Draft Integrated Feasibility Report and
Tier 1 Environmental Impact Statement

NEW YORK-NEW JERSEY HARBOR AND TRIBUTARIES COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

September 2022

NEW YORK STATE | Department of Environmental Conservation

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

NEW YORK STATE OF OPPORTUNITY. | Department of State

NYC Mayor's Office of Climate & Environmental Justice

NEW YORK-NEW JERSEY HARBOR AND TRIBUTARIES COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

DRAFT INTEGRATED FEASIBILITY REPORT AND TIER 1 ENVIRONMENTAL IMPACT STATEMENT

This report summarizes work done to date on the New York-New Jersey Harbor and Tributaries coastal storm risk management feasibility study. It was prepared by the New York District, North Atlantic Division of the U.S. Army Corps of Engineers, in partnership with the New Jersey Department of Environmental Protection, New York State Department of Environmental Conservation, New York State Department of State, and New York City Mayor's Office of Climate and Environmental Justice. Cooperating Agencies include the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Coast Guard, National Ocean and Atmospheric Administration National Marine Fisheries Service, and the National Park Service. The Federal Emergency Management Agency is a Participating Agency.

This report details engineering, economic, and environmental analyses, and a Tentatively Selected Plan that could provide coastal storm risk management to the Study Area. The Study Area includes 25 counties in New Jersey and New York, including Bergen, Passaic, Morris, Essex, Hudson, Union, Somerset, Middlesex, and Monmouth Counties in New Jersey; and Rensselaer, Albany, Columbia, Greene, Dutchess, Ulster, Putnam, Orange, Westchester, Rockland, Bronx, New York, Queens, Kings, Richmond, and Nassau Counties in New York.

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The public is invited to submit comments by January 6, 2023 to:

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EXECUTIVE SUMMARY

The New York-New Jersey Harbor and Tributaries (NYNJHAT) Draft Integrated Feasibility Report and Tier I Environmental Impact Statement documents the U.S. Army Corps of Engineers (USACE) feasibility study planning process for coastal storm risk management (CSRM) and complies with the National Environmental Policy Act (NEPA) as incorporated into the planning process.

In 2012, Hurricane Sandy caused considerable loss of life, extensive damage to development, and massive disruption to the North Atlantic Coast. Twenty-six states were impacted by Hurricane Sandy, and disaster declarations were issued in 13 states. New York and New Jersey were the most severely impacted states, with the greatest damage and most fatalities in the New York Metropolitan Area. Flood depths due to the storm surge were as much as nine feet in Manhattan, Staten Island, and other low-lying areas within the New York Metropolitan Area. At the time, Hurricane Sandy was the second costliest hurricane in the nation's history and the largest storm of its kind to hit the U.S. east coast. The storm exposed vulnerabilities associated with inadequate CSRM measures and lack of defense to critical transportation and energy infrastructure.

On January 29, 2013, President Obama signed into law the Disaster Relief Appropriations Act of 2013 (Public Law 113-2), to assist in the recovery in the aftermath of Hurricane Sandy. The USACE North Atlantic Division was authorized by Public Law 113-2 to commence the North Atlantic Coast Comprehensive Study (NACCS) to investigate CSRM strategies for areas impacted by the storm. In January 2015, USACE completed the NAACS, which identified high-risk areas on the Atlantic Coast warranting further investigation for flood risk management solutions. The NYNJHAT focus area was one of the three focus areas identified. USACE is authorized under Public Law 84-71, June 15, 1955 (69 Stat. 132), as modified, to conduct an investigation into potential CSRM solutions within the NYNJHAT Study Area. The study authority is provided by Public Law 84-71, approved June 15, 1955, which calls for:

> *"…an examination and survey to be made of the eastern and southern seaboard of the United States with respect to hurricanes, with particular reference to areas where severe damages have occurred… Such survey, to be made under the direction of the Chief of Engineers, shall include the securing of data on the behavior and frequency of hurricanes, and the determination of methods of forecasting their paths and improving warning services, and of possible means of preventing loss of human lives and damages to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams, and other structures, warning services, or other measures which might be required."*

The USACE New York District, in partnership with the New York State Department of Environmental Conservation (NYSDEC) and the New Jersey Department of Environmental Protection (NJDEP) as the non-federal sponsors, are undertaking this study. In addition, the City of New York and the New York State Department of State are non-federal partners. The Feasibility Cost Sharing Agreement was executed on July 15, 2016 between the USACE New York District, the NYSDEC, and NJDEP.

The study purpose is to determine the feasibility of constructing a technically feasible, environmentally acceptable, and economically justified project that will manage coastal storm risk while supporting the study area's economic and community resilience. This study area encompasses tidally influenced areas within the New York metropolitan area, which includes New York City, the country's most populous and densely populated city, as well as the six largest cities in the State of New Jersey. The need for this study derives from the significant and widespread damage to communities, infrastructure, and the economy caused by coastal storms. Potential damages are expected to increase in the future due to an increase in the extent and depth of inundation, increase in wave heights, and increased erosion caused by higher water levels and wave heights associated with a projected relative increase in the region's sea level.

NEPA requires federal agencies, including USACE, to consider the potential environmental impacts of their proposed actions and any reasonable alternatives before undertaking a major federal action, as defined by 40 Code of Federal Regulations (CFR) 1508.18. To evaluate potential environmental impacts, USACE has prepared this Integrated FR/Tier 1 Environmental Impact Statement. An Environmental Impact Statement is a supporting document that is the most thorough and comprehensive level of NEPA documentation used to assist in making a decision. The Environmental Impact Statement will be conducted in two stages or tiers. Tiering, which is defined in 40 CFR 1508.28, is a means of making the environmental review process more efficient by allowing parties to "eliminate repetitive discussions of the same issues and to focus on the actual issues suitable for decision at each level of environmental review" (40 CFR 1502.20). Tier 1 is a broad-level review, and Tier 2 consists of subsequent specific detailed reviews that will occur during the Preconstruction Engineering and Design phase of the project.

A Tier 1 Environmental Impact Statement involves technical analysis completed on a broad scale and is therefore an effective method for identifying existing and future conditions and understanding the comprehensive effects of the project. It provides the groundwork for future project-level environmental and technical studies and modeling and agency consultation. The Tier 2 Environmental Impact Statement(s) will include one or more subsequent detailed reviews, in the form of an Environmental Impact Statement, as the Recommended Plan design becomes more refined and is further assessed during Preconstruction Engineering and Design.

The study team recognizes the importance of sharing timely information with the public and agencies as an important key to the study's success. To support this, an Interim Report was released in February 2019 which summarized study activities completed through early 2019. The Interim Report presents a summary of existing information, technical analysis, interim planning activities, and conceptual alternative plans as of February 2019. It remains a resource for the study team and the public. The public and agencies were invited to provide comments. Feedback on the Interim Report was considered and incorporated into the analyses summarized in this report.

Utilizing the USACE Planning Process as specified in Engineer Regulation (ER) 1105-2-100 and the Planning Manual Part II: Risk-Informed Planning, plan formulation was conducted with a focus on achieving the federal objective of water and related land resources project planning, which is to contribute to the Nation's national economic development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable Executive Orders, and other federal planning requirements. Plan formulation also considers all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines (1983): NED, environmental quality, regional economic development, and other social effects.

USACE considered a range of nonstructural, structural, and natural and nature-based measures that have the potential to improve CSRM. These measures include floodwalls, levees, storm surge barriers, ring walls, wet and dry floodproofing, elevations, beaches and dunes, wetlands, and reefs. Alternative plans were developed from management measures to meet planning objectives and avoid the planning constraint while reasonably maximizing NED benefits. The alternative plans span the spectrum of predominantly off-shore, in-water structures such as storm surge barriers that provide CSRM for most of the study area, to solely shore-based measures consisting of measures such as floodwalls and levees at localized areas of high coastal storm risk. In between are the regional hybrid combinations of smaller barriers and land-based measures.

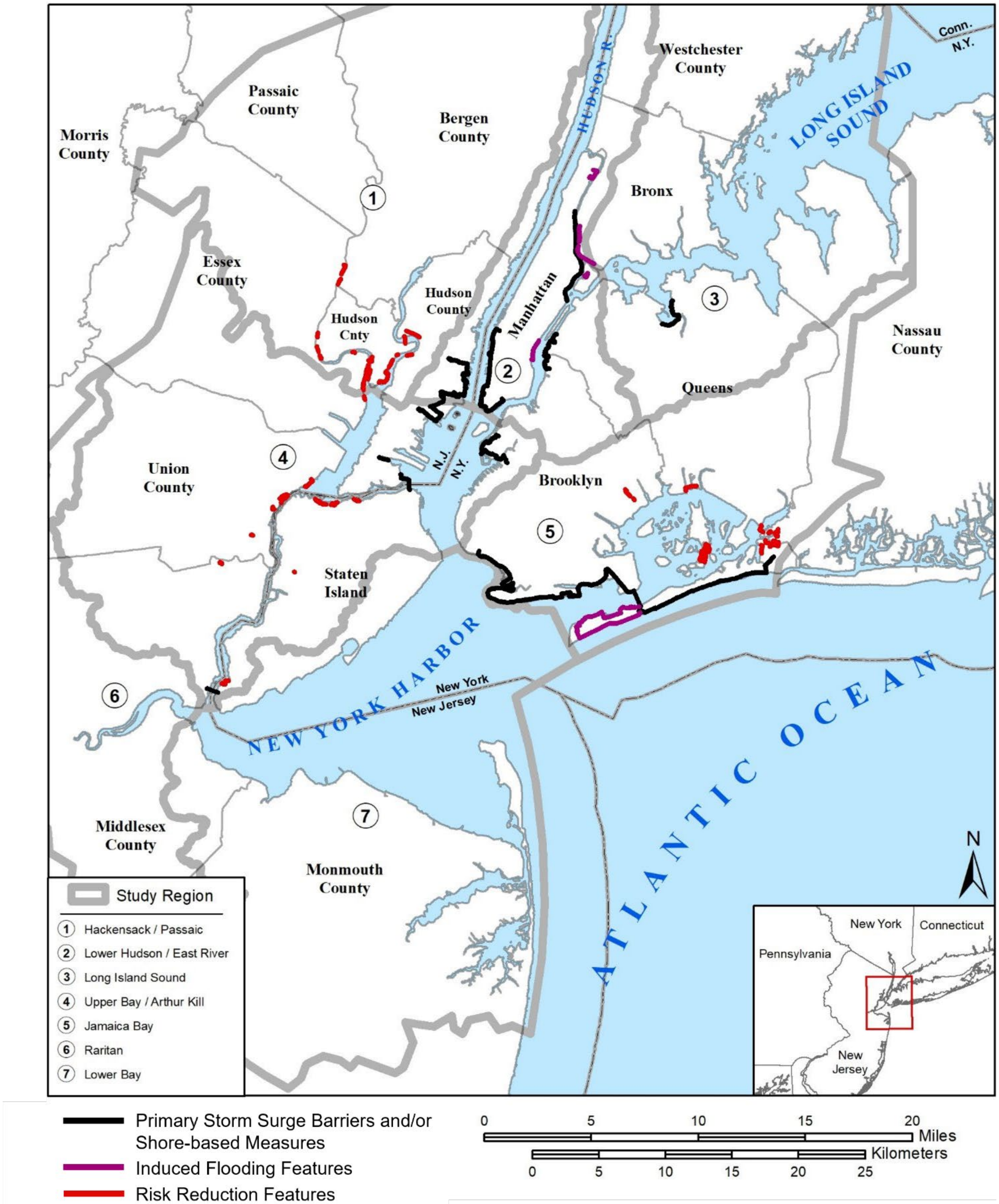
After careful evaluation of the alternatives and their tradeoffs, the study team and non-federal sponsors, NYSDEC and NJDEP, selected Alternative 3B – Multi-basin Storm Surge Barriers With Shore-Based Measures as the Tentatively Selected Plan. The Tentatively Selected Plan manages coastal storm risk through suite of CSRM measures that function as a system including: primary structural components consisting of storm surge barriers at the entrance to Jamaica Bay, Arthur Kill, and Kill Van Kull to provide CSRM on a multi-basin basis, three primary structural components involving storm surge barriers on the individual water bodies of Gowanus Canal, Newtown Creek and Flushing Creek located in Brooklyn and Queens, and three primary structural shore-based measures in Jersey City, the lower west side of Manhattan, and East Harlem. Portions of the study area that directly benefit from the Tentatively Selected Plan include the Hackensack and Passaic River watersheds, Upper Bay and Arthur Kill, Lower Hudson River, East River, Long Island Sound and Jamaica Bay Planning Regions.

In addition to the primary storm surge barriers and shore-based measures, there are also nonstructural measures, natural and nature-based features, land and water based measures to mitigate for any anticipated induced flooding from the project (known as Induced Flooding Features), and small scale measures that can be implemented quickly to address high frequency flooding at the most vulnerable potions of the study area (known as Residual Risk Features). In the instance of a large storm, storm surge barriers, navigable gates, and deployable flood barriers would help to reduce risk to vulnerable areas from flood damages relating to flooding, including the loss of human life and damage to existing infrastructure. Within areas of reduced risk are schools, parks, energy and transportation infrastructure, container and other cargo terminals, that would all see significant benefit through implementation of the study measures.

The Tentatively Selected Plan was designed to avoid and minimize environmental and cultural resource impacts while still reducing the risk of coastal storm surge. The mitigation measures being considered in this Tier 1 FR/ Environmental Impact Statement to avoid, minimize, reduce, or rectify potential adverse environmental impacts of the Tentatively Selected Plan.

As this is an Integrated Feasibility Report/Tier 1 Environmental Impact Statement with a conceptual level of design, compensatory mitigation and adaptive management will be further refined in subsequent phases of the study and in coordination with the appropriate federal, state, and local agencies. Impacts that cannot be avoided or minimized will be mitigated, either through the restoration and/or enhancement of habitat, purchasing of credits from a mitigation bank, or an in-lieu fee program. It is anticipated there may be affected habitat with limited opportunities for in-kind mitigation for a study of this scale, and therefore, out-of-kind mitigation will require a greater level of coordination with federal, state, and local agencies.

At current price levels (Fiscal Year 2022 price level), the Tentatively Selected Plan has an estimated project first cost of $52,627,325,000 and an annualized cost of $2,551,663,000 (based on 2.25% discount rate). The annualized cost includes planning, engineering and design, construction management, interest during construction, and operation and maintenance, including contingencies. The Tentatively Selected Plan provides an estimated $3,707,484,000 in annualized net benefits, and has a benefit-cost ratio of 2.5. The plan would be cost shared as 65 percent Federal ($34,207,761,000) and 35 percent Non-Federal ($18,419,564,000). Within the non-federal share, the costs for the value of lands, easements, rights-of-way, and relocations are estimated to be $5,805,739,000. The cost of operation and maintenance is estimated at $346,764,000 annually. The non-federal sponsors, NYSDEC and NJDEP, have indicated their support for releasing this report for public.



Regional Overview of All Features Included in the Tentatively Selected Plan.

PERTINENT DATA

Tentatively Selected Plan Features

The Tentatively Selected Plan (TSP) is Alternative 3B – Multi-basin Storm Surge Barriers With Shore-Based Measures. The TSP includes a combination of coastal storm risk management (CSRM) measures that function as a system to manage the risk of coastal storm damage in the New York Metropolitan Area, including a combination of shore-based and in-water measures. These measures are located within the Hackensack/Passaic, Upper Bay/Arthur Kill, Lower Hudson/East River, Long Island Sound and Jamaica Bay Planning Regions. The TSP measures include Multi-basin Storm Surge Barriers, Shore-Based Measures, complementary Induced Flooding-Mitigation Features and Risk Reduction Features as well as nonstructural measures and natural and nature-based features described in more detail as follows:

The TSP includes storm surge barriers and complementary shore-based measures at Jamaica Bay, Arthur Kill, Kill Van Kull, Gowanus Canal, Newtown Creek, Flushing Creek, Sheepshead Bay, Gerritsen Creek, Hackensack River, Head of Bay, Old Howard Beach East, and Old Howard Beach West. The shore-based measures would provide land-based CSRM and include floodwalls, levees, elevated promenades, buried seawalls/dunes, revetments, berms, bulkheads, pedestrian/vehicular gates, and road raisings. Ringwalls and shore-based measures will also be considered under the TSP, to be further refined for the Final Integrated FR/Tier 1 EIS.

Risk Reduction Features would provide CSRM in areas behind Storm Surge Barriers that may experience high frequency flooding when the barriers are not operated.

Induced Flooding-Mitigation Features would provide CSRM in areas in front of Storm Surge Barriers that may experience induced flooding due to operation of the Storm Surge Barriers.

Nonstructural measures to be included in the TSP may include structure elevations and floodproofing. Currently, conceptual nonstructural measure locations are located throughout the Study area; however, nonstructural measures and locations will be further refined for the Final Integrated FR/Tier 1 EIS.

Natural and nature-based features (NNBF) to be included in the TSP consist primarily of natural features such as wetlands and living shorelines that may provide both CSRM and ecological enhancement. Specific NNBF types and locations will be further refined for the Final Integrated FR/Tier 1 EIS. At this time, it is anticipated they will be located in areas that experience high frequency coastal flooding.

While the TSP will improve coastal flood risks in the project area, it will not totally eliminate flood risks; therefore, residual risk for flooding still remains a threat to life and property. It is essential that flood risk be proactively communicated to residents in accessible and thoughtful ways.

Construction

The project assumes a construction start date of 2030 with an overall duration of approximately 14 years, ending 2044. Construction years are assumed for the economics evaluation in the study and are subject to report and project approvals and funding requirements, including federal and non-federal funds. Construction will take place within the applicable environmental work windows.

Real Estate Requirements

Federal law requires that the non-federal sponsors (NJDEP and NYSDEC) provide the lands, easements, rights-of-way, and relocations necessary for a USACE project[1]. The TSP's total estimated real estate cost is $5,260,470,000 for the Lands, Easements and Rights of Way required in the State of New York and $545,270,000 for the Lands, Easements and Rights of Way required in the State of New Jersey. The Lands, Easements and Rights of Way required for the TSP will encompass an estimated land total of 531.35 acres and will impact approximately 1,590 parcels. These costs will be borne by the non-federal sponsors.

Project Cost

Project first cost is the constant dollar cost at the current price level and is the cost used in the authorizing document for a project. At current price levels (Fiscal Year 2022 price level), the Tentatively Selected Plan has an estimated project first cost of $52,627,320,000. The plan would be cost shared as 65% federal and 35% non-federal.

	Tentatively Selected Plan
First Cost	**$52,627,320,000**
Lands and Damages	$5,805,740,000
Relocations	$2,367,470,000
Fish & Wildlife Facilities	$5,045,100,000
Breakwaters and Seawalls	$17,934,480,000
Levees & Floodwalls	$14,145,890,000
Cultural Resource Preservation	$152,220,000
Buildings, Grounds & Utilities	$34,440,000
Planning, Engineering & Design	$5,654,080,000
Construction Management	$1,487,910,000
Average Annual Equivalent (AAEQ)	
Operation and Maintenance	$346,764,000
AAEQ Costs [2]	$2,551,660,000
AAEQ Benefits	$6,259,000,000
AAEQ Net Benefits	$3,707,480,000
Benefit-Cost Ratio	2.5

FY22 price level and discount rate of 2.25%.

[1] Includes first cost, interest during construction, and associated costs.

[2] Includes operation and maintenance

[1] Any conclusion or categorization that an item is a utility or facility relocation to be performed by the non-federal sponsor as part of its lands, easements, rights-of-way, and relocations responsibilities is preliminary only. USACE will make a final determination of the relocations necessary for the construction, operation or maintenance of the project after further analysis and completion and approval of a Final Attorney's Opinion of Compensability for each of the impacted utilities and facilities.

