in the Estuary.

3. The purpose of the CRIP is to serve as a master plan that lays out a comprehensive and coordinated strategy that, when implemented, will guide the ecological restoration of the Estuary. The CRIP will establish a framework within which the actions needed for successful restorations can be holistically evaluated and planned. The plan will address actions to enhance, expand, recreate, and diversify natural habitats, and actions to eliminate constraints to ecological functions, such as sediment contamination. The CRIP will describe the strategy for restoration efforts that will include immediate, mid-term, and long-range options. It will also provide a central focus for public input, data collection, restoration efforts, and management actions and policies, regardless of who might have authority, desire and/or funds to undertake any action.

Study Area Delineation of the Estuary

4. To get a more manageable and understandable picture of the Estuary, its history of degradation, local needs and desires, potential restoration opportunities, and current restoration efforts will be documented in eight Study Area Reports (SARs). The study area boundaries are typically delineated by major watersheds and/or major physical features, such as highways or waterways. By and large, each study area can be characterized by its ecological functions, history of degradation, and resulting needs and opportunities. For example, Jamaica Bay, a historically expansive wetlands complex, has been subject to extensive fill and loss of wetlands; the Hudson River system, to hardened shorelines and contaminated sediment; and the Lower Bay contains coastal and offshore environments, experiencing loss of dunes and benthic habitat. Separating the project area into smaller study areas will enable the study team and potential stakeholders to address study area-specific restoration needs as well as individual restoration opportunities within each study area, and to collect and characterize data in a more usable and understandable way, all under the ultimate umbrella of the CRIP, which links the study areas into one major plan.

5. The eight study areas to be included in the CRIP are as follows (see Figure 1):

1) Jamaica Bay,
2) Lower Bay,
3) Lower Raritan River,
4) Arthur Kill/Kill van Kull,
5) Newark Bay/Hackensack River/Passaic River,
6) Lower Hudson River,
7) Harlem River/East River/Western Long Island Sound,
8) Upper Bay.

Purpose of the Study Area Reports

6. The identification of potential restoration opportunities in each study area will be a two-fold process. First, the District will identify potential restoration sites based upon a preliminary needs

and opportunities survey of various interested groups/agencies conducted by the Regional Planning Association (RPA) and presented in their Needs and Opportunities Report. This information will be supplemented by additional analyses of restoration needs and opportunities on a more local level. Study area needs will be determined based upon the causes of ecosystem degradation and the condition of existing natural resources in each study area. This effort is already underway (but far from completed) and potential restoration sites in the Lower Hudson River study area have been identified.

7. Second, the District will hold stakeholder meetings in each study area. The purpose of these meetings will be to incorporate additional comments from environmental organizations, community groups, and other individuals and stakeholders in each study area. This process will ensure the needs and opinions of as wide and diverse a group as possible are incorporated into the CRIP.

Format of the Report

8. This Study Area Report addresses the Lower Hudson River study area. The **Study Area Description** section describes the setting, history of degradation, existing land/water usage, and existing natural resources in the study area. Restoration needs and existing restoration efforts are summarized in the **Ecosystem Restoration** section.

II. STUDY AREA DESCRIPTION

Setting

9. The Lower Hudson River study area extends from the Upper Bay (at The Battery in Manhattan) to just south of the Tappan Zee Bridge (Figure 2). Included in the study area is the Hudson River and the narrow strips of riparian land on each bank in Bergen County, New Jersey and, Rockland and Westchester Counties, New York. This area includes approximately 25 miles of the 315-mile long Hudson River, of which 155 miles is tidally influenced. Therefore, it encompasses only a small fraction of the Hudson River watershed, or Hudson River Valley.

Study Area History

10. In the centuries preceding European settlement of the region, the Hudson River Valley was home to several groups of Native Americans, including the Mohican and Haudenosaunee. The recorded history of the Hudson began with its exploration by Henry Hudson in 1609. Dutch colonists subsequently settled an area near the mouth of the Hudson River, which they named New Amsterdam, which subsequently became New York City.