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Glossary of Acronyms and Terms

Term/Acronym	Expanded
ADCIRC model	ADvanced CIRCulation model
AdH Model	Adaptive Hydraulics model
AEP	annual exceedance probability
BCR	benefit to cost ratio
CAFRA	Coastal Area Facility Review Act
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CEA	Critical Environmental Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CSO	Combined Sewer Outfalls
CSRM	Coastal Storm Risk Management
CZMA	Coastal Zone Management Act
DO	dissolved oxygen
DOI	Department of Interior
DOT	Department of Transportation
DRSAA	Disaster Relief Supplemental Appropriations Act
EDC	Economic Development Corporation
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
EOP	Environmental Operating Principles
EPA	Environmental Protection Agency
EQ	environmental quality
ERDC	U.S. Army Engineer Research and Development Center
ESA	Endangered Species Act
ESI	Environmental Sensitivity Index

FCSA	Fiscal cost share agreement
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FR	Feasibility Report
FSCA	Feasibility Cost Sharing Agreement
FWOP	future without project
FWOPC	future without project condition(s)
FWP	future with project
FWPC	future with project condition(s)
GIS	Geographic Information System
GMP	Gross Metropolitan Product
GNRA	Gateway National Recreation Area
HEC-FDA	Hydraulic Engineering Center Flood Damage Reduction Analysis
HTRW	Hazardous, Toxic, and Radioactive Waste
HUC	Hydrologic Unit Code
IFF	Induced Flooding-Mitigation Feature, referred to in prior study products as Induced Flooding Feature
IPaC	Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
IWR	Institute for Water Resources
LiDAR	Light detection and ranging
MBTA	Migratory Bird Treaty Act
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MTA	Mass Transit Authority
NACCS	North Atlantic Coast Comprehensive Study
NAVD88	North American Vertical Datum of 1988

NEPA	National Environmental Policy Act
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NHA	National Heritage Area
NLT	no later than
NMFS	National Marine Fisheries Service
NNBF	Natural and nature-based feature
NOAA	National Oceanic Atmospheric Administration
NPS	National Park Service
NWS	National Weather Service
NWSR	National Wild and Scenic River
NY	New York (State)
NYSDEC	New York State Department of Environmental Conservation
NYBEM	New York Bight Ecological Model
NYC	New York City
NYCT	NYC Transit
NYNJHAT	New York New Jersey Harbor and Tributaries
NYNJHATS	New York New Jersey Harbor and Tributaries Study
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York Department of State
OMRR&R	Operations, Maintenance, Repair, Rehabilitation & Replacement
OSE	other social effects
PATH	Port Authority Trans-Hudson
PCB	Polychlorinated biphenyl
PED	preconstruction, engineering, and design
RM	River mile
RRF	Risk Reduction Feature (referred to in prior study products as Residual Risk Feature)
RSLC	relative sea level change
SAV	submerged aquatic vegetation

SBM	shore-based measure
SIR	Staten Island Railway
SLC	sea level change
SSB	storm surge barrier
STP	Sewage Treatment Plant
TEU	Twenty-foot Equivalent Unit
TSP	Tentatively Selected Plan
US or U.S.	United States
USCG	U.S. Coast Guard
USACE	United States Army Corps of Engineers
USACE New York District	U.S. Army Corps of Engineers New York District
USACE North Atlantic Division	U.S. Army Corps of Engineers North Atlantic Division
USEPA or U.S. EPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
VN	Verrazano Narrows
WPCP	Water Pollution Control Plant
WRDA	water resources development act
WWTP	Wastewater Treatment Plant
NYCMOCEJ	New York City Mayor's Office of Climate and Environmental Justice

1 INTRODUCTION

1 INTRODUCTION TO THIS REPORT

The U.S. Army Corps of Engineers (USACE) New York District prepared this Draft Integrated Feasibility Report (FR) and Tier 1 Environmental Impact Statement (EIS) for the New York-New Jersey Harbor and Tributaries (NYNJHAT) Coastal Storm Risk Management (CSRM) Feasibility Study. It is a requirement of USACE planning policy and the National Environmental Policy Act (NEPA) of 1969 to make a report available for public review that describes analysis, risks, assumptions, and decision made by the Study team during the planning process.

Federal water and related land resources projects are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective. Pursuant to this goal, this report: 1) summarizes the problems, needs, and opportunities for flood risk mitigation in the NYNJHAT Study Area; 2) presents and discuss the results of the plan formulation for CSRM; 3) identifies specific details of a Tentatively Selected Plan (TSP), including inherent risks; and 4) will be used to assist in determining the extent of the federal interest and local support for the plan.

1.1.1 NEPA Requirements and Tiering

NEPA requires federal agencies, including USACE, to consider the potential environmental impacts of their proposed actions and any reasonable alternative plan before undertaking a major federal action, as defined by 40 Code of Federal Regulations (CFR) 1508.18. To evaluate potential environmental impacts, USACE has prepared this Integrated FR/Tier 1 EIS. An EIS is a supporting document that is the most thorough and comprehensive level of NEPA documentation used to assist in making a decision. The EIS will be conducted in two stages or tiers. Tiering, which is defined in 40 CFR 1508.28, is a means of making the environmental review process more efficient by allowing parties to “eliminate repetitive discussions of the same issues and to focus on the actual issues suitable for decision at each level of environmental review” (40 CFR 1502.20). Tier 1 is a broad-level review, and Tier 2 consists of subsequent specific detailed reviews that will occur during the Preconstruction Engineering and Design phase of the project. The broad-level review identifies and evaluates the issues that can be fully addressed and resolved, notwithstanding possible limited knowledge of the project. In addition, it establishes the standards, constraints, and processes to be followed in the specific detailed reviews. As proposed alternatives are developed and refined, incorporating a higher level of detail, the specific detailed reviews evaluate the remaining issues based on the policies established in the broad-level review. Together, the broad-level review and all specific detailed reviews will collectively comprise a complete environmental review addressing all required elements. Tiering the EIS resolves the “big-picture” issues so that subsequent studies can focus on project-specific impacts and issues. A Tier 1 EIS involves technical analysis completed on a broad scale and is therefore an effective method for identifying existing and future conditions and understanding the comprehensive effects of the project. It provides the groundwork for future project-level environmental and technical studies and modeling and agency consultation. The Tier 2 EIS(s) will include one or more subsequent detailed reviews, in the form of an EIS, as the Recommended Plan design becomes more refined and is further assessed during PED.

1.1.2 Standards and Processes of the Tier 1 and Tier 2 Environmental Impact Statement

As the Study will be conducted in two Tiers, below is a list that includes but is not limited to the standards, processes, and/or constraints of each Tiered phase:

The Final FR/Tier 1 EIS will include the following:

- The New York Bight Ecological Model (NYBEM) and Adaptive Hydraulics (AdH) modeling of closed Storm Surge Barrier gates resulting in a comparison of the open gate/closed gate impacts to the estuary and associated habitats
- Review and analysis of nonstructural measures, with refined development of conceptual placement locations and measures proposed in each alternative plan

- Review and analysis of natural and nature-based features (NNBFs) conceptual locations and measures proposed in each alternative plan
- Further refinement of the Recommended Plan construction, operations, and maintenance assumptions;
- Further refinement of conceptual compensatory mitigation and adaptive management to include additional analysis (e.g., NYBEM) and design refinements
- Further refinement of the parametric mitigation costs
- Consultations, including Section 7 consultations, will be ongoing, to support the current Tier 1 EIS, as well as any and all subsequent NEPA analyses, as required, to achieve compliance with The ESA for the NYNJHAT study and project

The Tier 2 EIS(s) will occur during the Preconstruction Engineering and Design phase and include the following:

- One or more subsequent detailed reviews, in the form of an EIS, as the Recommended Plan design becomes more refined
- Further refinement of the Recommended Plan construction, operations, and maintenance assumptions
- NEPA compliance and formal consultation with the affected agencies
- HTRW sampling and analysis, as work-in-kind by the nonfederal sponsor, to identify areas that may require remediation prior to construction
- Further consideration of modeling and monitoring, including but not limited to terrestrial vegetation surveys, environmental window restrictions, threatened and endangered species monitoring, erosion controls, etc.
- Further refinement of conceptual mitigation and compensatory mitigation and adaptive management plan to include any additional analysis completed
- Further refinement of the parametric mitigation costs
- Updated biological assessments to include additional analysis such as water quality modeling and/or noise modeling
- Consultations, including Section 7 consultations, will be ongoing, to support the current Tier 1 EIS, as well as any and all subsequent NEPA analyses, as required, to achieve compliance with The ESA for the NYNJHAT study and project

1.1.3 Report Outline

This report, including its appendices and supporting documentation, is significant in length and so may be challenging to understand and review. For this reason, the following products are available to readers who prefer to review different amounts of information.

Executive Summary. The Executive Summary presents a summary of Main Report, including key concepts, analyses, and recommendations.

Pertinent Information. The Pertinent Information summary presents key technical details of the proposed action.

Main Report. This Main Report is an integrated feasibility report and Tier 1 EIS. It presents a summary of the Study background, risks, assumptions, technical analyses, and decision making that are important to the Study.

- **Chapter 1: Introduction**. This Chapter provides an overview of the Study scope, authority, purpose, and need. Additionally, it provides information about the public and agency engagement process, including ways in which the public can submit comments during this report's public review period.
- **Chapter 2: Existing Conditions**. This Chapter presents a summary of existing conditions in the Planning Region. It is organized by four types of resources: 1) Natural Environment, 2) Physical Environment, 3) Built Environment (Infrastructure), and 4) Human Environment (Demographics and Socioeconomics). Resources within each Planning Region are described.
- **Chapter 3: Future Without-Project Conditions**. This Chapter presents a summary of future conditions in the Planning Region in the absence of a proposed project. It includes a description of major assumptions and trends that created the baseline to which alternative plans were compared.

- **Chapter 4: Planning Process**. This Chapter summarizes the planning process used to develop alternative plans and ultimately identify a Tentatively Selected Plan (TSP). It presents the logic and analysis used in plan formulation, evaluation, comparison, and selection.
- **Chapter 5: Tentatively Selected Plan**. This Chapter describes the TSP, which is the proposed project subject to refinement. It includes technical details, costs, benefits, risks, and uncertainties.
- **Chapter 6: Effects and Consequences of the Alternative Plans**. This Chapter presents a summary of projected future conditions in the Planning Region under each alternative scenario. It is organized similarly to Chapter 2.
- **Chapter 7: Environmental Compliance**. This Chapter summarizes consistency and compatibility with federal and state environmental compliance laws and guidance.
- **Chapter 8: Public Coordination and Views**. This Chapter presents a summary of public coordination activities and viewpoints. The final report will include a summary of comments received during the public review period for this report.
- **Chapter 9: Recommendations**. This Chapter summarizes the TSP and key considerations and concludes with the official recommendation of the USACE New York District Commander.
- **Chapter 10: List of Preparers**. This Chapter presents a list of report preparers, their titles, and their contributions.
- **Chapter 11: References**. This Chapter lists references used in the analyses presented in this report.

Appendices. Multiple technical appendices present in-depth information about the environmental, engineering, economic, real estate, and social analyses. They also include all pertinent correspondence submitted by the public and agencies.

Additionally, the following web-based tools supplement the information provided in this report.

Study Website. The previously-listed resources can be found on the Study website, in addition to fact sheets, status updates, briefing material, and other content. The Study website is located on the USACE New York District website at https://www.nan.usace.army.mil/NYNJHATS

StoryMap. ArcGIS (Geographic Information System) StoryMaps is a web-based application that includes maps in the context of narrative text and other multimedia content. A Study-specific StoryMap provides an interactive experience for readers who may want to explore maps, photos, videos, and other content. The StoryMap can be accessed from the Study website.

USACE New York District **social media accounts**, provide status updates and information about public meetings. Links to the accounts can be found on the USACE New York District website at https://www.nan.usace.army.mil

1.2 STUDY AUTHORITY

The Study authority is provided by Public Law 84-71, approved June 15, 1955, which calls for:

> *"…an examination and survey to be made of the eastern and southern seaboard of the United States with respect to hurricanes, with particular reference to areas where severe damages have occurred… Such survey, to be made under the direction of the Chief of Engineers, shall include the securing of data on the behavior and frequency of hurricanes, and the determination of methods of forecasting their paths and improving warning services, and of possible means of preventing loss of human lives and damages to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams, and other structures, warning services, or other measures which might be required."*

Why This Study? Why Now?

The NYNJHAT Study was identified as a Focus Area of Analysis at continued risk of coastal storm damage, as part of the North Atlantic Coast Comprehensive Study (NACCS). The NACCS was completed under the authority of Public Law 113-2, the Disaster Relief Appropriations Act of 2013, which was passed into law to assist in the recovery and long-term resilience of coastal communities impacted by Hurricane Sandy in 2012. The USACE North Atlantic Division was authorized by Public Law 113-2 to commence the NACCS to investigate CSRM strategies for areas impacted by the storm. The 2015 NACCS report identifies nine high-risk focus areas along the Atlantic Coast that warrant additional analyses to address coastal flood risk, including the NYNJHAT area. The current Study builds upon the NACCS analysis, and upon the New York-New Jersey Harbor and Tributaries Interim Report (2019), an informational report that documented the existing conditions and planning framework for this Study.

Future Congressional Action

After completion of this Study, and upon approval by the Chief of Engineers, a Recommended Plan will be presented to the U.S. Congress for authorization and appropriation (funding). If authorized and funded by the U.S Congress, subsequent project phases will include Preconstruction Engineering and Design, Construction, and Operations and Maintenance. It should be noted that all future phases of a potential project are reliant on authorization by the U.S Congress and subsequent appropriation of funds.

1.3 NON-FEDERAL SPONSORS AND PARTNERS

This study is a joint effort of USACE New York District and two non-federal sponsors, NJDEP and NYSDEC. NYSDOS and MOCEJ are study partners.

1.4 PURPOSE AND NEED*

In 2012, Hurricane Sandy caused considerable loss of life, extensive damage to development, and disruption to the North Atlantic Coast. The effects of this storm were particularly severe because of its tremendous size and the timing of its landfall during spring high tide. Twenty-six states were impacted by Hurricane Sandy, and disaster declarations were issued in 13 states. New York and New Jersey were the most severely impacted states, with the greatest damage and most fatalities in the New York Metropolitan Area. Flood depths due to the storm surge were as much as nine feet in Manhattan, Staten Island, and other low-lying areas within the New York Metropolitan Area. At the time, Hurricane Sandy was the second costliest hurricane in the nation's history and the largest storm of its kind to hit the U.S. east coast. The storm exposed vulnerabilities associated with inadequate CSRM measures and lack of defense to critical transportation and energy infrastructure.

On January 29, 2013, President Obama signed into law the Disaster Relief Appropriations Act of 2013 (Public Law 113-2), to assist in the recovery in the aftermath of Hurricane Sandy. The USACE North Atlantic Division was authorized by Public Law 113-2 to commence the North Atlantic Coast Comprehensive Study (NACCS) to investigate CSRM strategies for areas impacted by the storm. In January 2015, USACE completed the NAACS, which identified high-risk areas on the Atlantic Coast warranting further investigation for flood risk management solutions. The NYNJHAT focus area was one of the three focus areas identified, along with the Nassau County Back Bays and the New Jersey Back Bays studies. USACE is authorized under Public Law 84-71, June 15, 1955 (69 Stat. 132), as modified, to conduct an investigation into potential CSRM solutions within the NYNJHAT Study Area.

The USACE New York District, in partnership with NYSDEC and NJDEP as the non-federal sponsors, are undertaking this study. In addition, NYSDOS and MOCEJ are non-federal partners. The Feasibility Cost Sharing Agreement (FCSA) was executed on July 15, 2016 between the USACE New York District, NYSDEC, and NJDEP. An amended FCSA was executed between these parties on June 28, 2022.

The study purpose is to determine the feasibility of constructing a technically feasible, environmentally acceptable, and economically justified project that will manage coastal storm risk while supporting the Study Area's economic and community resilience. The need for the study derives from the significant and widespread damage to communities, infrastructure, and the economy caused by coastal storms. Potential damages are expected to increase in the future due to an increase in the extent and depth of inundation, increase in wave heights, and increased erosion caused by higher water levels and wave heights associated with a projected relative increase in the region’s sea level.

Hurricane Sandy (2012) highlighted a need for a comprehensive and collaborative evaluation of coastal storm risk to communities along the Atlantic Coast. The storm flooded or otherwise impacted homes, businesses, and critical infrastructure, and caused blackouts, school and businesses closures, gas shortages, and many deaths.

The need for the study has been recognized by the President, the U.S. Congress, USACE, the states of New York and New Jersey, the City of New York, other municipal governments, federal and local agencies, non-governmental organizations, and the public at large.

1.5 STUDY SCOPE

The Study scope is the extent and parameters of the feasibility Study. It is related to two driving guiding documents: 1) the Federal Objective for water resource planning, and 2) the Study authority.

The Federal Objective specifies the fundamental goal of Federal investments in water resources. It is specified in the Principles and Requirements for Federal Investments in Water Resources (or PR&G), which is a common framework for analyzing a diverse range of water resources projects, programs, activities, and related actions involving Federal investment as identified by the agencies in the context of their missions and authorities – including by USACE. The Federal Objective specifies that:

> *Federal water resources investments shall reflect national priorities, encourage economic development, and protect the environment by: 1) seeking to maximize sustainable economic development; 2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and 3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems… In consideration of the many competing demands for limited Federal resources, it is intended that Federal investments in water resources as a whole should strive to maximize public benefits, with appropriate consideration of costs. Public benefits encompass environmental, economic, and social goals, include monetary and nonmonetary effects and allow for the consideration of both quantified and unquantified measure*. (PR&G 2013)

The Study authority as provided by Public Law 84-71 is broadly to investigate ways to manage coastal storm risk along the nation’s eastern and southern seaboard. The NACCS identifies a more specific geographic scope to the study as the NYNJHAT Focus Area.

1.6 STUDY AREA

The Study Area encompasses tidally influenced areas within the New York metropolitan area, which includes New York City, the country’s most populous and densely populated city, as well as the six largest cities in the State of New Jersey (Figure 1). The Study area includes more than 2,150 square miles and comprises parts of 25 counties in New Jersey and New York, including Bergen, Passaic, Morris, Essex, Hudson, Union, Somerset, Middlesex, and Monmouth Counties in New Jersey; and Rensselaer, Albany, Columbia, Greene, Dutchess, Ulster, Putnam, Orange, Westchester, Rockland, Bronx, New York, Queens, Kings, Richmond, and Nassau Counties in New York. The Study Area is divided into nine Planning Regions. They include the Capital District Region, Hackensack/Passaic Region, Jamaica Bay Region, Long Island Sound Region, Lower Bay Region, Lower Hudson/East River Region, Mid-Hudson Region, Raritan Region, and Upper Bay/Arthur Kill Region.

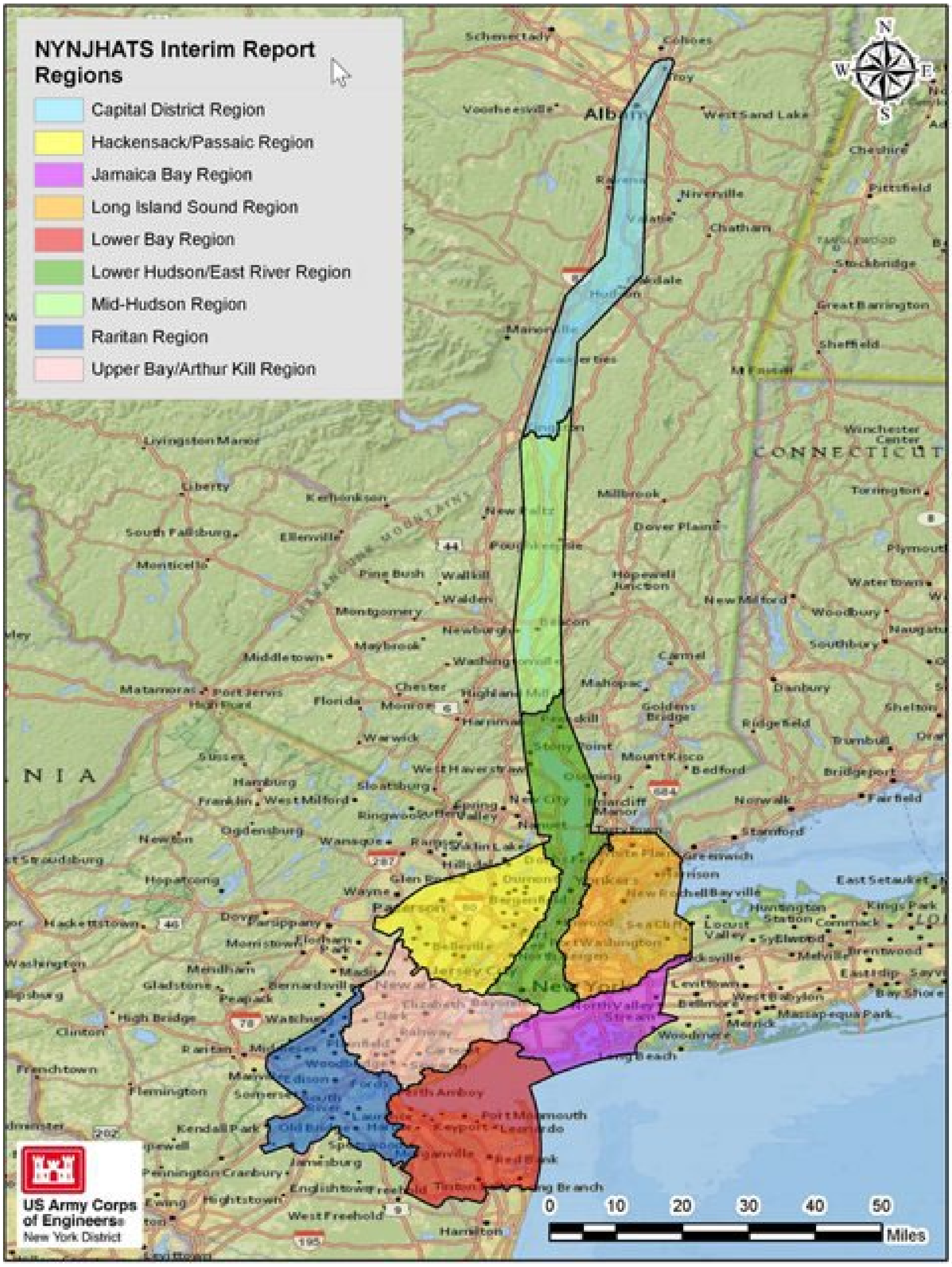

Figure 1: Study area.

Capital District Region

The Capital District Region is the Northern-most region of the Study Area, encompassing both the Eastern and Western sides of the Hudson River from Kingston, New York to Troy, New York. This region includes the state capital of New York, Albany.

Mid-Hudson Region

The Mid-Hudson Region falls just South of the Capital District Region and includes both the Eastern and Western sides of the Hudson River from Highland Falls, New York, up North to Kingston, New York.

Lower Hudson/East River Region

The Lower Hudson and East River Region includes the entire island of Manhattan and goes as far North as Bear Mountain, New York, encompassing both the Eastern and Western sides of the Hudson River and the East River until Randall's Island, New York. Included also in this area are the Brooklyn, Manhattan, Williamsburg, George Washington, and Governor Mario M. Cuomo Bridges.

Hackensack/Passaic Region

The Hackensack and Passaic Region is entirely located in New Jersey on the Western side of the Hudson River from the area of Newark, New Jersey up North to Tappan, New Jersey. The region encompasses the Hackensack River, Passaic River, and portions of the Bergen, Passaic, Hudson, Essex, and Union Counties in New Jersey.

Upper Bay/Arthur Kill Region

The Upper Bay Region includes the Upper New York Bay, beginning at the mouth of the Hudson River and connects to the Newark Bay and the Arthur Kill via the Kill Van Kull Channel. It also connects to the East River and exchanges water with the Long Island Sound. This region encompasses the area just North of the Verrazzano Narrow Bridge and includes parts of Union and Essex Counties, New Jersey to the West and areas of Brooklyn to the East. Also in this region is the sight of the Stature of Liberty, Ellis Island, and Newark International Airport.

Lower Bay Region

The Lower Bay Region includes the Lower Bay of New York, Raritan Bay, and Sandy Hook Bay. This region starts to the North, at the Verrazzano Narrows Bridge, includes the Eastern side of Staten Island, New York and hugs the Western shoreline of Brooklyn, New York. It continues through New Jersey and covers as far South as Monmouth County, New Jersey and Rockaway Point, New York.

Raritan Region

The Raritan Region is the Western-most region within the Study Area, encompassing the Raritan River before it joins the Raritan Bay at Perth Amboy. The region extends to parts of Union, Somerset, Middlesex, and Monmouth Counties, New Jersey.

Jamaica Bay Region

The Jamaica Bay Region is located on the Southwestern sores of Long Island, enclosed by the Rockaway Peninsula. Portions of Brooklyn, Queens, and Nassau County, New York are included within the region, as well as the John F. Kennedy International Airport. Rockaway Inlet, on the Western edge of the Bay, connects to New York's Lower Bay.

Long Island Sound Region

The Long Island Sound Region of the Study Area is located North of Manhattan where the East River and Long Island Sound meet. Portions of The Bronx, and Queens are within the limits of the region, along with a small portion of Nassau County, Long Island. The region includes LaGuardia Airport, the Whitestone Bridge, and the Throgs Neck Bridge, as well.

1.7 PROJECT AREA

The project area is defined for the study as the general location within the study area where a component or measure has been identified for possible physical implementation or construction. This includes areas in which the effects of coastal storms would be managed due to proposed project features. Therefore, the project area is any area that may benefit from the construction of a potential project.

1.8 PRIOR USACE STUDIES, REPORTS, AND EXISTING WATER PROJECTS

USACE has played a major role in water resource planning and project execution in the New York and New Jersey Harbor Estuary, Hudson River, Passaic River, Long Island Sound, and related waterways for more than 200 years. The following is a summary of major existing, planned, and ongoing USACE water resource projects, studies, and reports.

Interim Report (2019)

The study team recognizes the importance of sharing timely information with the public and agencies as an important key to the Study's success. To support this, an Interim Report was released in February 2019 which summarized Study activities completed through early 2019. It can be accessed from the Study website.[2]

The Interim Report presents a summary of existing information, technical analysis, interim planning activities, and conceptual alternative plans as of February 2019. It remains a resource for the Study team and the public. The public and agencies were invited to provide comments during the scoping process, which are included in the Public Engagement Appendix of the Interim Report. Feedback was considered and incorporated into the analyses summarized in this report.

Coastal Storm Risk Management Studies

USACE has constructed or completed studies for over a dozen major CSRM projects and erosion control projects in the Study Area. Major constructed projects include the ocean-side portion of the East Rockaway Inlet to Rockaway Inlet (Rockaway Beach) and Jamaica Bay project, and the Atlantic Coast of New York City, Rockaway Inlet to Norton Point (Coney Island) project.

In response to Hurricane Sandy in 2012, USACE completed near-term coastal restoration work at previously completed CSRM projects in the Study Area, which involved the placement of hundreds of thousands of cubic yards of sand along beaches on the New Jersey and New York shorelines impacted by the storm. In addition, twelve authorized but unconstructed CSRM projects and twelve CSRM studies received funding for completion by Public Law 113-2 as part of the USACE's post-Hurricane Sandy response mission. Most of these studies are completed or are near completion, and the ones that are most likely to have funding and permitting by July 2020 are included in the economics modeling for the Future Without Project Condition assumptions.

There are ongoing CSRM studies adjacent to the NYNJHAT Study Area: New Jersey Back Bays feasibility study on the Jersey shore and the Nassau County Back Bays feasibility study and the Fire Island to Montauk Point General Reevaluation study on the south shore of Long Island, which taken together with the NYNJHAT study, provide for contiguous assessments of coastal storm risk on the Atlantic shorelines of New Jersey and New York.

[2] https://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/New-York-New-Jersey-Harbor-Tributaries-Focus-Area-Feasibility-Study/

Flood Risk Management Projects

USACE has constructed or completed studies for almost two dozen major flood risk management projects and streambank stabilization projects in the Planning Region. Constructed projects include major portions of the Green Brook project along the Raritan River in New Jersey, and streambank stabilization projects in Westchester County, New York. Major ongoing or completed studies include those for the Rahway River, South River, Lower Saddle River, Ramapo River, Peckman River, Saw Mill River, Green Brook River, and the Mamaroneck River, Byram River and Westchester County streams in New York and Connecticut.

Navigation Projects

USACE has dredged and/or maintained over two dozen federal navigation channels in the Planning Region that support nationally important trade and recreation. Significantly, in 2016 the USACE completed the deepening of major harbor navigation channels of the New York and New Jersey Harbor to 50 feet at a cost of $2.1 billion, in support of regional and national economic growth. The Port of New York and New Jersey is the largest port on the east coast of North America, the third largest in the nation, and one of the most productive high-volume port operations globally. The Port of New York and New Jersey must be dredged to maintain navigation and commerce estimated to generate about $20 billion annually in direct and indirect benefits. The port has premier access to rail, road, and inland waterway routes to transport goods to 23 million local consumers and up to 100 million customers within 36 hours at markets all over the U.S. and Canada. Most federal navigation channels under the purview of the New York District in the Study Area are within the Port’s jurisdiction.

At the northern extent of the Study Area is the Troy Lock and Dam on mile 153 of the Hudson River, which the USACE operates and maintains. The lock provides significant economic and recreational support to the region and serves as a gateway to the New York State Canal System.

Ecosystem Restoration Projects

The New York and New Jersey Harbor Estuary, designated as an “Estuary of National Significance” by the U.S. Environmental Protection Agency, has experienced hundreds of years of urban development and extensive loss and degradation of natural habitats. These impacts have reduced the diversity, abundance, function and integrity of the multiple ecosystems in the Estuary. In support of the USACE ecosystem restoration mission, the USACE New York District completed the Hudson-Raritan Estuary Comprehensive Restoration Plan in 2009. It provides a framework for the estuary’s restoration, the feasibility of which is currently being investigated as part of the Hudson-Raritan Estuary Ecosystem Restoration Study and the Hudson River Habitat Restoration Study.

USACE has beneficially used hundreds of thousands of cubic yards of dredged material from channel dredging to restore habitat in the Study Area. A number of marsh island habitats have been restored in Jamaica Bay, New York via the beneficial use of dredged material program.

Water Supply Projects

USACE has executed over 40 projects that support and enhance the water supply system for the City of New York, which provides water for 8 million residents in New York City and 1 million residents in neighboring suburbs.

1.9 EXISTING WATER STUDIES AND PROJECTS BY OTHER AGENCIES

This Section presents prior USACE studies, existing reports, existing USACE water projects, and existing projects by other agencies. Some will affect economic justification of alternatives and need to be included in the modeling of potential benefits. Other projects included in the future without-project conditions may have unquantified, indirect or relatively localized/minor benefits to CSRM. In that case, they will be included in the assessment of cumulative impacts for the upcoming NEPA document.

Information on existing water studies and projects by other agencies comes from the Sandy Recovery Infrastructure Resilience Coordination Group, which compiled a tracking sheet of over 400 efforts in the region. The tracking sheet details the action and its current stage of development (e.g., conceptual to construction). While some efforts are relatively certain as they are near or in construction, others are largely conceptual with uncertainty in scope or funding. Given the uncertainty, for purposes of evaluating these projects for the future without project conditions for the study, the date of the USACE Milestone for the Study (i.e., January 2023) has been used as a cut-off date to screen which efforts are anticipated to be permitted and funded for construction by that date. Following the criteria and cut-off date of January 2023, out of over 400 projects tracked in the federal database, approximately 160 projects have been identified for inclusion in the cumulative impacts assessment for the study. Highlights of these 160 projects are presented in Table 1.

Table 1: Existing Water Studies and Projects by Other Agencies.

Main Agency	Types of Actions
DOI	• Provide community protection while strengthening ecosystem resiliency from floods and run-off impacts. • Restore ecosystem function and habitat. • Improve water quality and resilience through stream daylighting. • Develop a self-sustaining oyster population. • Restore 11 acres of salt marsh and 16 acres of coastal upland in Queens, New York. • Restore five acres of wetland and seven acres of upland habitat in Queens, New York. • Construct a 6,400 foot coastal dune and restore 17 acres of marsh in Monmouth Beach, NJ. • Strengthen Coney Island's resilience through installation of 14 green streets in Brooklyn, New York. • Incorporate natural and nature-based infrastructure into Block 12's redesign in Hoboken, New Jersey. • Perform 54 municipality assessments and impervious cover reduction action plans for the Raritan River Basin in New Jersey. • Restore Newark Bay's wetlands in New Jersey. • Create and improve Liberty State Park's 40 acres of salt marsh and 100 acres of upland habitat in Jersey City, New Jersey.
FEMA (Federal Emergency Management Act)	• Repair, rehabilitation, and stabilization of a 7,750-foot seawall in the City of Troy, NY. • construct a floodwall around the West Field Lighting Vault Building at LaGuardia Airport. • Elevation and extension of the Klein Avenue Levee in Clarkstown, NY. • A double dune system n Breezy Point, Queens. • Restore over 150 acres of valuable maritime habitats including 86.6 acres of upland buffer (dunes and maritime forest), 49 acres of low marsh, 10 acres of high marsh, and 6 acres of tidal creek. • Elevate flood prone private residential structures at or above the base flood elevation. • Acquire and demolish properties in the flood-prone communities in Middlesex County, NJ. • Upgrade and enhance resiliency of 104 scour-critical and flood prone bridges across the State of New York.

Main Agency	Types of Actions
HUD	• Experimental flood protection levee to keep the peninsula (Hunts Point, Bronx) dry while providing waterfront greenway for the everyday use. • System of breakwaters that buffer against wave damage, flooding, and erosion and are also designed to sustain habitat. • Comprehensive urban water strategy that deploys programmed hard infrastructure and soft landscape for coastal defense. • Protective system around Manhattan from West 57th Street south to The Battery and to East 42th Street. • Intricate system of berms and marshes to protect against storm surges, collect rainfall, and reduce sewer overflows in adjacent towns (Meadowlands, NJ).
NOAA (National Ocean and Atmospheric Administration)	• Contract topometric-bathymetric light detection and ranging (LiDAR) data collection of the shoreline in the highest impact areas from Hurricane Sandy. • Refine datum models to support hydro and shoreline surveys from Rhode Island to New Jersey (CO-OPS). • Establish global positioning system observations for determining geodetic to ellipsoid relationships at historic tidal gauge sites (NGS).
USDA/NRCS	• Provide $7.5 million to restore urban wetland. The project includes creating wetland pools that will reduce the speed of water flow and hold flood and storm water. • Floodplain Easement Program (EWP-FPE) acquires an easement in lieu of recovery measures is the more economical and prudent approach to reducing a threat to life or property.
USDOT/NJ TRANSIT	• Reduce the risk of flooding to Hoboken rail yard and the city by filling a deteriorated inlet inside the rail yard (Long Slip). • Replace the aged and deteriorated Raritan River Drawbridge that was damaged by Hurricane Sandy. • Raise and protect vulnerable train signal, communication, and switch systems located within the 1% floodplain multiple rail lines.
USDOT/ PANYNJ	• Floodproof major above ground PATH facilities and equipment to prevent flooding of underground assets. • Construct an automated flood barrier at the Harrison Car Maintenance Facility. • Construct a concrete seawall to protect PATH tracks near the Passaic River.
USDOT/ NYCDOT	• Acquire new ferry vessels for the Staten Island Ferry that are capable of side boarding; upgrade ferry landings to accommodate such vessels; and flood proof existing terminals to improve response to disasters.

Main Agency	Types of Actions
USDOT/MTA	• Construct multiple forms of flood protections at four rail yards that are vulnerable to flooding. • Make flood protections for substations throughout system, and acquire four mobile substations for use in emergency response. • Manage the risk of floodwaters entering and traversing underground infrastructure through sealing at vulnerable locations. • Make flood protections for three NYCT support facilities: The Tiffany Central Warehouse, Zerega Central Maintenance and Training, and Revenue Control Facility. • Install flood protections at street-level openings (stairs, vents, etc.) at locations throughout the system that are between the 1% and 0.2% floodplain areas and beyond. • Make flood protections for the Metro-North Railroad Hudson River Line, Long Island Rail Road, Amtrak subway, police stations, bus depots and critical underground infrastructure. • Flood proofing of communications and signal rooms at 20 key subway stations within the flood hazard area. • Upgrade pumping capacity by improving existing equipment, purchasing mobile equipment and creating two new pump trains.
NJDEP	• Union Beach Beachfill. • Sea Bright Seawall. • Bayshore Flood Gate facility management. • Build ecological solutions to coastal community hazards. • Study conducted by Rutgers University: a) determined the causes of flooding in the Cities of Elizabeth, Linden and Rahway, and Woodbridge Township; b) determined current measures and measures envisioned by officials; and c) offered recommendations to manage flood risks (Rutgers, 2014d). • Assessment of the flood pathways in Hudson County. • Identified regional and municipal CSRM strategies for both the Hackensack River and the Hudson River waterfront including the municipalities of Hoboken and Jersey City. • Investigation of alternative measures for flood mitigation in the Hackensack/Moonachie/Little Ferry area (NJIT, 2014a).
NY Rising	• Evaluate cost and feasibility of various stormwater capture and retention approaches, wetland creation, constructing berms and deployable floodwalls, develop flood protection strategies, and performing a feasibility study and conceptual design for multipurpose flood barriers using a raised greenway, berms, and deployable flood walls on the east and west sides of Lower Manhattan. • Develop flood prevention strategies, implement stormwater management measures. • Repair, rehabilitate, upgrade, and fortify critical infrastructure (transportation, wastewater facilities, interceptors, and sewer lines). • Enhance dune walkways; develop coastal protection projects in Breezy Point, Rockaway Point, and Roxbury. • Restore the Sunset Cove ecosystem and integrate it into a larger restoration project by the NYC DPR. • Use natural and nature-based infrastructure for stormwater collection and treatment. • Leverage existing coastal protection initiatives, including those by USACE, planting and stabilizing temporary dunes and to fill in the gaps of dunes, construction of a dune system. Additional projects include installing Best Management Practices to capture stormwater, alleviate flooding, and improve water quality in the Staten Island Bluebelt, along New Creek and Hylan Boulevard. Property acquisition and buyouts are another proposed project in South Beach.

Main Agency	Types of Actions
NYC EDC/ MOCEJ	• Construction of a new, more resilient boardwalk that features various coastal protection structures such as a sand retaining wall, a dune "betterment" which will increase the overall height of the USACE dune, sand infill underneath the new boardwalk, dune plantings, and other sand retention measures. • Elevated, steel-reinforced concrete and multiple layers of protection, including approximately six miles of retaining walls and planted dunes, the design is being rethought to make it sturdier and better able to withstand future hurricanes. • Understand the extent of shorelines exposed to Relative Sea Level Change (RSLC), reinforce the shoreline to prevent erosion, and address risk of RSLC by increasing the height of coastal edges. • Investigate hydrological management strategies that would prevent and mitigate upland flooding, improve waterfront open space, strengthen neighborhood connections, enhance infrastructure, and provide opportunity for economic development.

1.10 PUBLIC AND AGENCY PARTICIPATION

Public and agency involvement is at the heart of the USACE planning process and NEPA. The Study team has committed to proactively engaging with stakeholders in order to understand concerns and solicit feedback. Several forums and tools have been used in outreach and engagement, including a Study website, interactive online ArcGIS StoryMap, and virtual and in-person meetings. Public and agency feedback has been shared at meetings and through the Study email address, mailed comments, and phone calls. Additional feedback is solicited during the public comment period for this draft report and throughout the remainder of the study.

ENGAGEMENT

Stakeholders
10 Federal Agencies
5 Cooperating Agencies
1 Participating Agency
17 State and City Agencies
Many Municipalities and Stakeholder Groups

Scoping (2018)
9 Scoping Meetings
705 Participants
4,250 Comments Received, including from **26** Elected Officials and **30** Municipalities

Interim Report (2019)
18 Public Engagement Meetings
5,000+ Comments Received

This Report (2022)
6 - 10 Public Meetings (estimated)

Key Tenets

The Study team uses three Key Tenets of Public Agency Participation to guide its stakeholder engagement activities.

Tenet 1: Public Input Is Important

Public and agency participation is important because it contributes to better decisions. The Study team relies on input to understand different perspectives, needs, and concerns, and information about technical and social issues in order to develop better solutions. Decision makers take the needs and interests of all stakeholders into account when forming decisions and recommendations. For this reason, it is critical that public and agencies participate in the planning process.

Tenet 2: Information Will Be Shared Widely

The Study team commits to sharing information widely and in a timely manner. Study updates, and reports and other produces are posted to the Study website. Press releases, emails, and social media postings announce the available of information as soon as it is posted to the website. The Study team relies on agencies and stakeholder groups to share information through their respective channels, especially with stakeholders who do not have access to computers or the internet.

Tenet 3: Proposed Project Details Will Change Based on Feedback

The level of detail for USACE feasibility studies is generally conceptual and subject to change as more information is gathered throughout the Study process. Feedback and supplemental information will inform changes to plan details. Comments received during the public comment period for this draft report will be considered as the past is refined. A greater level of detail will be presented in subsequent reports, including the final integrated feasibility report and EIS. Final project designs will not be known until the Preconstruction Engineering and Design and Construction project phases, which is dependent upon action by the U.S. Congress for authorization and appropriation as well as non-federal sponsor partnering agreements.

1.10.1 NEPA Scoping Process

NEPA procedures require the completion of formal public engagement actions, including the publication of a Notice of Intent to produce an EIS and at least one NEPA scoping meeting. USACE published a Notice of Intent in the Federal Register on February 13, 2018 which started the official scoping process. The NEPA scoping period originally spanned 45 days from July 6 to August 20, 2018, and was extended by public request for an additional 77 days for a total of 122 days. The extended period was open until November 5, 2018. A series of NEPA scoping meetings were held to obtain public input on the Study scope and gather applicable local expertise. Nine scoping meetings at six locations were attended by over 700 participants. This includes four extra meetings that were scheduled at the request of elected officials.

Figure 1: Participants listen during a breakout group session at a Newark NJ meeting on January 18, 2017.