11. Colonial development in the region was minimal; however, following the American Revolution, the Hudson River Valley became an area of industrialization. The introduction of steamboat travel in 1807 was instrumental in getting people and supplies up and down the Hudson River and promoting development. By 1850, estimates suggest that roughly 150 vessels carried as many as a million passengers each year (HTRC, 2002). During the industrial period, the Hudson River served as the nation's first great commercial transportation artery, linking New York City to the west by the Erie Canal, and to the coalmines of Pennsylvania by the Delaware and Hudson Canal.

12. The Hudson River was the setting for some of the most significant American industrial and commercial enterprises of the 19th century, including the West Point Foundry, the first steamships, and the iron mills of Troy (EPA, 1998). Industrial enterprises that thrived along the Hudson River also included whale processing, ice production, brick making, and brewing (HTRC, 2002). Port cities like Newburgh, Kingston and Poughkeepsie stimulated agricultural development in the surrounding counties.

13. Immigration to the eastern U.S. in the late 19th century was primarily through New York City. Spurred by the Irish famine, and German political and economic unrest, and inspired by the opening of land in the West, millions of immigrants passed through New York during this period (NJDEP, 2003), causing New York City to surge in size.

14. After World War II, businesses such as IBM, General Motors and General Electric invested heavily in the Hudson River Valley. The suburbanization of the Valley was accelerated by the construction of one of the nation's busiest commuter railroad networks and the expansion of the interstate highway system. As the lower Hudson River Valley became an increasingly popular bedroom community for the New York City metropolitan area, agricultural land in the Valley came under tremendous pressure (EPA, 1998).

15. Due to its impact throughout American history on historical events and trends of the northeastern United States — exploration, war, industrialization — the Hudson River has been designated as an American Heritage River.

History of Degradation

16. Human activities, particularly industrial and former agricultural land use, have directly affected the ecosystems of the Lower Hudson River study area. Toxic contamination and an abundance of nutrients have degraded water quality and sediments. Hardened shorelines replaced natural habitat, marshes and coves were cut off from the river, the circulation of tidal water into bays was restricted, and shallows adjacent to wetlands/mudflats filled (NYSDEC, 2001). Invasive species have reduced habitat quality in many wetland habitats.

PCB Contamination

Background

17. From approximately 1947 to 1977, the General Electric Company (GE) discharged as much as 1.3 million pounds of polychlorinated biphenyls (PCBs) from its capacitor manufacturing plants at the Hudson Falls and Fort Edward facilities into the Upper Hudson River (EPA, 2003). Since 1974, numerous studies have documented continued high levels of PCBs in the water, sediments, and fish downstream of these sites. Because of this contamination, the United States Environmental

Protection Agency (USEPA) designated a 200-mile stretch of the Hudson River, from Hudson Falls to the Battery in New York City, as a Superfund site.

18. Although GE ceased using PCBs at its plants in 1977, residual contamination at the plant sites has continued to impact the river. In 1991 and 1992, measured PCB levels in the waters of the Hudson River actually rose significantly. This was a result of continuing PCB releases from PCB-saturated bedrock beneath the Hudson Falls plant as well as releases of PCBs from other areas due to sudden erosion. Additional seepage of PCBs has been found as recently as 1994. Contaminated sediments and soils also continue to contribute a significant amount of PCBs to the water column. The EPA concluded that the contaminated sediments in the upper river are a major source of PCBs to the entire river environment as far as New York Harbor.

19. Remnant deposits in the upper Hudson, located in the river between Hudson Falls and Fort Edward, were exposed when the removal of the Fort Edward dam in 1973 lowered the river level upstream of the former dam site by approximately 15 feet. Four of these deposits were capped by GE in 1991. A continuing remediation program, consisting of dredging, treatment, and removal of the contaminated sediment, is currently being developed and could play a major role in curtailing or even eliminating this major existing source of contamination (USDOI, et al., 2001).

Impact of PCBs on Fisheries

20. Although the source of PCB contamination is in the Upper Hudson River, the release of contaminants impacts fish along the entire length of the river and into the HRE study area. New York State began assessing the levels of chemical contaminants in fish flesh in the early 1960s and elevated levels of PCBs were first discovered in Hudson River biota in 1969, but their importance was not recognized for several years. In the early 1970s, the DEC began collecting limited data on PCBs in New York waters and fish.