A total of 4,250 submissions were received during the NEPA scoping period, of which 393 were unique comments. The Interim Report (2019) includes these comments and responses to unique questions.

1.10.2 Agency Coordination

The NYNHAT Study team continues to coordinate with federal, state, and local governmental agencies in support of interagency coordination and environmental compliance. Coordination with these agencies has included attendance at meetings hosted by USACE and other agencies. The NYNJHAT Study team will continue to engage with agencies throughout the planning process, and specifically to support environmental compliance activities described in Chapter 8.

NEPA regulations and processes define three types of formal roles for federal agencies. A Lead Agency is the federal agency preparing or having taken primary responsibility for preparing a NEPA document. A Cooperating Agency is any federal agency other than a lead agency which has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major federal action significantly affecting the quality of the human environment. A Participating Agency is a federal agency that has an interest in the proposal. Cooperating and Participating Agencies must provide comments within their special expertise or jurisdiction and use the NEPA process to address any environmental issues of concern to its agency. The following is a list of formal federal agency roles for this Study:

- **Lead Agency**: USACE
- **Cooperating Agencies**: U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), U.S. Coast Guard (USCG), National Ocean and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), and the National Park Service (NPS)
- **Participating Agency**: Federal Emergency Management Agency (FEMA)

1.11 PUBLIC RELEASE OF THIS REPORT

A Notice of Intent to prepare this report was included in the Federal Register on August 22, 2022. A Notice of Availability for this report was published in the Federal Register on September 23, 2022. The public and agencies are invited to participate in public meetings and submit comments during the comment period. An estimated six to ten public meetings will be held during the public comment period, information for which will be posted to the Study website. A summary of comments received will be included in the final version of this report.

Submitting Comments

Comments regarding the information presented in this report should be submitted to the Project Manager, contact information for whom is located on the report’s title page. Comments can also be shared during planned virtual and in-person public meetings, details for which will be posted to the public website. USACE, non-federal sponsors, Study partners, and stakeholder groups will share information about public meetings in additional forums which may include email, press releases, posters, and announcements.

2 EXISTING CONDITIONS*

This chapter presents a summary of existing conditions in the Study Area. It is organized by four types of resources: 1) Natural Environment, 2) Physical Environment, 3) Built Environment (Infrastructure), and 4) Human Environment (Demographics and Socioeconomics). Resources within each Planning Region are described in each subsection.

2.1 COASTAL STORM FLOOD RISK

The Study Area is vulnerable to damage from storm surge, wave attack, erosion, and intense rainfall events that can also cause riverine or inland flooding. These forces constitute a threat to human life and increase the risk of flood damages to public and private property and infrastructure. The Study Area encompasses the New York Metropolitan Area including the most populous and densely populated city in the United States and the six largest cities in New Jersey. This region is the hub of financial centers and international trade, qualifying it as one of the most important economic regions in the world. The City of New York alone had a Gross Metropolitan Product (GMP) of $1.5 trillion in 2022 (Statista Research Department, 2022). A large portion of the Study Area is highly urbanized, and also includes suburban neighborhoods, that with existing geography, topography, and proximity to tidally influenced areas, are highly vulnerable to coastal storm damage.

Coastal storms have played important roles in shaping the present-day shoreline through erosion and movement of sand. Development of housing and waterfront properties along the coastline has placed many property owners in areas of high vulnerability due to the lack of shoreline stabilization, erosion of supportive and protective landforms, and surge during coastal storms. Since 1900, relative sea level has risen by more than a foot within the Study Area due to global climate change and local land subsidence (NPCC2, 2013). Between 1996 and 2013, 22 major coastal flooding events were recorded for the Study Area (NOAA NCDC, 2013).
Most recently, Hurricane Sandy damaged or destroyed at least 650,000 houses and left approximately 8.5 million customers without power during the storm and its aftermath. Preliminary estimates from the event exceed $50 billion in damages (NOAA, 2013), with 24 states impacted by the storm. Hurricane Sandy caused devastation in the Study Area, damaging property and disrupting millions of lives. As a result of the storm, 48 people lost their lives in NYC and 12 people lost their lives in NJ.

Some of the highest storm surges and greatest inundation, which reached record levels, occurred in New York and New Jersey. Storm surge caused flooding at 10 feet above ground level in some locations. The storm exposed vulnerabilities associated with inadequate CSRM measures and a lack of critical transportation and energy infrastructure resilience. Environmental impacts to the Study Area were also significant. Storm surge inundated regional wastewater treatment plants (WWTPs) and with additional loss of power to key electrical and operational components, billions of gallons of untreated and partially-treated wastewater were discharged into receiving water bodies. Hazardous waste sites, such as those identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise referred to as Superfund Sites, brownfields, petrochemical plants, and fuel refineries were also inundated and spills reported. Hurricane Sandy's size, path, and timing caused unprecedented damages within the Study Area. Collateral losses also include disruption of commerce, unemployment due to inundated workplaces and transportation systems, expenses for disaster relief and cleanup, and other related costs.

In support of a comprehensive and systematic characterization of the problem, a geographic information system (GIS) inventory of vulnerable resources and their risk from coastal storms was compiled for the NACCS and the NYNJHAT Focus Area Analysis, in what is known as the composite risk index (see GIS Appendix). This product can be used to determine which areas are considered high risk. For the current Study effort, the composite risk index was updated through the following tasks:

- USACE or local projects have modified the shoreline in the NYNJHAT Study Area. Best available ground surface elevation data can be obtained to represent current conditions. With projects implemented along the shoreline of the NYNJHAT area, residual risk will always remain. Residual risk is the flood risk to people and assets after all implementation efforts to manage risk are completed. It is important to identify residual risk to account for extreme flood extents associated with a catastrophic event. Often, CSRM measures do not manage risk associated with an extreme event.

- Advanced Circulation Model storm surge modeling, completed as part of NACCS, is now available to determine inundation extents for typical and extreme flooding events (Figure 14).
- Available exposure data has since been updated. Nationwide, regional, and local datasets are updated and incorporated.
- Since the NACCS covered such a broad area, city or area-specific exposure datasets were not incorporated due to lack of consistent coverage across regions and states. Because the study is focused entirely on the NYNJHAT area, additional refinement to specific data (airports and train stations) where detailed data was available allowed for factoring in passenger volume and ridership on a location-by-location basis into the development of weights within those data layers.
- Additional datasets, not included in NACCS, are incorporated to enhance the Study output, notably building replacement value and employment data.
- In coordination with USACE and local sponsors, modifications to weighting and datasets preferences were incorporated. The weights as defined in NACCS were rigid for consistency across the NACCS Study Area. Flexibility of on-the-fly factoring of datasets allows for a comparison of different preferences.
- In NACCS, exposure indices were a function of the three broad exposure categories: 1) Population Density and Infrastructure, 2) Social Vulnerability, and 3) Environmental and Cultural Resources. Each of these exposure categories were comprised of subcategories (i.e., population density and infrastructure were combined as one index; environmental and cultural resources index was comprised of environmental data layers, habitat, and cultural resources). For the update, each exposure index is assigned its own weight (Table 6).
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Table 2. Update to Exposure Index Weights from NACCS for NYNJYHAT Study

NACCS CATEGORY	NACCS WEIGHT	NYNJHAT CATEGORY	NYNJHAT WEIGHT
Population Density Infrastructure	80%	Population Density	25%
		Infrastructure	30%
		Building Value	20%
Social Vulnerability	10%	Social Vulnerability	10%
		Employment	10%
Cultural and Environmental Resources	10%	Cultural	5%
		Environmental	0%
		Habitat	0%
Total	**100%**	**Total**	**100%**

This simplifies the risk equation, allows for expansion with additional categories and clarifies the impact of weighting on the final risk product (Figure 15).

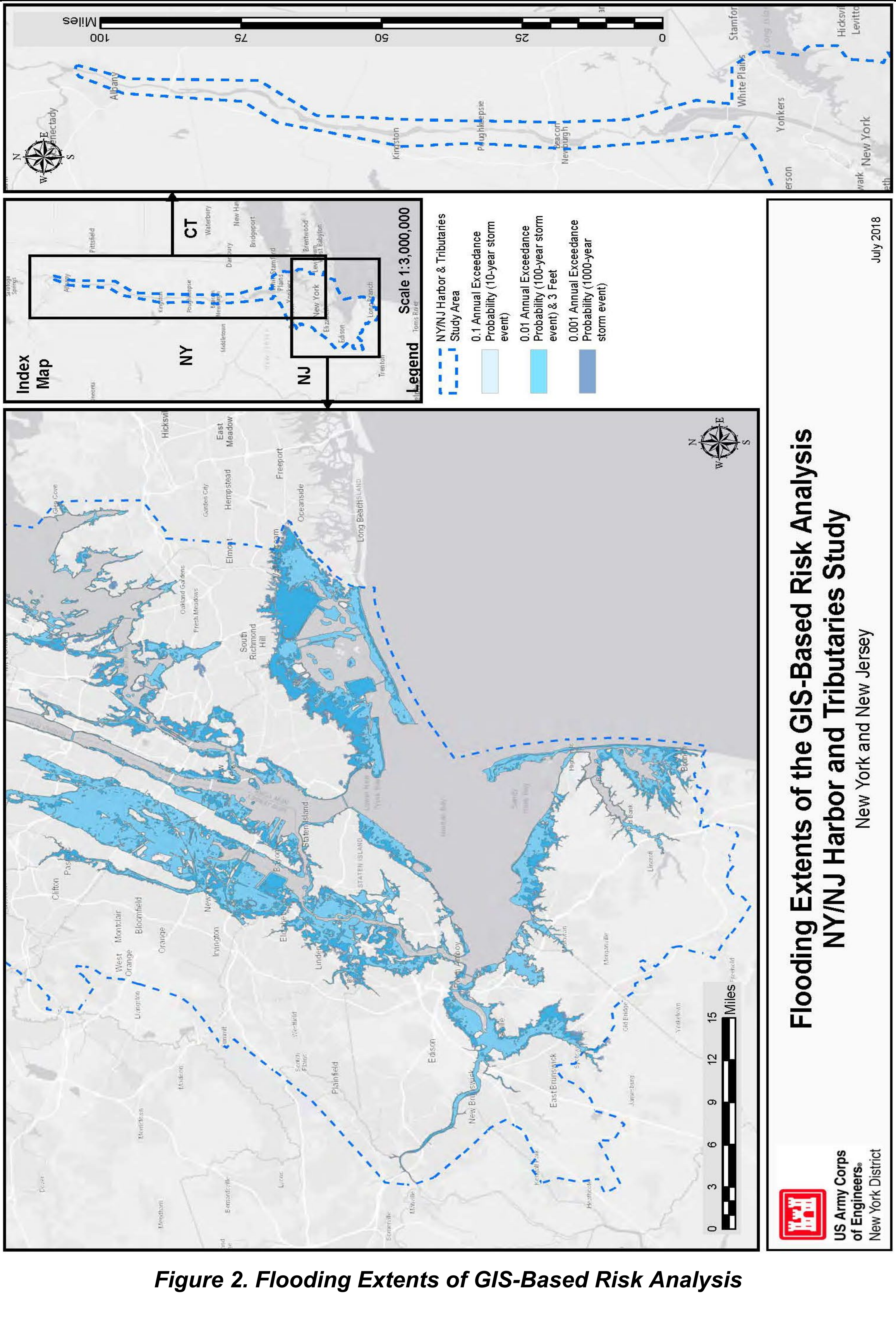


Figure 2. Flooding Extents of GIS-Based Risk Analysis

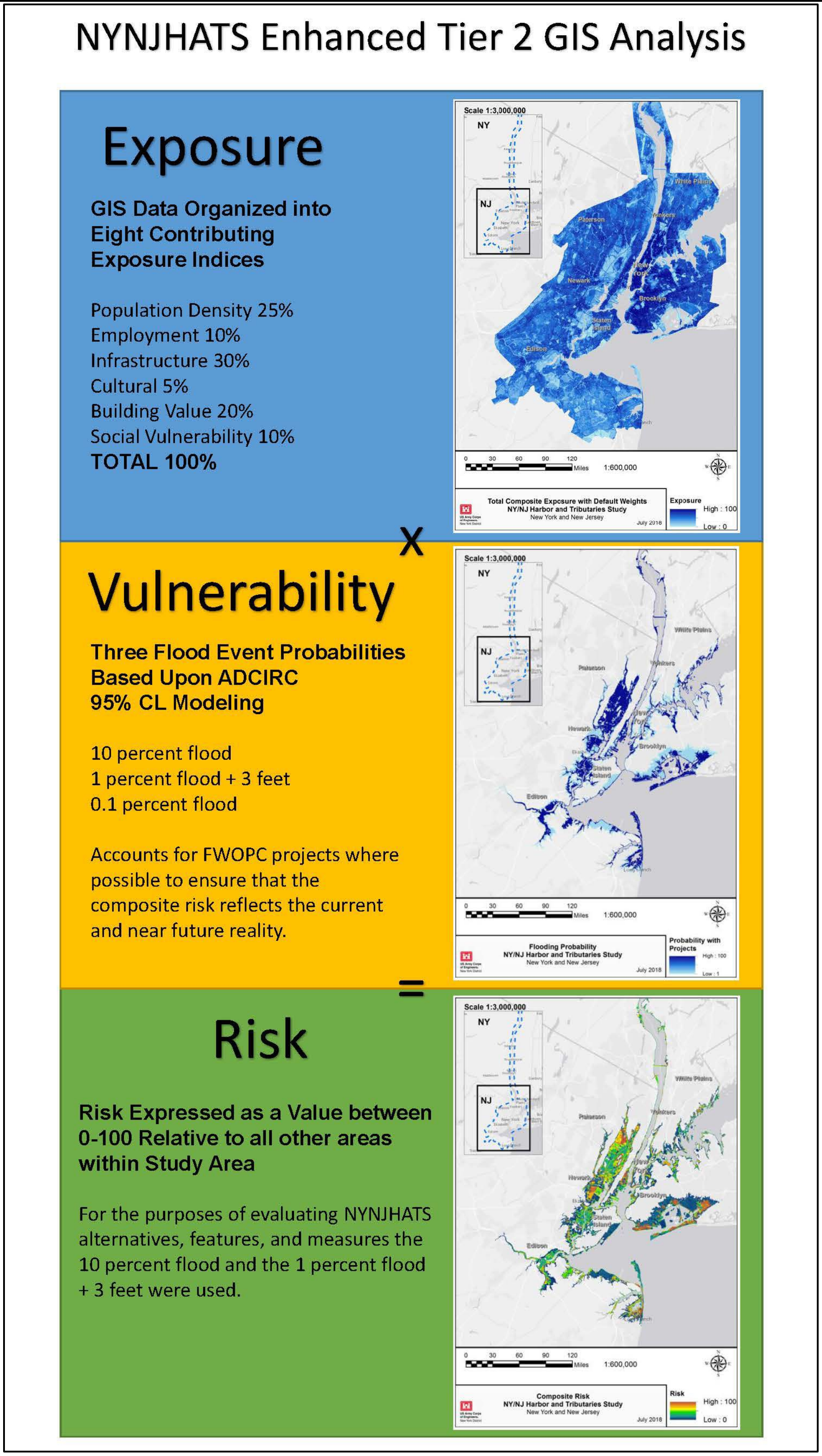


Figure 3. Risk Calculation

Note: CL = Confidence Level

2.2 NATURAL ENVIRONMENT

The Natural Environment includes a discussion of the existing conditions for wildlife, special status species, special status areas, and other relevant environmental resources within Study Area. Due to the size of the Study Area, existing conditions are organized by Planning Region, or a combination of Planning Regions where appropriate based on similar conditions. Relevant data from recent USACE reports within the Study Area were incorporated, and other available data sources supplemented this assessment. Additional information on existing conditions within the Study Area can be found in the USACE *Hudson River Habitat Restoration Ecosystem Restoration Integrated Feasibility Report and Environmental Assessment* (USACE 2020a), the USACE *Hudson-Raritan Estuary Ecosystem Restoration Integrated Feasibility Report and Environmental Assessment* (USACE 2020b), the USACE *East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Integrated Hurricane Sandy General Reevaluation Report and EIS* (USACE 2019), *and* the USACE *Harbor Deepening Channel Improvements Navigation Study Integrated Feasibility Report and Environmental Assessment* (USACE 2022). These documents are listed in the References Section of this Report. Refer to the online NYNJHAT Study StoryMap to explore some of the publicly available environmental resource data sets and mappers of environmental resources within the Study Area that were considered in preparation of this Draft Integrated FR/Tier 1 EIS.

2.2.1 Wildlife and Vegetation

The Wildlife and Vegetation category describes wildlife, fish, vegetation, and invasive and aquatic nuisance species present within the Study Area. Special status species, such as threatened and endangered species and Marine Mammal Protection Act species, may be mentioned in this Section; however, special status species are discussed in more detail in subsequent Sections.

Wildlife

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Figure 4: North American river otter. (Source: NYSDEC 2022)

Mammals reported in the Hudson River valley include, but are not limited to, muskrat (*Ondatra zibethicus*), American mink (*Neovison vison*), North American river otter (*Lontra canadensis*), white-tailed deer (*Odocoileus virginianus*), white-footed mouse (*Peromyscus leucopus*), eastern cottontail (*Sylvilagus floridanus*), eastern gray squirrel (*Sciurus carolinensis*), meadow vole (*Microtus pennsylvanicus*), northern shorttail shrew (*Blarina brevicauda*), raccoon (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), Virginia opossum (*Didelphis virginiana*) and North American beaver (*Castor Canadensis*) (USACE 2020a). The striped skunk (*Mephitis mephitis*), groundhog (*Marmota monax*), house mouse (*Mus musculus*), moles (*Scalopus spp.*), eastern chipmunk (*Tamias striatus*), and Virginia opossum (*Didelphis virginiana*), eastern coyote (*Canis latrans*), little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cenerius*), silver-haired bat (*Lasionycteris noctivagans*), and eastern red bat (*Lasiurus borealis*) are also reported to be present, if not throughout, at least in the Lower Hudson/East River Region (FHA 2012).

The Hudson River corridor (in addition to all NYNJHAT Planning Regions and surrounding States) is part of the Atlantic Flyway, one of four major avian migratory routes in North America. The Atlantic

Flyway is comprised of some of the most productive ecosystems (including forests, beaches, and coastal wetlands) but is under threat of RSLC and human activity disturbances to habitat (Audubon 2022). Over 200 species of birds are present along the corridor, some of which can be found year-round, while others may utilize areas along the way for nesting, overwintering, or migration (FHA 2012). Spring migration occurs along the corridor from February to May and fall migration occurs from September to November. Concentrations of mixed waterfowl can be seen resting and feeding in shallow areas such as Stockport Flats, Tappan Zee, Esopus Meadows, and the flats north of Kingston. Dabbling ducks often congregate in shallows supporting beds of water celery (*Vallisneria americana*). Diving ducks overwinter on open water portions of the estuary, feeding on small fishes such as killifish, shellfish and crustaceans. Herons and egrets commonly feed in sub-tidal shallows during late summer and early fall. Birds of prey migrate south during autumn along the Palisades ridgeline and circle above the river feeding on fishes and small mammals. Marshes provide nesting habitat for a limited number of songbirds (USACE 2020a). Peregrine falcons (*Falco perefrinus*) have been observed to be more adapted in urban areas and nesting on the Tappan Zee Bridge (FHA 2012).

Reptile and amphibian species that frequent tidal marshes and shallows, woodland pools, ponds, freshwater wetlands, and adjacent terrestrial forests include the snapping turtle (*Chelydra serpentina*), northern map turtle (*Graptemys geographica*), painted turtle (*Chrysemys picta*), spotted turtle (*Clemmys guttata*), common box turtle (*Terrapene Carolina*), wood turtle (*Glyptemys insculpta*), and five-lined skink (*Plestiodon fasciatus*) (USACE 2020a). Reptile and amphibian species richness and diversity are particularly high in the lower Hudson Valley, where the range limits of many northern and southern species converge; however, many of the habitats present in the area, particularly noted in the Lower Hudson/East River Region, are disturbed, degraded, and unable to support reptiles and amphibians other than species that are disturbance-tolerant (FHA 2012).

Hackensack/Passaic Region

This Planning Region supports species tolerant to a wide range of conditions and disturbances of a highly urban environment. Mammals reported include, but are not limited to, several bat species that migrate through the area such as the little brown bat (*Myotis lucifugus*), silver-haired bat (*Lasionycteris noctivans*), red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*). White-tailed deer (*Odocoileus virginianus*) are abundant in the suburban outskirts of the area (USACE 2020b). A variety of urban-adapted small mammals are likely to occur including the meadow vole (*Microtus pennsylvanicus*), cottontail rabbit (*Sylvilagus floridanus*), gray squirrel (*Sciurus carolenensis*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), white-footed mouse (*Peromyscus leucopus*), short-tail shrew (*Blarina blevicauda*), and eastern chipmunk (*Tamias striatus*). Small mammals introduced by humans include house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), and feral dogs (*Canis familiaris*) and cats (*Felis catus*) (USACE 2020b). Other mammals reported these Planning Regions include the eastern gray squirrel (*Sciurus carolinensis*), eastern chipmunk (*Tamias striatus*), common raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), groundhog (*Marmota monax*), among many other mammals (iNaturalist 2022).

Like the other Planning Regions within the Study Area, this Planning Region also falls within the Atlantic Flyway, discussed in more detail in the former Planning Region Section. Commonly reported species from several surveys conducted in 1999, 2000, 2010, and 2011 identified 41 avian species including Canada geese (*Branta canadesis*), mallard ducks (*Anas platyrhynchos*), ring-billed gulls (*Larus delawarensis*), terns, sandpipers, killdeer (*Charadrius vociferous*), sanderlings, swans, belted kingfishers (*Megaceryle alcyon*), double-crested cormorant (*Phalacrocorax auritus*), and red-winged black birds (*Agelaius phoeniceus*) (USACE 2020b). The Hackensack Meadowlands provide important habitat for thousands of shorebirds, both in spring and fall migrations, and for wintering and summering waterfowl (USFWS, 1997). Owls and hawks, such as northern harrier, rough-legged hawk (*Buteo lagopus*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), short-eared owl, and long-eared owl (*Asio otus*), forage on small mammals that inhabit landfills and other upland areas within this Planning Region (USACE 2020b).

Reptiles and amphibian species are intolerant of urbanization and limited in the highly urban environments; however, eight snake species, six terrestrial turtle species, and ten amphibian species known to be present in northeastern New Jersey have been reported in the Meadowlands, including the snapping turtle (*Chelydra* *serpentina*), diamondback terrapin (*Malaclemys terrpin)*, green frog (*Rana clamitans*), Fowler's toad (*Bufo fowleri*), the red-eared slider (*Trachemys scripta elegans*), and northern water snake (*Nerodia sipedon*) (Kiviat et al 2004).

Upper Bay/Arthur Kill Region

The highly urban and industrial Upper Bay Region shoreline and surrounding areas limit the prevalence of wildlife, bird, reptile, and amphibian species. Wildlife species that may tolerate, or be more easily adapted to, urban industrial environments that are most likely to be present in these areas include mice, rats, racoons, skunks, squirrels, pigeons, and sparrows. Both shoreline habitat and aquatic habitat in the Upper Bay are limited (USACE 2020b). The remainder of this Planning Region, extending into Union County and the northern portion of Middlesex County of New Jersey, and Staten Island, may also support species tolerant to a wide range of conditions and disturbances of a highly urban environment, similar to the Hackensack/Passaic Region. Portions of the Ash Brook Reservation located within Union County reportedly provides wildlife habitat suitable for gray squirrel, eastern chipmunk, white-tailed deer, red fox, opossum and woodchuck. White-tailed deer are adapted to suburban and urban environments of New Jersey and frequent the wetland and upland areas for breeding and foraging (Arsenault 2009).

Like the other Planning Regions within the Study Area, this Planning Region falls within the Atlantic Flyway, discussed in more detail in the former Planning Region sections. Large breeding populations of herons, egrets, and ibises have used the uninhabited islands of Pralls Island and the Isle of Meadows as nesting sites, and the marshlands and mudflats as foraging areas; however, while none of the islands in this region have recently supported active wading bird rookeries, they do provide habitat for other bird species (USACE 2016). Approximately 57 bird species have been reported in portions of the Ash Brook Reservation, including birds such as the yellow-throat, Carolina wren, and catbird that have adapted to Piedmont-Plains grasslands, where over 4 acres of grasslands and scrub-shrub habitat have been observed (Arsenault 2009). The William T. Davis Wildlife Refuge located in Staten Island has observed over 117 bird species including sharp-tailed sparrow (*Ammodramus caudacutus*), wood duck (*Aix sponsa*), several species of herons, egrets, ibis, cormorants, barn (*Tyto alba*), great horned (*Bubo virginianus*), and short-eared (*Asio flammeus*) owls, red-tailed (*Buteo jamaicensis*), red-shouldered (*Buteo lineatus*), rough-legged (*Buteo lagopus*), and marsh hawks (*Circus cyaneus*) (NYC Parks 2022).

Reptiles and amphibians that have been reported throughout this Planning Region, where habitat or environmental conditions allow, include the common garter snake (*Thamnophis sirtalis*), common snapping turtle (*Chelydra serpentina*), common box turtle (*Terrapene Carolina*), American bullfrog (*Lithobates catesbeianus*), eastern red-backed salamander (*Plethodon cinereus*), and pond slider (*Trachemys scripta*) (NYC Parks 2022 and iNaturalist 2022); although, reptile and amphibian species are limited in the highly urban and industrial areas.

Lower Bay Region

Mammals reported in this Planning Region include, but not limited to, the white-tailed deer (*Odocoileus virginianus*), eastern coyote (*Canis latrans*), mink (*Mustela vison*), red fox (*Vulpes fulva*), racoon (*Procyon lotor*), longtail weasel (*Mustela frenata*), white-footed mouse (*Peromyscus leucopus*), groundhog (*Marmota monax*), river otter (*Lutra canadensis*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethica*), striped skunk (*Mephitis mephitis*), eastern cottontail rabbit (*Sylvilagus floridanus*), Norway rat (*Rattus norvegicus*), and eastern mole (*Scalopus aquaticus*) (Monmouth County 2013). Wildlife reported in Staten Island are similar to the remainder of this Planning Region, particularly wild turkey (*Meleagris gallopavo*), eastern gray squirrel (*Sciurus carolinensis*), and groundhog (*Marmota monax*) (iNaturalist 2022).

Marine mammals and sea turtles that may be present in this Planning Region, and the surrounding Planning Regions overlapping with the New York Bight, include the harbor seal (*Phoca vitulina*), humpback whale (*Megaptera novaeangliae*), bottlenose dolphin (*Tursiops truncates*), and sperm whale (Physeter microcephalus, endangered), in addition to other species that have been observed or may occur include the blue whale

(*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), North Atlantic right whale (*Eubalaena glacialis*, endangered), common dolphin (*Delphinus delphis*), Cuvier's beaked whale (*Ziphius cavirostris*), minke whale (*Balaenoptera acutorostrata*), pilot whale (*Globicephala melas*), Risso's dolphin (*Grampus griseus*), loggerhead sea turtle (*Caretta caretta*, threatened), Kemp's ridley sea turtle (*Lepidochelys kempii*, endangered), green sea turtle (*Chelonia mydas*, threatened), and leatherback sea turtle (*Dermochelys coriacea*, endangered) (USFWS 2018).

Like the other Planning Regions within the Study Area, this Planning Region falls within the Atlantic Flyway, discussed in more detail in the former Planning Region sections. The geographic location and productive bay wetlands, flats, and waters make this Planning Region an important migratory staging area for species migrating along the Atlantic Flyway (USACE 2020b). The Raritan Bay-Sandy Hook Bay is listed as one of the USFWS significant complexes of the New York Bight Watershed, where beach habitat provides foraging for waterfowl and water birds and Sandy Hook provides as a corridor for northern harrier, osprey, common bark owl, red-tail hawk, Cooper's hawk (*Accipiter cooperii*), sharp-skinned hawk (*Accipiter striatus*), American kestrel, and peregrine falcon. Small mammals and songbirds common to the area provide a source of food for raptor populations (USACE 2020b).

Approximately 13 turtle, three lizard, 23 snake, 16 salamanders, and 16 frog and toad species are found throughout the State of New Jersey (NJDEP 2001). Those species that may be present in this Planning Region include, but not limited to, the bog turtle (*Clemmys muhlenbergii,* state endangered), northern diamondback terrapin (*Malaclemys terrapin terrapin*), eastern painted turtle (*Chrysemys picta picta*), five-lined skink (*Eumeces fasciatus*), northern fence lizard (*Sceloporus undulatus hyacinthinus*), black rat snake (*Elaphe obsoleta obsoleta*), eastern hognose snake (*Heterodon platyrhinos*), northern water snake (*Nerodia sipedon sipedon*), four-toed salamander (*Hemidactylium scutatum*), and red spotted newt (*Notophthalmus viridescens viridescens*). Several toad and frog species reported include the American toad (*Bufo americanus*), Fowler's toad (*Bufo woodhousii fowleri*), northern cricket frog (*Acris crepitans crepitans*), pine barrens treefrog (*Hyla andersonii,* state endangered), northern gray tree frog (*Hyla versicolor*), northern spring peeper (*Pseudacris crucifer crucifer*), and bullfrog (*Rana catesbeiana*) (NJDEP 2001). These frog and toad species may be found, depending on species, in sandy or loose soil habitats, residential backyards, remote woodland areas, vernal ponds or shallow stream edges, permanent bodies of water vegetated with shrubs and trees (NJDEP 2001). Staten Island species reported include eastern red-backed salamander (*Plethodon cinereus*), common garter snake (*Thamnophis sirtalis*), and pond slider (*Trachemys scripta*) (iNaturalist 2022).

Raritan Region

Mammals within this Planning Region are abundant and relatively adapted to suburban environments including, but not limited to, fox, coyotes, raccoons, hawks, deer, Canadian geese, groundhogs, rabbits, opossum, snakes, and sometimes bears (Township of Edison 2022). Species that have been reported throughout the area are similar to those found in the other Planning Regions including white-tailed deer (*Odocoileus virginianus*), eastern gray squirrel (*Sciurus carolinensis*), eastern cottontail (*Sylvilagus floridanus*), groundhog (*Marmota monax*), eastern chipmunk (*Tamias striatus*), red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), Virginia opossum (*Didelphis virginiana*), and the American black bear (*Ursus americanus*) (iNaturalist 2022).

Like the other Planning Regions within the Study Area, this Planning Region falls within the Atlantic Flyway, discussed in more detail in the former Planning Region section. Some of the birds reported in this Planning Region include, among many species, the red-winged blackbird (*Agelaius phoeniceus*), blue jay (*Cyanocitta cristata*), great blue heron (*Ardea herodias*), mourning dove (*Zenaida macroura*), Canada goose (*Branta canadensis*), downy woodpecker (*Dryobates pubescens*), osprey (*Pandion haliaetus*), and wild turkey (*Meleagris gallopavo*) (iNaturalist 2022).

Reptiles and amphibians that have been reported and/or may be present within the Region include the wood turtle (*Clemmys insculpta,* state threatened), common snapping turtle (*Chelydra serpentina serpentina*), red-eared slider and yellowbelly slider (*Trachemys scripta elegans and Trachemys scripta scripta*), northern fence lizard (*Sceloporus undulatus hyacinthinus*), eastern garter snake (*Thamnophis sirtalis sirtalis*), northern water snake (*Nerodia sipedon sipedon*), four-toed salamander (*Hemidactylium scutatum*), American toad (*Bufo americanus*), carpenter frog (*Rana virgatipes*), southern leopard frog (*Rana utricularia*), and Fowler's toad (*Bufo woodhousii fowleri*) (NJDEP 2003).

Jamaica Bay Region

Jamaica Bay is part of the Gateway National Park, Jamaica Bay Wildlife Refuge and Special Natural Waterfront Area designations in NYC. The Jamaica Bay estuary is an important ecosystem for many wildlife populations that frequent habitats of wooded uplands, wetlands, grassy fields, marshes, and sand dunes, and some of which in the New York Metropolitan Area have adapted to urban encroachment. Mammals reported in this area include the red fox (*Vulpes vulpes*), harbor seal (*Pinniped phocidae*), raccoons (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), and muskrat (*Ondatra zibethicus*) (NPS 2022). The Jamaica Bay Planning Region encompasses the Gateway National Recreation Area which provides an important habitat for wildlife, including 91 species of fish, reptiles, amphibians, and mammals. Horseshoe crabs (*Limulus polyphemus*) utilize the bay beaches and tidal flats as spawning grounds and serving as an important food source for migratory shorebirds (NPS 2019). Other wildlife species that may be present in the area include the little brown bat (*Myotis lucifugus*), and silver-haired bat (*Lasionycteris noctivagans*), particularly in the upland habitats adjacent to Jamaica Bay, opossum (*Didelphis virginiana*), eastern cottontail rabbit (*Sylvilagus floridanus*), eastern chipmunk (*Tamias striatus*), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethicus*), and house mouse (*Mus musculus*), as well as several marine mammals including finback (Balaenoptera physalus), minke (*B. acutorostrata*), and pilot (*Globicephala melaena*) whales, several dolphin species including common (*Delphinus delphis*), bottle-nosed (*Tursiops truncatus*), white-sided (*Lagenorhynchus acutus*), and striped (*Stenella coerulealba*), harbor porpoise (*Phocoena phocoena*), and harbor seals. While not observed as frequently, grey seal (*Halichoerus grypus*) habitat overlaps the Planning Region (USACE 2019).

Figure 5: American oystercatcher. (Photo Credit: Jesse Miller, Biologist, USACE New York District)

Like each of the nine Planning Regions, Jamaica Bay Region is also part of the Atlantic Flyway, serving as an important habitat for resident, nesting, overwintering, and migrating species; particularly shorebirds, raptors, waterfowl, and land birds. More than 300 bird species have been observed along the beach, bay and islands including ospreys, hawks, owls, glossy ibis, egrets, herons, laughing gulls, ducks, geese, warblers, and songbirds (NYSDEC 2022). Piping plover (*Charadrius melodus*), American oystercatcher (*Haematopus palliatus*), osprey (*Pandion haliaetus*), tree swallows (*Tachycineta bicolor*), and the American woodcock (*Scolopax minor*) are resident and/or migrating/nesting birds in the area (NPS 2022). Common species include herring gull (*Larus argentatus*), greater black-backed gull (*Larus marinus*), American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), barn swallow (*Hirundo rustica*), black-bellied plover (*Pluvialis squatarola*), black scoter (*Melanitta nigra*), bufflehead (*Bucephala albeola*), common grackle (*Quiscalus quiscula*), common yellowthroat (*Geothlypis trichas*), double-crested cormorant (*Phalacrocorax auritus*), European starling (*Sturnus vulgaris*), gray catbird (*Dumetella carolinensis*), mourning dove (*Zenaida macroura*), rock dove/pigeon (*Columba livia*), sanderling (*Calidris alba*), song sparrow (*Milospiza melodia*), house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), and tree swallow (*Iridoprocne bicolor*) (USACE 2019).

Reptile and amphibian species of Jamaica Bay frequent habitats of fresh and brackish waters, woods, meadows, and shallow pools including turtles, snakes, and frogs: such as the diamondback terrapins (*Malaclemys terrapin*), eastern box turtle (*Terrapene carolina carolina*), painted turtle (*Chrysemys picta picta*), snapping turtle, and eastern gray tree frog (*Hyla versicolor*). Raccoons and loss of salt marsh habitat are the biggest recent threat to the diamondback terrapins, since adults are no longer over harvested for food (NPS 2022). Jamaica Bay has the largest terrapin (*Malaclemys terrapin*) population in New York (NPS 2019). Other amphibians and reptiles species that may potentially be present in the Planning Region include Fowler's toad (*Bufo woodhousii fowleri*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor)*, green frog (*Rana clamitans*), spotted salamander, redback salamander (*Plethodon cinereus*), northern brown snake (*Storeria d. dekayi*), smooth green snake (*Opheodrys vernalis*), eastern hognose snake (*Heterodon platirhinos*), eastern milk snake (*Lampropeltis triangulum triangulum*), northern black racer (*Coluber c. constrictor*), snapping turtle (*Chelydra serpentina*), eastern painted turtle (*Chrysemys p. picta*), and eastern box turtle (*Terrapene c. carolina*) (USACE 2019).

Long Island Sound Region

Mammals reported in the Long Island Sound Region are consistent with the other Planning Regions with disturbed urban environments, such as the eastern gray squirrel (*Sciurus carolinensis*), eastern chipmunk (*Tamais striatus*), common raccoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), and groundhog (*Marmota monax*). Marine mammals that may be present in the vicinity, as well as within the Planning Regions that overlap with the New York Bight discussed in a subsequent Planning Region, include but not limited to the harbor seal (*Phoca vitulina*), common bottlenose dolphin (*Tursiops truncates*), humpback whale (*Megaptera novaeangliae*), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), North Atlantic right whale (*Eubalaena glacialis,* endangered) and harbor porpoise (*Phocoena phocoena*) (iNaturalist 2022 and USFWS 2018).

Like each of the nine Planning Regions, the Long Island Sound Region is also within the Atlantic Flyway, discussed in more detail in former Planning Region Sections. Species of birds known in the vicinity include the American robin (*Turdus migratorius*), Canada goose (*Branta canadensis*), red-winged blackbird (*Agelaius phoeniceus*), mourning dove (*Zenaida macroura*), osprey (*Pandion haliaetus*), and ducks (*Ocyura jamaicensis, Aix sponsa,* and *Anas platurhynchos*). Several islands in this Planning Region support large populations of wading birds, most notably South Brother Island, which has been estimated to support almost 500 breeding pairs of wading birds and over 300 cormorant nests and further east into Long Island Sound, the southern shore contains significant waterfowl wintering areas including Little Neck Bay, Manhasset Bay, and Hempstead Harbor (USACE 2020b). The wetlands along the mainland in this Planning Region provide important nesting habitat for several species, including green-backed heron (Butorides striata), yellow-crowned night-heron (Nyctanassa violacea), American bittern (Botaurus lentiginosus), Canada goose (Branta canadensis), American black duck (Anas rubripes), and clapper rail (Rallus crepitans); however, heron nesting habitat is threatened by cormorants and human intrusion disturbances (USACE 2020b).

Figure 6: Yellow crowned night heron. (Photo Credit: Jesse Miller, Biologist, USACE New York District)

Reptiles and amphibians reported in Long Island Sound and Northwestern Nassau County include the diamondback terrapin (*Malaclemys terrapin*), pond slider (*Trachemys scripta*), painted turtle (*Chrysemys picta*), Italian wall lizard (*Podarcis siculus*), Fowler's toad (*Anaxyrus fowleri*), American bullfrog (*Lithobates catesbeianus*), and eastern red-backed salamander (*Plethodon cinereus*) (iNaturalist 2022); although, many of these species are anticipated to be limited in the disturbed urban environments of this Region, except for those species that are disturbance-tolerant.

2.2.2 Fish

This Section generally lists fish located within each Planning Region. This Section may mention migratory and special status fish; however, refer to subsequent Sections for additional details on migratory fish and Appendix A2 and A3 for additional details on special status fish.

There are four main categories of fish found throughout the waters within the NYNJHAT Study Area. The first is Estuarine fishes; they live in tidal waters where fresh and saltwaters mix. The salt content varies: water closer to the ocean has a has higher salinity. The shallow water and low wave action of estuaries make them an important nursery for juvenile fish. Examples of Estuarine fishes include bluefish and weakfish. The second is Anadromous fish. Anadromous fish migrate from the ocean to freshwater to spawn. After spawning, adult fish often swim downstream to an estuary and eventually out to sea. Examples of anadromous fish found in the boundaries of the Study Area include striped bass, shad, and river herring. The next category of fish is Marine or pelagic, these fish spend much time living in the open ocean. These are often large, fast-growing and swift-moving species adapted to living in deep waters. Examples of Pelagic fish that can be found within the Study Area are: tuna and predatory pelagic sharks. The last is Catadromous fish, they migrate from freshwater to the ocean to spawn. Spawning often takes place offshore and a great distance from waters with the NYNJHAT Study bounds. An example of a Catadromous fish is the American eel (Monmouth County Parks 2015).

Atlantic menhaden (*Brevoortia tyrannus*), anchovies (*Anchoa spp.*), silversides (*Menidia spp.*), and killifish (*Fundulus spp.*) are important forage species found in all of the Planning Regions. An abundance of these important prey species are present within the Lower Bay, Jamaica Bay, Upper Bay/Arthur Kill, and Lower Hudson/East River makes each Region important foraging and nursery habitat for several migratory, EFH-designated, and/or commercially and recreationally important fish species such as summer flounder, winter flounder, tautog, bluefish, and weakfish.