21. In 1973, the Federal Food and Drug Administration (FDA) adopted a “tolerance” level for PCBs in food sold commercially, including fish. At least 7 of the 11 species of Hudson River fish sampled between 1970 and 1972 had concentrations of PCBs which exceeded that level. In 1975, the EPA

concluded that the contamination of the Hudson River exceeded, in level and scope, any other area in the United States. Beginning in December 1974, DEC undertook a systematic PCB sampling program and found that most species of Hudson River fish were contaminated with levels of PCBs that exceeded FDA guidelines by a substantial margin. Subsequently, the DEC issued a set of regulations prohibiting commercial fishing in the river and restricting recreation landings of fish. The orders and advisories have been modified periodically since 1975 as a result of periodic releases of additional PCBs into the river; however, PCB-based consumption advisories continue for many species of Hudson River fish (USDOI et al., 2001).

Eastern Oyster Loss

22. The eastern oyster (*Crassostrea virginica)* has long been a native to the Hudson River Estuary; however, it has undergone a distinct period of degradation since European settlement in the region. Although climate conditions over recent centuries have become increasingly more suitable for oyster survivorship, oyster abundance has dramatically declined. This decline of oyster abundance in the Hudson River estuary can be directly attributed to human alterations to environmental mechanisms, namely increased sewage discharge and overall neglect of environmental assets, and has resulted in the virtual disappearance of the oyster from the Lower Hudson estuary. Decreases in dissolved oxygen and urbanization in New York City, primarily resulting from discharges of untreated sewage, has diminished water quality in which oysters were unable to survive (Chin-Sweeney, 2003).

Contaminated Sediments

23. Prior to the inception of the Clean Water Act in 1972, many of the industrial facilities in the region, such as GE, released toxic contaminants into local waterways. Because the amount of industry in the region is much less than that surrounding areas such as the Arthur Kill and Newark Bay, the extent of contaminated sediments is significantly less than those areas. However, localized areas of contamination remain, including areas high in polyaromatic hydrocarbons (PAHs), copper, and chromium.

24. Numerous studies of the problems have been undertaken by various organizations and agencies, including the Environmental Protection Agency, the National Oceanic and Atmospheric

Administration (NOAA), the USACE, and the States of New York and New Jersey, which have focused on the relationship between sediment contaminant levels and benthic habitat quality. More detailed discussions and results of past and current studies of sediment contamination are described in the more detail in the *Summary of Sediment Characterization Studies* (USACE – under development).

Water Quality

25. The Hudson River was once treated as the region's sewer. From the beginning of the industrial period, industrial waste, untreated sewage, and toxic chemicals were routinely discharged into the river for disposal. It was not until the 1960's that concerted efforts were begun to remedy the problem of degraded water quality. Initial environmental efforts, followed by the Clean Water Act in 1972, have led to a significant decrease in the discharge of pollutants in the river and a general improvement in water quality (Riverkeeper, 2003). However, due to the dense urbanization in the region, the study area is still plagued by point and non-point source discharges of pollutants and contaminants into the river. Occasionally malfunctioning STPs and CSOs discharge raw sewage to the river. Historic discharges (pre-1960s) frequently contained up to 70% raw sewage. As a result of these discharges, low DO concentrations sometimes occur during the spring and summer.

Hardened Shorelines

26. The majority of the shoreline areas in the study area have been disturbed due to commercial, industrial, or residential development. These activities have resulted in the bulkheading or filling of substantial areas along the Hudson River. On the east side of the river, most of the Manhattan shoreline to the George Washington Bridge has been bulkheaded to facilitate urban development. Where structures or roadways are not constructed to the waters edge, countless piers have been constructed to facilitate maritime commerce, travel, and recreation. One small area of natural shoreline remains in northern Manhattan, near the mouth of Spuyten Duyvil. North of Spuyten Duyvil, the shoreline has been reinforced with riprap as part of the Hudson Line, the rail line that runs along the river to Albany.

27. On the west side of the river, comparable development and redevelopment has and is occurring

from Jersey City north to Weehawken and Ft. Lee, New Jersey. Here, too, the shoreline has been bulkheaded to support development. North of the George Washington Bridge is the Palisades, which reaches over 800 feet above the river at its highest point (Beczak, 2003). The cliffs of the Palisades are a natural obstruction to development. The last few remaining natural wetlands areas exist near the Tappan Zee Bridge.