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

With fresh water upriver and saltwater flowing into the river near New York City, the Hudson River estuary and its watershed are home to more than 200 fish species. In 2021, during a fish collecting event, NYSDEC named the following species as present in the Hudson, East River, and Harlem River: Alewife (*Alosa pseudoharengus*), American eel (*Anguilla rostrata*), Atlantic menhanden (*Brevoortia tyrannus)*, Atlantic silverside (*Menidia menidia*), Atlantic tomcod (*Microgadus tomcod*), banded killifish (*Fundulus diaphanus*), black crappie (*Pomoxis nigromaculatus*), blueback herring (*Alosa aestivalis*), bluefish (*Pomatomus saltatrix*), bluegill (*Lepomis macrochirus*), brook silverside (*Labidesthes sicculus*), brown bullhead (*Ameiurus nebulosus*), channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), emerald shiner (*Notropis atherinoides*), freshwater drum (*Aplodinotus grunniens*), gizzard shad (*Dorosoma cepedianum*), golden shiner (*Notemigonus crysoleucas*), goldfish (*Carassius auratus*), hogchoker (*Trinectes maculatus*), largemouth bass (*Micropterus salmoides*), logperch (*Percidae*), mummichog (*Fundulus heteroclitus*), northern hog sucker (*Hypentelium nigricans*), northern pipefish (*Syngnathus fuscus*), porgie (*Sparidae*), pumpkinseed (*Lepomis gibbosus*), redbreast sunfish (*Lepomis auritus*), rock bass (*Ambloplites rupestris*), rosyface shiner (*Notropis rubellus*), sea robin (*Prionotus*), smallmouth bass (*Micropterus dolomieu*), spotfin shiner (*Cyprinella* spiloptera), spottail shiner (*Notropis hudsonius*), striped bass (*Morone saxatilis*), tessellated darter (*Etheostoma olmstedi*), walleye (*Sander vitreus*), white perch (*Morone americana*), white sucker (*Catostomus commersonii*), and yellow perch (*Perca flavescens*) (NYSDEC 2021).

Emphasis in these Regions are put on the American eel as they are highly migratory. Silversides, anchovies, menhaden, and killifish are important prey species identified in these Regions. These Regions also offer foraging habitat for several EFH-designated and/or commercially and recreationally important fish species such as bluefish.

Hackensack/Passaic Region

The most abundant species of fish in this Region are as follows: mummichog (Fundulus heteroclitus), Atlantic silverside (Menidia menidia), inland silverside (Menidia beryllina), white perch (Morone americana), blueback herring (Alosa aesrivalis), Atlantic tomcod (Microgadus tomcod), brown bullhead (Ictaluws nebulous), pumpkinseed (Lepomis gibbosus), American eel (Anguilla rostrata), bay anchovy (Anchoa mitchilli), striped killifish (Fundulus majalis), and striped bass (Morone saxatilis). Killifish (*Fundulus spp.*) are an important forage species found in this region (Braggin 1988).

Upper Bay/Arthur Kill Region and Lower Bay Region

The finfish community in these Regions, consists of a variety of estuarine, marine, and anadromous fish species, is typical of large coastal estuaries and inshore waterways along the Mid-Atlantic Bight. Situated in the transition zone between northern cold water (boreal) species and temperate (warm-water) species, New York Bight and the NY/NJ Harbor estuary serve as a spawning ground, migratory pathway, and nursery/foraging area for many fish species. Many of the species that are seasonally abundant in these regions are transient or migratory, moving through the Bay to upstream spawning grounds in the Hudson River or entering the area on a seasonal basis from nearby ocean waters. These species include estuarine migratory species that use the estuary primarily as a nursery, or as a forage area for juveniles or adults. Species that migrate from marine waters to spawn in the freshwater reaches of the Hudson River, in freshwater tributaries, or in the upper reaches of the estuary are considered anadromous. This includes several common species of herring (*Clupeidae)* such as blueback herring (*Alosa aestivalis*), alewife (*A. pseudoharengus*), and American shad (*A. sapidissima*), as well as the relatively less common hickory shad (*A. mediocris*) and gizzard shad (*Dorosoma cepedianum*) (USFWS, 1997). These species occur in the project area primarily as adults, migrating to spawning areas, and heavily influence the seasonal composition and abundance of the fish community. Other anadromous species occurring in the project area include Atlantic tomcod (Microgadus tomcod), Atlantic sturgeon (Acipenser oxyrhyncus), rainbow smelt (Osmerus mordax), and striped bass. Deeper, open-water habitats in these regions support over 60 migratory and resident fish species including species of commercial or recreational importance such as winter flounder and black sea bass. Northwest Staten Island and the islands along the Kill Van Kull were designated as a Special Natural Waterfront Area by New York City due to the diverse landscape of habitats. Arlington Marsh and Graniteville Swamp are examples of important habitats within this region (USACE 2022).

Raritan Region

The Raritan Region is mainly focused on the tidally influenced portions of the Raritan River. Some prevalent and important fish species found here are as follows: American eel (*Anguilla rostrata*), Summer flounder *(Paralichthys dentatus*), weakfish, white catfish, and white perch (Monmouth County Parks 2015).

All fish mentioned above are important recreationally fished and consumed by the public. Weakfish are an important prey species, and summer flounder are an important commercially fished species.

Jamaica Bay Region

The Jamaica Bay Estuary supports around 90 different species of fish. Some of the common and/or important species are as follows: American eel (*Anguilla rostrata*), Atlantic menhaden (*Brevoortia tyrannus*), Atlantic silverside (*Menidia menidia*), bluefish (*Pomatomus saltatrix*), lined seahorse (*Hippocampus erectus*), mummichog (*Fundulus heteroclitus*), northern pipefish (*Syngnathus fuscus*), northern puffer (*Sphoeroides maculates*), northern searobin (*Prionotus carolinus*), striped killifish (*Fundulus majalis*), striped mullet *(Mugil cephalus*), summer flounder (Fluke) *(Paralichthys dentatus*), tautog (Blackfish) (*Tautoga onitis*), and winter flounder (*Pseudopleuronectes americanus*) (NYCDEP 2021).

Summer flounder, winter flounder, menhaden, and bluefish, are all recognized as commercially and recreationally important species.

Long Island Sound Region

The most common and abundant species in the Long Island Sound are: porgy, butterfish, winter flounder, summer flounder, windowpane flounder, fourspot flounder, northern and striped sea robin, little skate, menhaden, Atlantic silversides, black seabass, blackfish (tautog), cunner, bluefish, and smooth dogfish (Fishkill Flea 2022)

Winter flounder, summer flounder, menhaden, bluefish, and little skate are all recognized as commercially and recreationally important fish species that are found in this region.

Migratory Fish

Highly migratory fish travel long distances and often cross domestic and international boundaries. These pelagic species live in water of the open ocean, although they may spend part of their life cycle nearshore waters. Continuous disturbances to benthic habitat, littoral environments, and irregular changes to tidal flow change cause irreparable damage to the species within these regions (NOAA 2022). For additional information on fish and special status fish, refer to other Sections of this Chapter. Refer to Appendix A2 and A3 for additional information on special status migratory fish.

The following list details conditions of each Planning Region relative to migratory fish:

- Capital District- The Capital Region provides shelter and nursery habitat for several species of migratory fish
- Mid-Hudson Region -The Mid-Hudson Region contains migratory fish runs for many species and provides those fish with access to important feeding, overwintering, and nursery areas (USACE 2004a).
- Lower Hudson/East River Region -The Lower Hudson is the primary nursery and overwintering area for striped bass in the Hudson River estuary.
- Hackensack/Passaic Region- Support commercial fishing operations
- Upper Bay/Arthur Kill Region- The Upper Bay is a critical component of the Planning Region because it serves as a migratory pathway for many fish species, providing access to important feeding, overwintering, and nursery areas (USACE 2004a). Deeper, open-water habitats in this region support over 60 species of migratory and resident fishes (RPA 2003; USACE 2004a).
- Lower Bay Region- Popular for recreational fishing.
- Raritan Region- Known for striped bass and American eel habitat within the Raritan River (during annual migrations and are among the commercial and recreational fish species found in the Region)
- Jamaica Bay Region
- Long Island Sound Region- The Region is a significant route for migratory fish, and the bays are also productive nurseries and feeding areas for marine finfish and shellfish (USFWS 1997)

The following Table discusses migratory fish present within the Study Area, including the Planning Region they are most likely utilize for foraging, shelter, or nursery habitat. These species include alewife (also known as river herring), American eel, American shad, Atlantic herring, Atlantic tomcod, blueback herring, sea lamprey, stiped bass, Atlantic sturgeon and shortnose sturgeon. Note that while special status species may be mentioned in this Section, they are discussed in subsequent Sections of Chapter 2 (e.g. threatened and endangered species).

Table 3: Migratory fish summary in the Study Area.

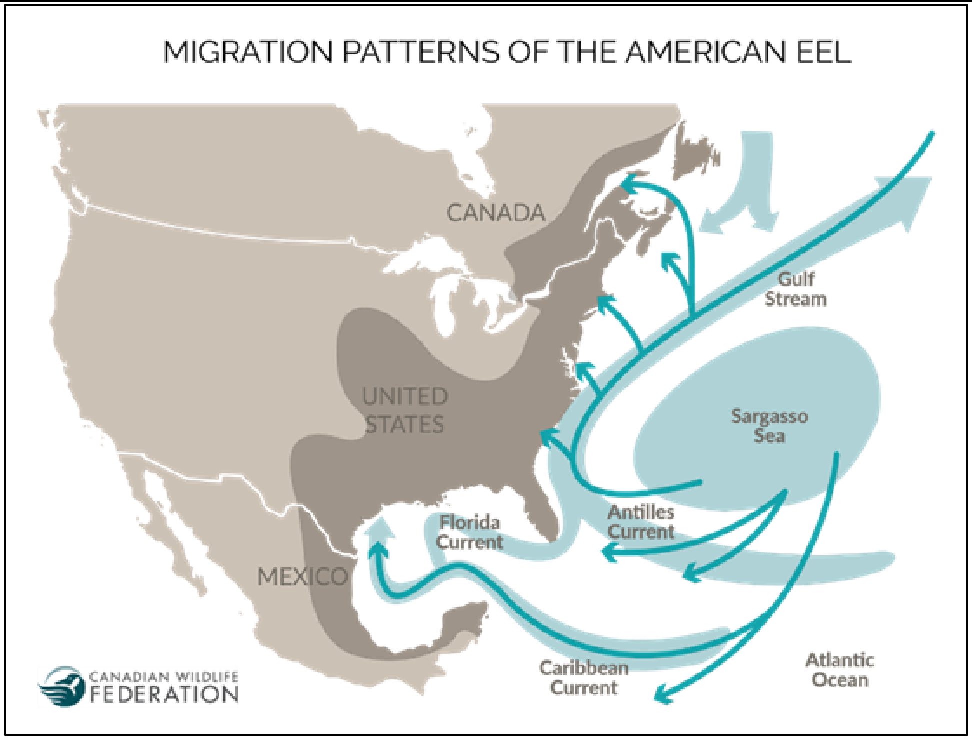
Species Name: Alewife (*Alosa pseudoharengus),* also called River Herring **Region:** Mid-Hudson, Hackensack/Passaic **Habitat:** Alewife is anadromous and euryhaline, but occurs in landlocked water bodies, it exists at various depths ranging throughout the year from littoral to profundal zones depending on the season. In spring, Alewife spreads out across a lake, staying in warmer waters above the thermocline in schools and dispersing shoreward at night to spawn near the surface of open lake shores, bays, harbors, and lower reaches of. When near shore, Alewife prefers rocky substrates to sandy substrates During summer, young-of-year Alewife stays in the warmer epilimnion while older fish will often venture into the thermocline and cooler waters (USGS 2022).

Migratory Patterns: Alewife spends its adult life in the ocean and returns to coastal streams to spawn. It also lives in landlocked lakes where it has been introduced. In lakes it swims in schools and occupies both deep and shallow waters. Its native range as an ocean migrant includes the coastal streams of Long Island, Lower Hudson, Upper Hudson, Susquehanna, Chemung and Delaware watersheds. It was native to Lake Ontario and the Saint Lawrence River, but modern populations extend far beyond those migratory boundaries because of introductions to upstream landlocked lakes (NYSDEC 2022).

Photo Credit: *Alosa pseudoharengus* (Wilson, 1811), https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=490

Species Name: American eel (*Anguilla rostrata)*
Regions: Capital, Raritan, Mid-Hudson
Habitat: Estuaries are productive habitats the American eel. Productivity of yellow-phase eels is higher in downstream brackish-water habitats than in upstream freshwater locations. Despite strong evidence for limited dispersal within a 1-year period, other evidence indicated that some yellow-phase eels did disperse among estuarine regions over longer periods of time (Morris and Secor 2003).
Migration Patterns: American eels live in rivers and estuaries along the Atlantic coastline from Venezuela to Greenland and Iceland. They also are found along the Gulf Coast and Mississippi River (USFWSb 2022). American eel, a catadromous species of finfish, utilizes the Region to access upriver freshwater habitat (ASMFC 2009). Catadromous species spawn in the marine environment, then travel upstream to freshwater habitat as juveniles, where individuals mature and live as adults before returning to sea for spawning (ASMFC 2009).

Photo credit: Sam Stukel/USFWS, American eel | FWS.gov



Source:([https://blog.cwf-fcf.org/index.php/en/raise-your-voice-and-get-the-american-eel-listed-by-sara/eel-migration-map-en/)*](https://blog.cwf-fcf.org/index.php/en/raise-your-voice-and-get-the-american-eel-listed-by-sara/eel-migration-map-en/)

Species Name: American shad (*Alosa sapidissima),* is a species of anadromous herring fish
Region: Mid- Hudson, Hackensack/Passaic
Habitat: Young shad in fresh and tidal portions of rivers feed on zooplankton (microscopic animals) and insect larvae; Adult shad in the ocean eat primarily zooplankton (microscopic animals) but can take worms or small fish (NYSDEC 2022).
Migratory Patterns: They live in the Atlantic Ocean but travel upstream to spawn in brackish or freshwater rivers. Every spring, adult shad return to large freshwater river systems to spawn. After spawning, surviving adults return to the ocean. Newly hatched young remain in freshwater until fall; in the fall, they move downstream to brackish estuaries where they may remain for a year or more before moving out to the ocean (Virginia Dept of Wildlife Resources 2022).

Photo Credit: USFWS, https://www.fws.gov/media/146527

Species Name: Atlantic Herring (*Clupea harengus*)
Regions: Capital District, Jamaica Bay, Lower Bay Hackensack/Passaic Region
Habitat: The spatial distribution of spawning is restricted to locations with coarse gravel and hard bottom habitats in waters <100 m depth. This specific spawning habitat restricts spawning to discrete areas of the continental shelf, which results in a discontinuous pattern to spawning (Hare and Richardson 2014).
Migratory Patterns: Atlantic herring migrate in schools to areas where they feed, spawn, and spend the winter. They spawn as early as August in Nova Scotia and eastern Maine and from October through November in the southern Gulf of Maine, Georges Bank, and Nantucket Shoals. By late spring, larvae grow into juvenile herring, which form large schools in coastal waters during the summer.

Photo credit: [Dockside: It's Time for Herring - The Fisherman]

Species Name: Atlantic tomcod *(Microgadus tomcod)*
Regions: Mid-Hudson
Habitat: Shoals, harbors, river mouths from Newfoundland to Virginia Atlantic tomcod are distributed along the coast from south Labrador to Virginia. They prefer the brackish waters of salt marshes and river mouths but can also be found in freshwater. They are usually not found in depths exceeding 6 meters. Atlantic Tomcod frequently inhabit the mouths of streams or estuaries. Sometimes they are found in salt marshes. Young-of-the-year and small adults are often found in shallow eelgrass beds. Tomcod are resistant to sudden changes in temperature and salinity.
Migratory Patterns: Migrate Upstream- October and November; Spawn**-** November through February, peaking in January; Migrate Downstream February to May; later for young-of-the-year

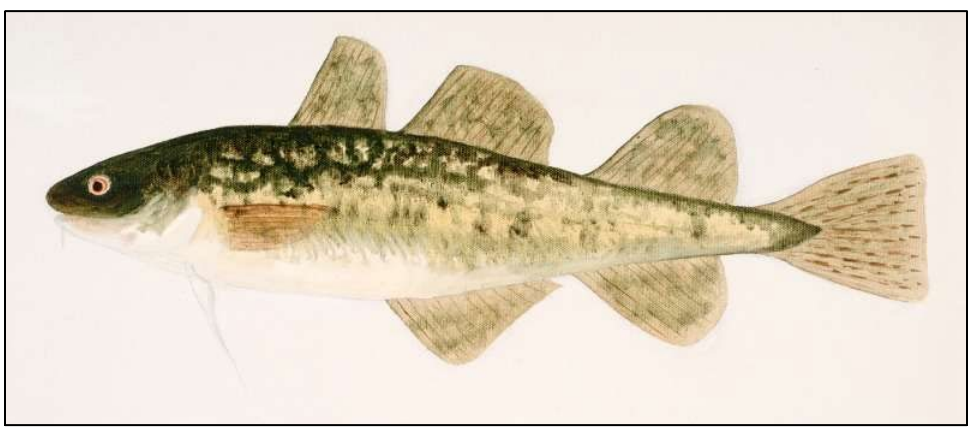


Photo Credit: [Atlantic Tomcod – Wells Reserve]

Species Name: Blueback herring (*Alosa aestivalis)*
Region: Mid-Hudson, Hackensack/Passaic
Habitat: The blueback herring can be found in estuaries, channel entrances and coastal waters located in the mid-Hudson region (NMFS 2019).
Migratory Patterns: Migratory fish, which occur along the Atlantic coast of North America from Nova Scotia, Canada to northern Florida. They were once part of the largest commercial and recreational fishery on the Atlantic Coast and were historically more abundant and widely distributed in river systems along the east coast. They are an important forage base in marine, estuarine and freshwater systems (USFWS 2022).

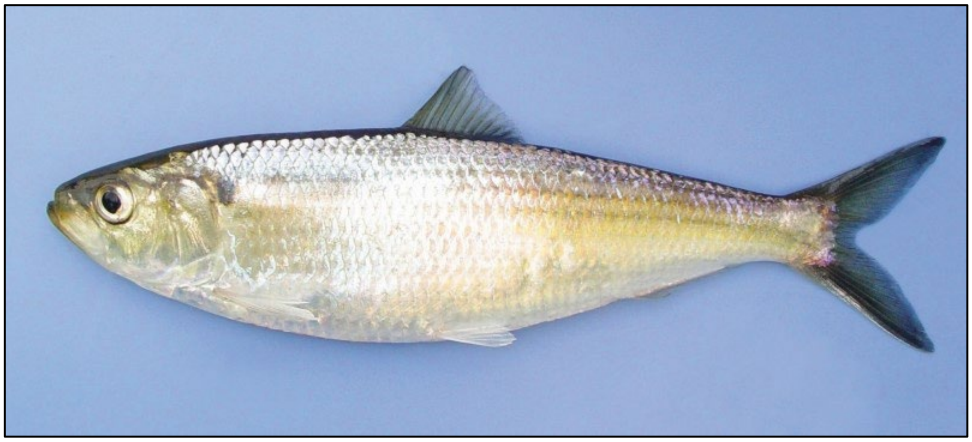


Photo credit: Blueback Herring (ct.gov)

Species Name: Sea lamprey (*Petromyzon marinus)*
Regions: Mid-Hudson
Habitat: This species is diadromous, spending the early stages of their life in streams and rivers and the middle stage of their life in the ocean or, in the case of the Great Lakes populations, in a large freshwater lake. They then return as breeding adults to spawn in the freshwater streams and rivers and die shortly after spawning. The blind, worm-like larval lamprey, known as ammocoetes, can grow up to 5 inches long. They hatch from eggs in gravel nests in tributaries and drift downstream with the current. When they locate suitable habitat -- usually silt or sand stream bottoms and banks in slower-moving stretches of water -- they burrow in and take up residence, filter-feeding on algae, detritus and microscopic organisms and materials.
Migratory Patterns: Anadromous lifestyles are still easily seen in the Delaware, Lower Hudson and Long Island watersheds but have been eliminated from Susquehanna and Chemung watersheds. Land locked (and native) populations are found in Lake Ontario, Oswego, Champlain and Saint Lawrence watersheds, and they are detrimental to sportfish management of salmonids. Large-scale control programs are underway in those tributaries of the Lake Ontario, the Finger Lakes, Lake Champlain and Lake Erie. Generally marine but ascends freshwater rivers to spawn. Atlantic Coast from the Gulf of St. Lawrence to the St. Johns River, Florida; Atlantic Coast of Europe and Mediterranean Sea (Page and Burr 2011).

Photo credit: agnathan - Evolution and classification | Britannica

Species Name: Striped bass
Regions: Mid-Hudson, Jamaica Bay, Raritan Region, Lower Bay (Striped bass is an anadromous species and mature individuals utilize the Region to reach upriver spawning habitat in the spring, while juveniles travel downriver during summer and fall to reach coastal waters to live as adults (ASMFC 2009)).
Habitat: These basses generally live from Canada down to Florida into Louisiana. Due to being introduced to lakes and rivers by humans, striped bass can also be found inland and on the West Coast as well as the East coast. Striped bass spend most of their time either in rivers or in the ocean just off the coast. Since they move between fresh water and saltwater for breeding, they will usually stay in saltwater for most months before embarking on their annual trip to mate.
Migratory Patterns: Migration for the mass of the stock s: (a) in summer, they school near the surface on feeding migrations in the tributaries , bays, and ocean along the New England coast; (b) in autumn, schools move into lower tributaries and bays partly for feeding but primarily for overwintering; (c) in winter, they concentrate in a somewhat less active condition in the deeper waters of the lower tributaries and bays (in Chesapeake Bay they live as deep as 15 0 feet); and (d) in spring, they move from the deeper waters, mature fish ascend rivers to spawn, and immature ones start on their feeding migration. From April to early June, striped bass will either move back to their birthplace or find a new location to breed.