Invasive Species

28. Wetlands have been disturbed by human activities such as dredging, filling, altered hydrology, and in-river and shore-side construction. These activities, along with the degraded water quality, affected many species. Disturbance to wetland habitats and alteration of wetland hydrology has allowed invasive species to dominate many wetland systems. For example, common reed and purple loosestrife (*Lythrum salicaria*) dominate Piermont Marsh, which is a large wetland complex in the study area, greatly reducing the diversity, natural vegetation, and overall ecological value of the system from historical conditions.

Existing Land/Water Usage

29. The landscape surrounding the study area is predominantly developed. Along the waterfront, land and water uses are typified by marinas, marine parks, vacant disturbed land and residential land. Industrial and commercial land uses are common; however, the density of these facilities are not as high when compared to other study areas in the Estuary. Primary water uses include swimming, boating and fishing. Commercial navigation is prevalent. Some public and private bathing beaches are located along the lower Hudson, including the beach at Croton Point Park in Westchester County, as well as several public sites that were operated as beaches in the past along both sides of the Hudson River; however, none of these are within the study area.

30. Water is withdrawn for use as cooling water at three locations: the 59th Street Power Plant located on the west side of Manhattan; and the Bowline and Lovett Generating Stations, both located in Rockland County. Five sewage treatment plants (STPs) located in New Jersey (Edgewater, Hoboken, Paterson, West New York, and Woodcliff) and four STPs in New York (New York City's North River in Manhattan, Orangetown and Rockland County Sewer District No. 1 in Rockland

County, and Yonkers in Westchester County) discharge treated wastewater that is assimilated by the receiving waters. As stated previously, the Hudson River is used for commercial and recreational navigation and secondary contact recreation including water/jet skiing and fishing.

Natural Resources Conditions

31. The Lower Hudson River is an estuarine environment with moderate to high salinity zones. Turbidity is high in the study area, which limits phytoplankton production. As a result, the food web is detritus-based. Twenty-three fish species are common in the study area with bay anchovy (*Anchoa mitchilli*), winter flounder (*Pleuronectes americanus*), American shad (*Aalosa sapidissima*), Atlantic tomcod (*Microgadus tomcod*), and alewife (*Alosa pseudoharengus*) being the dominant species. The study area is also extremely important nursery and wintering habitat for striped bass (*Morone saxitilis*). The conditions prevalent in pier, shoal, and inter-pier areas may be particularly important foraging and overwintering areas for juvenile fish as they move from nursery habitat upstream of the study area to the more saline waters of the Estuary. Limited spawning and nursery habitat for anadromous fish exists on tributaries to the Lower Hudson study area due to impediments to fish movement.

32. A shallow subtidal area near Piermont Marsh supports some submerged aquatic vegetation (SAV). Species reported to be present include water celery (*Valisneria americana*), sago pondweed (*Potomogeton pectinatus*), and horned pondweed (*Zannichellia palustris*). Areas of SAV provide cover and nursery habitat for fish. Water celery and other aquatic plants are important food resources for canvasback ducks (*Aythya valisineria*).

33. Wetlands types present include brackish marsh and intertidal mudflats that transition into shallow, subtidal aquatic beds. Dominant species in these wetland areas include common reed (*Phragmites communis*) and narrow-leaved cattail (*Typha latifolia*). Other species that are present, but not dominant, include smooth cordgrass (*Spartina alterniflora*), spike grass (*Distichlis spicata*), rose-mallow (*Hibiscus moscheutos*) and purple loosestrife (*Lythrum salicaria*). Common reed dominates many wetland areas. For example, common reed covers approximately 70% of Piermont Marsh.

34. Wetlands and open water habitats support diverse bird communities. Concentrations of shorebirds, herons, and waterfowl use the shallow water habitats and mudflats as staging areas during migration. Breeding birds found in wetlands of the study area include Virginia rail (*Rallus limicola*), marsh wren (*Cistothorus palustris*), wood duck (*Aix sponsa*), and least bittern (*Ixobrychus exilis*). These wetlands also support a diverse community of reptiles such as northern water snake (*Nerodia sipedon sipedon*), diamond-backed terrapin (*Malaclemys terrapin terrapin*), and snapping turtle (*Cheldrya serpentine*). Furbearers commonly found include raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), and mink (*Mustela vison*).

35. This study area provides habitat for several threatened and endangered species including the pergrine falcon (*Falco pregrinus*), shortnose sturgeon (*Acipenser brevirostrum*), and bald eagle (*Haliaeetus leucocephalus*).

III. ECOSYSTEM RESTORATION

Hudson-Raritan Estuary Ecosystem

36. The New York-New Jersey Harbor Estuary Program (HEP 1996) has identified five primary factors that have caused ecosystem impairments or otherwise degraded water or habitat quality in the Estuary. These factors are:

- Habitat Loss and Degradation: Recent wetland inventories estimate at least 80% of the Estuary's wetlands have been lost or significantly altered.

- Toxic Contamination: The presence of toxins in the Estuary's waters, sediments, and biota is the result of historic and residual contamination by industrial and non-point sources. Today, wastewater discharges, CSOs, accidental releases, vehicle exhaust emissions, household chemicals, pesticides, atmospheric deposition, landfill leachate, urban runoff, and other non-point sources are continuing sources of toxic substances (HEP 1996).

- Pathogens: The primary sources of pathogens include CSOs, sewage treatment plant malfunctions, illegal connections to storm sewers, vessel sewage discharge, urban runoff, and other non-point sources.

- Floatable Debris: Floatable debris is made up of two primary components: trash or litter and harbor drift. Trash and litter enters the Estuary via runoff, storm sewer discharges, CSOs, beach and boat litter, and poor solid waste handling operations. Harbor drift composed primarily of material from dilapidated shoreline structures such as piers, bulkheads, and pilings, is a significant problem in the Estuary.

- Nutrient and Organic Enrichment: Eutrophication due to excessive discharges of nitrogen is a significant problem in the Estuary. Organic matter comprised primarily of carbon is decomposed as DO and used in the biochemical process. Nitrogen and carbon enter the Estuary through point and non-point sources such as sewage treatment plants, runoff (primarily from over-fertilized lawns), rivers and tributaries and atmospheric deposition.

Primary Restoration Needs of the Hudson-Raritan Estuary

37. The overall goal of the HRE is to restore and enhance aquatic and nearshore terrestrial habitats that have been lost or degraded as a result of human activities. To achieve this goal, primary restoration needs of the Estuary have been established. These categories were identified in the document entitled *Restoration Opportunities in the Hudson-Raritan Estuary* (USACE 2001) These needs are:

- Restore and create intertidal wetlands and mudflats,
- Restore benthic habitats and remediate “hot spots” of contaminated sediments,
- Restore and create freshwater/riparian wetlands,
- Restore fish habitat (remove impediments to fish passage; construct artificial reefs),
- Restore shellfish habitat,
- Restore and enhance shoreline/coastal fringe habitat (including upland areas),
- Create, restore, or enhance vegetated and non-vegetated shallow water habitat.

Restoration Needs of the Lower Hudson River Study Area

38. Ecosystem degradation in the Lower Hudson River study area has resulted from toxic contamination, shoreline modifications, wetland disturbance, wetland loss, and urbanization. Intense development along the Hudson River and its tributaries contributes significant amounts of non-point source pollution including contaminated urban runoff, nutrients, and sediments. Water quality impairments that are the result of this non-point source pollution can be detrimental to aquatic life. Therefore, the primary restoration needs in the study area are:

- Improve water quality,
- Restore river habitat and fish havens,

- Improve existing wetlands,
- Soften shorelines.

Riparian Buffers

39. Vegetated riparian buffers should be restored. These buffers help to filter runoff, reduce erosion, isolate aquatic areas from future human disturbance, and are effective in trapping sediments, nutrients, and contaminants before they enter the river. In addition, upland control of stormwater and the reduction of CSO effluent would be effective in improving water quality.

Shallow Water Habitat

40. The study area is an important migratory pathway for fish that spawn upstream of the HRE study area. Thus, there is a need for restoration and enhancement of shallow water habitat for juvenile fish that migrate downstream through the study area. The beneficial use of dredged material might be one option to create shallow, nearshore habitat. Creation of such habitat could allow for the reestablishment of beds of SAV, which provide important cover for juvenile fish and would provide foraging habitat for wading birds and waterfowl.