Photo credit: Everything You Want To Know About The Striped Bass (proangler.us)

Species Name: Atlantic sturgeon (*A. oxyrhynchus*)
Regions: Lower Hudson/East River
Habitat: Atlantic sturgeon live in rivers and coastal waters from Canada to Florida. Hatched in the freshwater of rivers, Atlantic sturgeon head out to sea as sub-adults, and return to their birthplace to spawn, or lay eggs, when they reach adulthood.
Migratory Patterns: Atlantic sturgeon do migrate through waters of Lower New York Bay, and adjacent channels and waters. The local juvenile population aggregates in the spring and fall near Breezy Point, known as the Rockaway Aggregation.

Photo credit: Atlantic sturgeon - Bing images

Species Name: Shortnose sturgeon (*Acipenser brevirostrum)*
Regions: Mid-Hudson Lower Hudson/East River Region
Habitat: Shortnose sturgeon live in rivers and coastal waters from Canada to Florida. They hatch in the freshwater of rivers and spend most of their time in the estuaries of these rivers.
Migratory Patterns: Shortnose sturgeon tend to spend relatively little time in the ocean. When they do enter marine waters, they generally stay close to shore. In the spring, adults move far upstream and away from saltwater to spawn. After spawning, the adults move rapidly back downstream to the estuaries, where they feed, rest, and spend most of their time. Both the Atlantic and shortnose sturgeon (*Acipenser brevirostrum*) migrate through waters of the Hudson River and New York Bay to reach spawning waters in freshwater reaches of the Hudson River. The Hudson River population of shortnose sturgeon is one of the healthiest remaining populations of this species (Woodland and Secor, 2007). Shortnose sturgeon are, however, transient in upper New York Harbor waters and likely only to be found there during their migrations to spawning grounds and are not known to occur in lower New York Harbor.

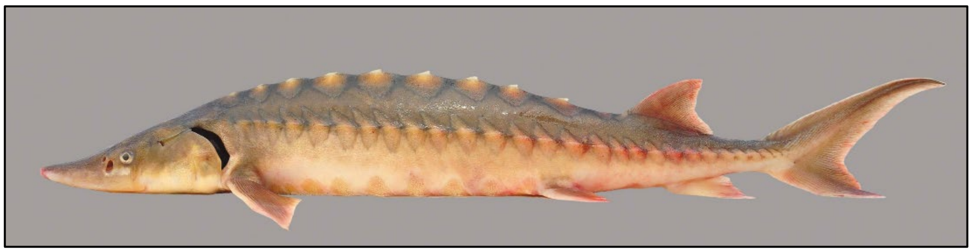


Photo credit: Photograph courtesy of the University of Georgia Sturgeon Research Lab

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Terrestrial Vegetation

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Terrestrial vegetation along the Hudson River in undeveloped areas is generally deciduous forest. Extensive areas of the river shores are forested with oaks (*Quercus spp.*), maples (*Acer spp.*), beeches (*Fagus spp.*), birches (*Betula spp.*), and pines (*Pinaceae spp*). Dry rocky slopes such as the Palisades Ridge and Hudson Highlands support oaks. Areas with deeper soils, generally located in the mid-upper reaches of the estuary, as well as moist ravines down river, support oaks, maples, tulips (*Liriodendroidae spp.*), birches, beeches, and dogwood (*Cornaceae spp.*) (USACE 2020a).

In the more urban areas, and particularly noted within the Lower Hudson/East River Region, vegetation is dominated by non-native and invasive species indicative of disturbed habitats. Common vegetated communities include urban vacant lots, mowed lawns, mowed lawns with trees, paved pathways and roads, railroads, residential, commercial, and some industrial communities, and successional forest communities consisting of wind dispersed species well adapted to disturbed areas. Norway maple and black locust (*Robinia pseudoacacia*) are common trees of successional hardwood forests (FHA 2020).

Hackensack/Passaic Region

In heavily urban environments, terrestrial vegetation is generally indicative of and/or limited by residential, commercial, and industrial manmade structures, landscaping, local parks, highway and railroad corridors, and other human disturbed environments. Within the heavily urban environment of this Planning Region, the Hackensack Meadowlands is a habitat of regional importance and ecological value. Over 400 vascular plants have been historically reported in the Hackensack Meadowlands including New Jersey rare species: floating marsh-pennywort (*Hydrocotyle ranunculoides*), wild calla (*Calla palustris*), rough cotton-grass (*Eriophorum tenellum*), bunchberry (*Cornus canadensis*), and crested yellow orchid (*Platanthera cristata*). Presently the floral assemblage is much less diverse with the non-native common reed that dominates throughout. Uplands within the Hackensack Meadowlands are mostly artificial (including closed landfills) and include grassland, shrubland, and early successional forest; however, smaller undeveloped uplands are scattered along the Hackensack Meadowlands edges (USACE 2020b).

Garrett Mountain Reservation located in Passaic County, consists primarily of deciduous forest with riparian habitats and ponds, serving as an important stopover/flyover point for land birds (Audubon 2022b). To the adjacent west/northwest of this Planning Region is Preakness Mountain, Troy Meadows, and the Great Piece Meadows. Preakness Mountain is vegetated with open woodland and dense forest with six upland ecological communities including the hickory-ask-red cedar woodland, dry-mesic inland mixed oak forest, mesic hemlock-hardwood forest, and successional old field; Troy Meadows consists of half large emergency marsh, including cattails (*Typha*), common reed (*Phragmites australis*), and sedges (*Carex spp.*) and a mix of forested and scrub-shrub swamps, ephemeral ponds, floodplain, and grasslands; and the Great Piece Meadows primarily consists of a forested wetland with some scrub-shrub and emergent marsh areas (USACE 2020b). In 2010, surveys were conducted along the Lower Passaic River that observed plants were less diverse and mostly comprised of scrub-shrub vegetation with few trees occasionally present, where those areas of emergent vegetation were found in intertidal mudflats, consisting of smooth cordgrass or common reed, and areas of mixed forest and urban green spaces/parks were more prevalent upriver (USACE 2020b).

Upper Bay/Arthur Kill Region

In the urban-dominated areas of this Planning Region, terrestrial vegetation is generally indicative of and/or limited by areas of large impervious surfaces, residential, commercial, and industrial manmade structures, roadways/railroad networks, golf courses, and local parks as the environment is dominated by heavily human populated areas. Along the shoreline of the Upper Bay near the Arthur Kill and Kill Van Kull, the extensive tributary system of the Arthur Kill supports tidal and freshwater wetlands, mudflats, and riparian forest; however, many of the coastal wetland sections of this Planning Region are fragmented or degraded by common reed (*Phragmites australis)* (USACE 2020b). Further inland, portions of the Ash Brook Reservation, particularly the Red Hill, contains unique vegetation to Union County, including 4.5 acres of herbaceous-dominated cover and grass dominated habitat along the highest portions of the area, where native grasses including little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), rosette panic grass (*Dichanthelium*), narrow-leaf goldenrod (*Euthamia graminifolia*), dwarf dandelion (*Krigia virginica*), hairy thoroughwort (*Eupatorium pubescens Muhl*), and sweet everlasting (*Pseudognaphalium obtusifolium*) have been reported (Arsenault 2009). Ash Swamp contains a large forest of native trees, shrubs and herbs with deciduous forest comprised of red maple, sweet gum, and American beech trees (Arsenault 2009). A large undeveloped and/or minimally developed area of terrestrial vegetation is observed at the South Mountain Reservation. The South Mountain Reservation covers approximately 2,112 acres in central Essex County extending through West Orange, Maplewood, and Milburn, between the first and second ridges on the Watchung Mountain Range. Woodland communities comprised of hardwood trees and hemlocks are observed throughout near streams, creeks and ponds including a tributary to the Rahway River. Although manmade, the South Mountain Reservation is primarily preserved in a wild state (Essex County 2022). Non-native terrestrial vegetation in Staten Island has increased over time, noted in lowland forest, upland forest, coastal, lowland meadow, and upland meadow habitats. The highest native species loss was observed in 1879 and 1930; and between 1879 and 1991 non-native species increased from 19.2% to 33.5% of the entire species population (Robinson et al 1994).

Lower Bay Region

The Lower Bay Planning Region has a diversity of plant communities including marine, estuarine, and upland terrestrial habitats scattered throughout. The south shore of Raritan Bay to Sandy Hook Bay is characterized by a narrow strip of high and low salt marsh and creeks with intertidal and shallow subtidal mudflats and sandflats extending from these habitats. The salt marshes along this shoreline consist of high and low marsh cordgrass with some black grass, marsh elder (*Iva frutescens*), and groundsel bush (*Baccharis halimifolia*) in the high tide zone, as well as invasive common reed. Riparian forests of the Atlantic Highlands line the freshwater tributaries that feed into Sandy Hook Bay, the Navesink and Shrewsbury Rivers (USACE 2020b). Sandy Hook is a nine-mile narrow sand spit that has an extensive vegetated dune system and two distinct maritime forest communities that encompass 285 acres. Extensive areas of back dune habitat occur toward the northern end, with dry sandy soils supporting shrubby vegetation. The west side of the Sandy Hook spit consists of extensive tidal mud and sandflats and salt marsh dominated by low marsh cordgrass, with a few small inland marsh areas dominated by common reed (USFWS, 1997). Eastern Staten Island comprises the northwestern boundary of the Lower Bay Planning Region. Beach, maritime shrub and grassland, and forest communities, as well as highly urbanized areas, are located along the eastern Staten Island shoreline from the Verrazano Narrows to Tottenville (USACE 2020b).

Raritan Region

This Region is also comprised of heavily urban to suburban environment with a few large areas of observed terrestrial vegetation at the Watchung Reservation and Pigeon Swamp State Park; however, the majority of urban terrestrial vegetation is generally indicative of and/or limited by residential, commercial, and industrial manmade structures, golf courses, roadway/railroad corridors, and some clusters of wooded vegetation throughout (GIS LandCover 2022). The Watchung Reservation is an over 2,000-acre preserve located in the northern part of Union County, comprised of wooded vegetation. The Union County Department of Parks and Recreation rehabilitated a new pollinator meadow with native plant species including monarda, bee balm, spotted St. John's wort, black-eyed Susan, coreopsis, blue vervain, and milkweed (Union County 2022). Pigeon Swamp State Park contains a mix of habitats including open ponds, upland hardwood forests, and inner coastal plain lowland deciduous hardwood forest. A variety of flora and fauna is observed along the trails, including sweetgum, red maple, pin oak, and black gum (NJDEP 2022x).

Jamaica Bay Region

In the urban-dominated areas of this Planning Region, terrestrial vegetation is generally indicative of and/or limited in areas of large impervious surfaces, manmade structures, roadways/railroad networks, residential and commercial structures with landscaping and local parks as the environment is dominated by heavily human populated areas. Most notable terrestrial vegetation is within the Jamaica Bay Wildlife Refuge and the NPS Gateway National Recreation Area.

Terrestrial vegetation within Jamaica Bay consists of a mix of grass, shrub, trees, and bare ground/sand intermixing at surface water areas and areas that experience both seasonal and coastal flooding. Clusters of wooded vegetation and dense tall vegetation are observed in a few areas throughout (land use GIS source). Smooth cordgrass *(Spartina alterniflora)* is a dominant species in Jamaica Bay salt marshes; however, it has been determined that wastewater discharges in the bay have contributed to the degradation of the terrestrial environment and growth of salt marsh vegetation (NPS 2022). The center of Jamaica Bay is dominated by subtidal open water and extensive low-lying islands where the average low tide exposes mudflats and low salt marshes dominated by smooth cordgrass. The high marsh is dominated by saltmeadow cordgrass (*S. patens*) and microalgal growth in the intertidal areas is dominated by sea lettuce (*Ulva latuca*). Upland communities include grasslands, scrub-shrub, developing woodlands, and beachgrass dune. Although the surrounding area is heavily urban, the Jamaica Bay Planning Region has an abundance of plant species (USACE 2020b). Fresh Creek Nature Preserve, located in Brooklyn near, and around, E 108th Street, is comprised of 42 acres of salt marsh with Faber's foxtail and velvetleaf (NYC Parks 2022).

Long Island Sound Region

Similar to the urban areas of the other Planning Regions within the Study Area, terrestrial vegetation in the Long Island Sound Region is generally indicative of and/or limited in areas of large impervious surfaces, residential, commercial and industrial manmade structures, roadways/railroad networks, and local parks as the environment is dominated by heavily human populated areas. Parks with greenspace include Pelham Bay Park, Old Croton Trailway State Park, and Bronx Park, characterized by wooded areas with clusters of tall dense vegetation. A few areas within this Planning Region also contain open areas covered in homogenous grasses with little to no tall vegetation, with a mix of small clusters of plants dispersed on exposed soil or rock landscapes and scrub-filled clearings particularly noted in Pelham Bay Park and Ferry Point Park, Sands Point County Park, and the North Hempstead Beach Park (GIS LandCover 2022). Many parks, golf courses, and country clubs are scattered throughout, particularly in the northern portions of this Planning Region, with areas of terrestrial vegetation increasing further to the north outside the densely populated areas of the Bronx, and Queens.

Many of the shorelines, tidal rivers, and embayments of this Planning Region are densely urbanized with sparse remnants of tidal wetlands, sandy/gravelly beaches and upland habitats, where areas of open space contain maritime salt marsh, mixed hardwood woodland, grassland/meadow, mixed deciduous forests, swamps, marshes, open fields, and freshwater ponds (USACE 2020b). The Islands throughout the Region are mostly covered with grass, shrub, deciduous forest, if not heavily urbanized. Flushing Bay and Flushing Creek contain tidal habitat with adjacent tidal marsh wetlands and mudflats, where the lower marsh areas are dominated by smooth cordgrass and the high tide/spring tide elevation is dominated by spike grass and saltmeadow cordgrass (USACE 2020).

Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) are plants that are predominantly submerged under water, except for periods of brief exposure to low tides, and provide an important habitat for juvenile fish, macroinvertebrates, and food for waterfowl. Development in areas inhabited by submerged aquatic vegetation is prohibited, except in limited circumstances (NYSDEC 2022b and Cooke et al 2021). SAV habitats perform a number of irreplaceable ecological functions which range from chemical cycling and physical modification of the water column and sediments to providing food and shelter for commercial, recreational, and economically important organisms (NOAA 2018).

The most common SAV species on the North Atlantic coast is eelgrass (*Zostera marina*). Other species found in more freshwater habitats of the Hudson River include water celery (*Vallisneria americana*), Eurasian watermilfoil (*Myriophyllum spicatum*), and sago palmweed (*Potamogeton pectinatus*).

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Vegetation in the Hudson River varies depending on the salinity, depth of water, and currents. Typical SAV in a brackish subtidal community consists of native wild celery (*Vallisneria americana*) and clasping pondweed (*Potamogeton perfoliatus*) as well as nonnative Eurasian water milfoil (Myriophyllum spicatum) and curly pondweed (*Potamogeton crispus*). Mudflat plant communities are often characterized with rosette structures (i.e., having leaves in a circular arrangement). The plant communities may include native awl-leaf arrowhead (*Sagittaria subulata*), kidneyleaf mud-plantain (*Heteranthera reniformis*), and soft-stemmed bulrush (*Scirpus validus*), and the non-native spatterdock (*Nuphar advena*). The freshwater intertidal zone is characterized by native threesquare (*Scirpus americanus*), wild rice (*Zizania spp.*), pickerelweed (*Pontederia cordata*), cattail (*Typha spp.*), jewelweed (*Impatiens capensis*), and spatter dock (*Nuphar advena*), and nonnative common reed (*Phragmities spp.*) and purple loosetrife (*Lythrum salicaria*) (USACE 2020a).

NYSDEC has documented SAV locations, and maintain these records on a GIS database, all of which are combined into one map referenced as the “Hudson River Estuary Documented Submerged Aquatic Vegetation”. NYSDEC observed during Summer 2012 that a particular species of SAV, water celery, was not found in areas where it was observed in previous years, possibly due to an influx of sediment transport caused by Hurricane Irene and Tropical Storm Lee covering and blocking light from reaching the submerged plants (NYSDEC 2022b). In previous years submerged aquatic vegetation shallows habitat loss occurred as a result of the development of Federal navigation channels where SAV may have existed previously between Catskill and Troy, New York (NYSDEC 2022b). SAV is also under threat of invasive/aquatic nuisance species.

Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, and Raritan Region

There is no documented SAV within these Planning Regions. Submerged aquatic vegetation in New Jersey is predominately located along southern New Jersey in Navesink, Shrewsbury, Manasquan, and Metedeconk Rivers, and in Barnegat, Manahawkin, and Little Egg Harbor Bays (Cooke et al 2021). In 2010, surveys were conducted along the Lower Passaic River finding that no extant submerged aquatic vegetation was documented in the Lower Passaic River (USACE 2020b).

Lower Bay Region

According to a 1979 New Jersey Submersed Aquatic Vegetation Distribution map of Sandy Hook, SAV was documented on the bay side to the north of Monmouth Hills and to the southwest of Navesink Beach (NJDEP 1979).

Jamaica Bay Region

Aquatic vegetation in this Planning Region is limited by a history of extensive dredging, dredge material placement, and infrastructure development contributing to thriving invasive species including the common reed (*Phragmites australis*) (USACE 2020b). Survey charts from the nineteenth century of the coast exhibited eelgrass (*Zostera marina*) along the northern edge of Jamaica Bay, but now are no longer present, potentially attributed to increased nitrogen input and/or light penetration that may limit growth on benthic surfaces (Sanderson et al, 2016).

Long Island Sound Region

There is no reported SAV in the Long Island Sound Region.

Invasive and Aquatic Nuisance Species

Invasive species are non-native animal and plant species that can cause harm to the environment, the economy, and human health. Harm caused by invasive non-indigenous species may include habitat degradation and loss, loss of native wildlife and plant species, impacts to recreation, agriculture, livestock, and risks to public health and safety (NYSDEC 2022).

Invasive species Executive Orders (E.O. 13312 and 13751) were enacted, as amended, to ensure Federal agencies do not authorize, fund, or carry out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that is has prescribed, the agency has determined and made public it's determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species, and that all feasible and prudent measures to manage risk of harm will be taken in conjunction with the actions.

The following terrestrial[3] (T) and aquatic[4] (A) invasive species of concern in New York State include, but are not limited to, the following plants and animals (NYSDEC 2022):

Plants:

Giant hogweed (T)	Slender false brome (T)	Wild parsnip (T)
Didymo (A)	Hydrilla (A)	Starry stoneword (A)
Water chestnut (A)		

Animals:

Asian longhorned beetle (T)	Emerald ash borer (T)	Eurasian boar (T)
Spondy moth (gypsy moth) (T)	Hemlock woolly adelgid (T)	Sirex woodwasp (T)
Spotted lanternfly (T)	Chinese mitten crab (A)	Northern snakehead fish (A)
Sea lamprey (A)	Spiny waterflea (A)	

The following terrestrial[2] (T) and aquatic[3] (A) invasive species of concern in the State of New Jersey include, but is not limited to, the following plants and animals (NJDEP 2022):

Plants:

Canadian thistle (T)	Japanese knotweed (T)	Japanese stiltgrass (T)
Eurasian water-milfoil (A)	Garlic Mustard (T)	Mile-a-minute (T)
Japanese barberry (T)	Multiflora Rose (T)	Japanese honeysuckle (T)
Purple loosestrife (T)	Water chestnut (T)	

[3] Terrestrial refers to on-land species, denoted by (T)

[4] Aquatic refers to in-water species, denoted by (A)

Animals:

Asian longhorn beetle (T)	Woolly adelgid (T)	Asian Tiger Mosquito (T)
Gypsy moth (T)		

While invasive and/or aquatic nuisance species are found throughout New York and New Jersey, below are a few examples of invasive species that have been reported within, but are not limited to the boundaries of, each Planning Region:

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region

The Hudson River serves as a corridor, valuable habitat, and migration pathway for many native species, where invasive species pose a serious threat to ecological and economic resources that the River provides (NYSDEC 2022). Some of the aquatic invasive species known to be inhabiting the Hudson River and surrounding tributaries include water chestnuts, hydrilla, didymo, zebra mussels, and grass carp (Riverkeeper 2022). Zebra mussels were introduced to the river in 1992, which depleted the river's standing stock of phytoplankton and impacted other successive food chain components, including zooplankton (USACE 2020A). A few emerging plant and animal species of concern monitored by the Hudson River Aquatic Invasive Species Task Force include alligatorweed (*Alternanthera philoxeroides*), European frogbit (*Hydrocharis morsus-ranae*), the green crab (*Carcinus maenas*), and northern snakehead (*Channa argus*), among several others. Kudzu (*Pueraria montana*), an invasive vine, can be observed overgrowing terrestrial vegetation landscape and manmade structures along highway corridors of the Hudson River.