Invasive Species

41. Invasive species have over-taken many of the wetland areas that remain. Therefore, there is a need for the restoration of native vegetation in both freshwater and intertidal wetlands. Filled wetland sites should be regraded to restore tidal flow, eliminate common reed, and reestablish native salt marsh vegetation. Restoration will improve foraging habitat for wading birds, waterfowl, and raptors. Restoration of freshwater habitats will also benefit amphibians in the study area.

Hardened Shorelines

42. Hardened shorelines no longer in use or available for alternative technology or bioengineering protection should be softened to enable redevelopment of native areas.

Existing Restoration Efforts

43. Habitat restoration work in the Estuary has been underway for some time and various organizations, most notably, the Harbor Estuary Program (HEP) Habitat Workgroup, have identified potential sites and sought to promote restoration efforts. Several habitat restoration initiatives have also been completed or are moving forward in this study area.

Northern Manhattan Parks

44. The Natural Resources Group (NRG) of the New York City Parks Department has initiated restoration efforts at three city parks in northern Manhattan. The NRG is implementing a series of ecosystem restoration projects at Inwood Hill Park, Fort Washington Park, and Fort Tryon Park, in northern Manhattan, New York. The projects will reduce the amount of non-point source pollution entering the Hudson River through runoff from eroding slopes within the riparian zones. Geotextiles and other bioengineering materials will be used to stabilize eroding slopes. Several species of native trees, shrubs, and forbs have already been planted. These plantings have increased native plant species diversity, helped to reduce soil erosion, and have increased wildlife habitat in the parks. In addition to the plantings, invasive species have been removed from some areas. The portion of the restoration efforts that have been completed to date will improve the overall ecological value of the parks and will reduce the amount of sediments, nutrients, and contaminated urban runoff entering the Lower Hudson River.

Remediation of PCB Sediments

45. On August 13, 2003, the EPA signed an agreement with GE to perform the project design work for the cleanup of PCB-contaminated sediment in the Upper Hudson River. Under the agreement, embodied in the *Administrative Order on Consent for Remedial Design and Cost Recovery* (Design AOC), GE is responsible for designing a dredging project that will be conducted over a six-year period (anticipated to start in 2006), in two phases, consistent with the February 2002 Record of Decision (ROD) for the site and the engineering performance standards developed by EPA to ensure that the dredging is done safely and effectively (EPA, 2003).

Potential Restoration Sites

46. In addition to the existing and on-going restoration efforts, 10 potential restoration sites have been identified in the Lower Hudson River study area and are listed in Table 1. Each site not currently under study or construction will be evaluated to determine which of the proposed restoration activities, if any, are feasible from an engineering, ecological, and economic perspective.

Table 1 - Potential Restoration Sites in the Lower Hudson River

HRE Site ID	Name	Restoration Opportunities(1)
1LH	Akzo Chemical	*
2LH	Riverdale Park/Hudson River	8,9
3LH	Spuyten Duyvil	8,9
4LH	Inwood Park	7,8,9
5LH	Fort Tryon Park/Hudson River	9
6LH	Fort Washington Park/Hudson River	1,8
7LH	Hudson River Breakwaters	4
8LH	Riverside Park/Hudson River	9
9LH	Hudson / Bergen County Waterfront	1,2,6,7
10LH	Hudson River Park Estuarine Sanctuary	7,11

(1) Restoration Opportunities:
1 – Restoration/Creation of Intertidal Wetlands/Mudflats
2 – Benthic Habitat Restoration (Hotspot Removal)
3 – Restoration/Creation of Freshwater/Riparian Wetlands
4 – Restoration of Fishery Habitats (Anadramous Fish Migration, Artificial Reefs)
5 – Shellfish Habitat Restoration
6 – Restoration/Enhancement of Shoreline/Coastal Fringe Habitat (Dunes, Bird Habitat)
7 – Creation/Restoration/Enhancement of Shallow Water Habitat (including Eelgrass)
8 – Shoreline Enhancement/Bank Stabilization
9 – Water Quality Improvement
10 – Riparian Habitat Restoration
11 – Environmental Interpretation
* To be determined

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FIGURES