Invasive terrestrial species that are indicative of disturbed environments, particularly as reported within the Lower Hudson/East River Region, including the Norway maple (*Acer platanoides*), tree-of-heaven (*Ailanthus altissima*), mugwort (*Artemisia vulgaris*), foxtail grasses (*Setaria faberi, Setaria sp.*), and Japanese honeysuckle (*Lonicera japonica*) with areas of Asiatic bittersweet (*Celastrus orbiculatus*), porcelainberry (*Ampelopsis brevipedunculata*), Japanese knotweed (Polygonum cuspidatum), mugwort, multiflora rose (Rosa multiflora), white snakeroot (Ageratina altissima), and seaside goldenrod (Solidago sempervirens) (FHA 2020).

Hackensack/Passaic Region

Bio-benchmark studies conducted along the Passaic River for the Lower Passaic River Restoration Project (October 2008) identified invasive species present in the area vary depending on habitat, which include swamp smartweed (*Polygonum hydropiperoides*), Japanese knotweed (*Polygonum cuspidatum*), tree of heaven (*Ailanthus altissima*), multiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiolata*), and desert false indigo (*Amorpha fruticosa*). The common reed (*Pragmites austriais*) is present along the Passaic River and dominates in the Meadowlands which have been found to have greater habitat related effects to some estuarine organisms over others (Thiesing 2003).

Upper Bay/Arthur Kill Region

This Planning Region contains invasive species that are indicative of disturbed environments including wineberry (*Rubus phoenicolasius*) and multiflora rose (*Rosa multiflora*) (iNaturalist 2022). Japanese knotweed is considered a major invasive species of concern in Union and Essex Counties as it can tolerate a wide range of adverse and disturbed environment conditions and is known to completely take over and eliminate native plants. This species is most often observed near streams and rivers, in low-lying areas, waste ridden areas, utility corridors, and residential properties. The USFWS has been conducting herbicide spraying operations of Japanese knotweed to control overgrowth (Union County 2022). Spotted lanternfly have been reported in both the New Jersey and New York State portions of this Planning Region, discussed in more detail below.

Lower Bay Region

Invasive species are present throughout the Lower Bay Region, those that are most prevalent, particularly in Monmouth County, include the Norway maple (*Acer platanoides*), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), garlic mustard (*Alliaria petiolata*), tree of heaven (*Ailanthus altissima*), Japanese stilt grass (*Microstegium vimineum*), and Japanese honeysuckle (*Lonicera japonica*). Other invasive species of concern that may be present or are being monitored include the Asian longhorned beetle (*Anoplophora glabripennis*), gypsy moth (*Lymantria dispar*), kudzu (*Pueraria montana*), wineberry (*Rubus phoenicolasius*), and Japanese knotweed (*Reynoutria japonica*) (Monmouth County 2022). Spotted lanternfly have been reported in both the New Jersey and New York State portions of this Planning Region, discussed in more detail below.

Raritan Region

Figure 7: Adult spotted lanternfly. (Source: NJ Department of Agriculture 2022)

Invasive species are present throughout the Raritan Region, including the spotted lanternfly (*Lycorma delicatula*), which is found in terrestrial habitats throughout New Jersey and New York (in addition to several other surrounding States). Spotted lanternfly are attracted to walnut, maple, and birch trees, especially the tree of heaven (*Ailanthus altissima*) which is the species host plant, prompting locals to destroy eggs, nymphs, and adults where found (Middlesex County 2022). The New Jersey Department of Agriculture, (in addition to the New York State Department of Agriculture) and the United States Department of Agriculture monitor spotted lanternfly prevalence through online reporting and monitoring tools.

Jamaica Bay Region

Phragmites (*Phragmites australis*) are one of the most invasive plant species in New York State and are prevalent throughout New York City ponds and marshes. Phragmites have been identified in much of the marshland of Jamaica Bay Marine Park, where historical soil disturbances have occurred. Although invasive, phragmites aggressive growth pattern can remove contaminants from degraded soils and wetlands (NYC 2022). Aquatic vegetation habitat within the Jamaica Bay Region has been disturbed by dredging, dredge material placement, and infrastructure development which has contributed to expanding invasive/aquatic nuisance species (USACE 2020b).

Long Island Sound Region

Over 692 invasive species have been found within the Long Island Invasive Species Management Area, which include the zebra, quagga mussels (*Dreissena polymorpha*), yellow flag iris (*Iris pseudacorus*), yellow archangel (*Lamiastrum galeobdolon*), wisteria (*Wisteria spp.*), wineberry (*Rubus phoenicolasius*), wild parsnip (*Pastinaca sativa*), water chestnut (*Trapa natans*), the spotted lanternfly (*Lycorma delicatula*), southern pine beetle (*Dendroctonus frontalis*), sea lamprey (*Petromyzon marinus*), rock snot (*Didymosphenia geminata*), red-eared slider (*Trachemys scripta elegans)*, and many other plant and animal species (LIISM 2022). The common reed is a dominant invasive species in much of the Long Island Sound Region marsh areas. Inter-tidal emergent marshlands persist along the western bank of Flushing Creek and are dominated by invasive species (USACE 2020b).

2.2.3 Special Status Species

Threatened and Endangered Species

The Endangered Species Act (ESA) of 1973 was passed to protect and recover imperiled species and the ecosystems upon which they depend. The ESA is administered by the USFWS and the National Marine Fisheries Service (NMFS). Under the ESA, species may be listed as either endangered or threatened, whereby species are either in danger of extinction through all, or a significant portion, of its range (endangered) or are species that are likely to become endangered within the foreseeable future (threatened). The ESA prohibits the "take" of protected species, including harassment, hunting, capturing, collecting, or killing. A list of federal and state listed terrestrial and aquatic threatened and endangered species occurring within the NYNJHAT Study Area are listed on the following tables:

Table 5: Terrestrial listed species in the NYNJHAT Study Area.

Common Name	Scientific Name	Federal Status[1]	New York Status[1]	New Jersey Status[1]	Listing/ Recovery Plan Citation	Region(s) Where Species May Occur[2]
Mammals						
Indiana bat	*Myotis sodalis*	E	E	E	32 FR 4001; Draft Recovery Plan: USFWS 2007	UB, MH, ER, LIS, RAR, HP
Northern long-eared bat	*Myotis septentrionalis*	T	T	NL	80 FR 17973 18033	All Regions
Birds						
Piping plover	*Charadius melodus*	T	E	E	49 FR 44712; Recovery plan USFWS 2016	UB, ER, LIS, JB, LB
Red knot	*Calidris canutus rufa*	T	T	E	79 FR 73705; Draft Recovery plan: USFWS 2021	UB, ER, LIS, JB, LB
Roseate tern	*Sterna dougalli dougalli*	E	E	E	52 FR 42064; Recovery plan USFWS 1998	UB, ER, LIS, JB, LB
Least Bittern	*Ixobrychus exilis*	NL	T	NL	N/A	All Regions
Bald Eagle	*Haliaeetus leucocephalus*	NL	T	E	N/A	All Regions
Reptiles						
Bog turtle	*Glyptemys muhlenbergii*	T	E	E	62 FR 59605 59623; Recovery plan: USFWS 2001	UB, MH, ER, RAR, HP, LB
Insects						
Monarch butterfly	*Danaus plexippus*	C	NL	NL	85 FR 81813	All Regions
Northeast beach tiger beetle	*Habroscelimorpha dorsalis dorsalis*	T	T	E	55 FR 32088; Recovery plan: USFWS 1994	LB

Flowering Plants						
American chaffseed	*Schwalbea americana*	E	NL	E	57 FR 44703 44708; Recovery plan: USFWS 2019	LB
Knieskern beaked-rush	*Rhynchospora knieskernii*	T	NL	E	56 FR 32978 32983; Recovery plan: USFWS 1993	LB
Sandplain gerardia	*Agalinis acuta*	E	E	NL	53 FR 34701 34705; Recovery plan: USFWS 1989	JB
Seabeach amaranth	*Amaranthus pumilus*	T	T	E	58 FR 18035; Recovery plan: USFWS 1996	UB, ER, LIS, JB, LB
Small whorled pogonia	*Isotria medeoloides*	T	E	E	59 FR 50852 50857; Recovery plan: USFWS 1992	MH, ER
Swamp pink	*Helonias bullata*	T	NL	E	53 FR 35076 35080; Recovery plan: USFWS 1991	RAR, LB

Notes: [1] Status Abbreviations – Threatened (T), Endangered (E), Candidate (C), Not Listed (NL)
[2] Region Abbreviations - Upper Bay/Arthur Kill Region (UB), Mid-Hudson Region (MH), Long Island Sound Region (LIS), Lower Hudson/East River Region (ER), Raritan Region (RAR), Hackensack-Passaic Region (HP), Jamaica Bay Region (JB), Lower Bay Region (LB), Capital District Region (CD)

Table 4: Aquatic listed species in the NYNJHAT Study Area.

Common Name	Scientific Name	Federal Status[1]	New York Status[1]	New Jersey Status[1]	Listing/Recovery Plan Citation	Region(s) Where Species May Occur[2]
Fish						
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	E	E	E	77 FR 5880 and 77 FR 5914	UB, MH, LIS, ER, RAR, HP, JB, LB, CD
Shortnose sturgeon	*Acipenser brevirostrum*	E	E	E	32 FR 4001; Recovery plan: NFMS 1998	UB, MH, LIS, ER, HP, CD
Reptiles						
Green sea turtle	*Chelonia mydas*	T	T	T	81 FR 20057; Recovery plan: NMFS & USFWS 1991	UB, LIS, ER, JB, LB
Kemp's ridley turtle	*Lepidochelys kempii*	E	E	E	35 FR 18319; Recovery plan: NMFS et al. 2011	UB, LIS, ER, JB, LB

Leatherback turtle	*Dermochelys coriacea*	E	E	E	35 FR 8491; Recovery plan: NMFS & USFWS 1992	UB, LIS, ER, JB, LB
Loggerhead turtle	*Caretta caretta*	E	T	E	76 FR 58868; Recovery plan: NMFS & USFWS 2008	UB, LIS, ER, JB, LB
Mammals						
Fin Whale	*Balaenoptera physalus*	E	E	E	35 FR 18319; Recovery plan: NMFS 2010	LB
Humpback Whale	*Megaptera novaeangliae*	NL – delisted for U.S. harbors	E	E	FR 15993; Recovery plan: NMFS 1991	LB
North Atlantic Right Whale	*Eubalaena glacialis*	E	E	E	73 FR 12024; Recovery plan: NMFS 2005	LB

Notes: [1] Status Abbreviations – Threatened (T), Endangered (E), Candidate (C), Not Listed (NL)
Notes: [2] Region Abbreviations - Upper Bay/Arthur Kill Region (UB), Mid-Hudson Region (MH), Long Island Sound Region (LIS), Lower Hudson/East River Region (ER), Raritan Region (RAR), Hackensack-Passaic Region (HP), Jamaica Bay Region (JB), Lower Bay Region (LB), Capital District Region (CD)

Migratory Bird Treaty Act Species and the Bald and Golden Eagle Protection Act Species

The Migratory Bird Treaty Act (MBTA) of 1918, as amended, was implemented for the protection and conservation of migratory birds. The MBTA prohibits, unless permitted by regulations, actions that could cause detrimental effects to migratory birds. Under the MBTA, it is illegal to possess, import, export, transport, sell, purchase, barter or offer for sale migratory birds, including their parts, feathers, nests, and eggs. The law additionally makes it illegal to engage in a “take”, or to “pursue, hunt, shoot, wound, kill, trap, capture or collect, or any attempt to carry out these activities” of migratory birds including their parts, feathers, nests, and eggs (USFWS 2022a).

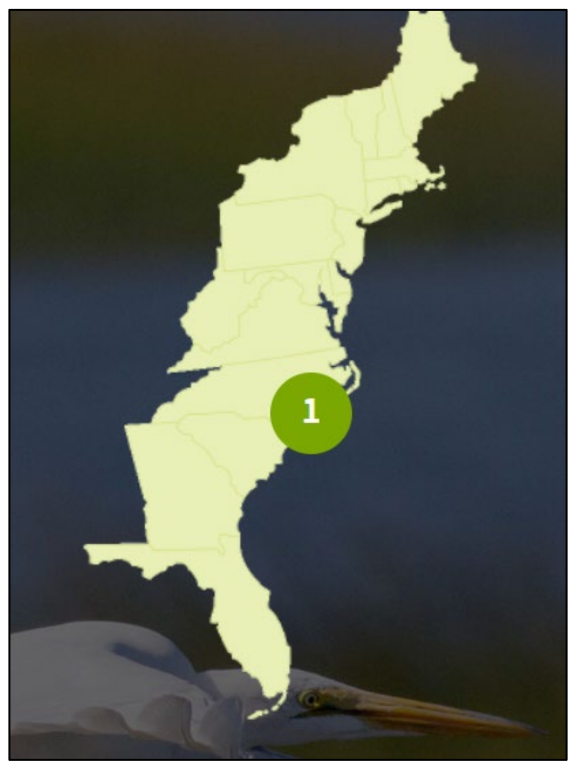


Figure 8: Atlantic flyway. (Source: Audubon 2022)

The Bald and Golden Eagle Protection Act of 1940, as amended, prohibits, unless under permit issued by the Secretary of the Interior, actions that could disturb or cause detrimental effects to bald and golden eagles. Under this Act, and similar to the MBTA, it is illegal to possess, import, export, transport, sell, purchase, barter or offer for sale, including their parts, feathers, nests and eggs. The law additionally makes it illegal to engage in a “take”, or to “pursue, hunt, shoot, wound, kill, trap, capture or collect, or any attempt to carry out these activities” of bald and golden eagles, including their parts, feathers, nests and eggs (USFWS 2022a).

As discussed in prior sections of this Report the NYNJHAT Study Area is located within the Atlantic Flyway. New Jersey has at least 120, and New York has at least 136, identified critical bird breeding, migratory stop-over, feeding, and overwintering areas, referred to as Important Bird Areas, which include forests shrub/scrub, grasslands, freshwater and saltwater wetlands, and bodies of water (Audubon 2022b). The list of migratory bird species protected under the MBTA is extensive and includes many native species found in each of the Planning Regions (USFWS 2022f). The Bald Eagle (*Haliaeetus leucocephalus*) is found within each of the Planning Regions and the Golden Eagle (*Aquila chrysaetos*) migrates through the Study Area each year. MBTA and Bald and Golden Eagle Protection Act species, and the habitats upon which they depend, are under threat of climate change, RSLC, and human disturbances.

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region

Important Bird Areas within these Planning Regions are observed scattered along the Hudson River, with a significantly sized area present in the Fahnestock and Hudson Highlands State Parks and lower Hudson River. Rockefeller State Park, Palisades Interstate Park, Van Cortlandt Park, and Central Park are also listed as Important Bird Areas (Audubon 2022b). Birds of particular concern that may be observed within these Planning Regions, whether throughout or in particular areas include:

Table 5: Birds of particular concern within the Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region.

Common Name	Scientific Name	Common Name	Scientific Name
American oystercatcher	*Haematopus palliatus*	Bald eagle	*Haliaeetus leucocephalus*
Black skimmer	*Rynchops niger*	Black-billed cuckoo	*Coccyzus erythropthalmus*
Blue-winged warbler	*Vermivora pinus*	Bobolink	*Dolichonyx oryzivorus*
Canada warbler	*Cardellina canadensis*	Cerulean warbler	*Dendroica cerulea*
Chimney swift	*Chaetura pelagica*	Eastern whip-poor-will	*Antrostomus vociferus*
Golden eagle	*Aquila chrysaetos*	Hudsonian godwit	*Limosa haemastica*
Kentucky warbler	*Oporornis formosus*	Lesser yellowlegs	*Tringa flavipes*
Long-eared owl	*Asio otus*	Prairie warbler	*Dendroica discolor*
Prothonotary warbler	*Protonotaria citrea*	Purple sandpiper	*Calidris maritima*
Red-headed woodpecker	*Melanerpes erythrocephalus*	Rusty blackbird	*Euphagus carolinus*
Short-billed dowitcher	*Limnodromus griseus*	Willet	*Tringa semipalmata*
Wood thrush	*Hylocichla mustelina*	Belted kingfisher	*Megaceryle alcyon*
Eastern meadowlark	*Sturnella magna*	Evening grosbeak	*Coccothraustes vespertinus*
Black-capped chickadee	*Poecile atricapillus practicus*	Golden-winged warbler	*Vermivora chrysoptera*
Northern saw-whet owl	*Aegolius acadicus acadicus*	Rusty blackbird	*Euphagus carolinus*

Source: USFWS IPaC Database: https://ipac.ecosphere.fws.gov/location/index

Hackensack/Passaic Region

Important Bird Areas within this Planning Region include the Hackensack Meadowlands District, Garret Mountain, and Oradell Reservoir (Audubon 2022b). Birds of particular concern that may be observed within these Planning Regions, whether throughout or in particular areas include:

Table 6: Birds of particular concern within the Hackensack/Passaic Region.

Common Name	Scientific Name	Common Name	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*	Black-billed cuckoo	*Coccyzus erythropthalmus*
Blue-winged warbler	*Vermivora pinus*	Bobolink	*Dolichonyx oryzivorus*
Canada warbler	*Cardellina canadensis*	Cerulean warbler	*Dendroica cerulea*
Chimney swift	*Chaetura pelagica*	Golden eagle	*Aquila chrysaetos*
Kentucky warbler	*Oporornis formosus*	Lesser yellowlegs	*Tringa flavipes*
Long-eared owl	*Asio otus*	Prairie warbler	*Dendroica discolor*
Prothonotary warbler	*Protonotaria citrea*	Red-headed woodpecker	*Melanerpes erythrocephalus*
Rusty blackbird	*Euphagus carolinus*	Wood thrush	*Hylocichla mustelina*

Source: USFWS IPaC Database: https://ipac.ecosphere.fws.gov/location/index

Upper Bay/Arthur Kill Region

Important Bird Areas within this Planning Region include the Arthur Kill Complex and Tributaries and Harbor Herons Complex (Audubon 2022b). Birds of particular concern that may be observed within these Planning Regions, whether throughout or in particular areas include:

Table 7: Birds of particular concern within the Upper Bay/Arthur Kill Region

Common Name	Scientific Name	Common Name	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*	Black-billed cuckoo	*Coccyzus erythropthalmus*
Chimney swift	*Chaetura pelagica*	Prairie warbler	*Dendroica discolor*
Prothonotary warbler	*Protonotaria citrea*	Red-headed woodpecker	*Melanerpes erythrocephalus*
Rusty blackbird	*Euphagus carolinus*	Wood thrush	*Hylocichla mustelina*

Source: USFWS IPaC Database: https://ipac.ecosphere.fws.gov/location/index

Lower Bay Region

Important Bird Areas within this Planning Region include the Raritan Bay and Southern Shore, Sandy Hook/Gateway National Recreation Area, Navesink and Shrewsbury Rivers, and Big Brook Park Region Grasslands (Audubon 2022b). Birds of particular concern that may be observed within these Planning Regions, whether throughout or in particular areas are presented below. Note this is not an exhaustive list, as at least 43 birds of particular concern species were identified on the USFWS IPaC database, some of which are also listed in previous Planning Region Sections.

Table 8: Birds of particular concern within the Lower Bay Region

Common Name	Scientific Name	Common Name	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*	American oystercatcher	*Haematopus palliates*
Black scoter	*Melanitta nigra*	Black skimmer	*Rynchops niger*
Black-legged kittiwake	*Rissa tridactyla*	Brown Pelican	*Pelecanus occidentalis*

Dovekie	*Alle alle*	Double-crested cormorant	*Phalacrocorax auratus*
Long-tailed duck	*Clangula hyemalis*	Purple sandpiper	*Calidris maritima*
Red-breasted Merganser	*Mergus serrator*	Red-throated loon	*Gavia stellata*
Roseate tern	*Sterna dougallii*	Short-billed dowitcher	*Limnodromus griseus*

Source: USFWS IPaC Database: https://ipac.ecosphere.fws.gov/location/index

Raritan Region

An Important Bird Area within this Planning Region includes the Delaware and Raritan Canal State Park (Audubon 2022b). Birds of particular concern that may be observed within these Planning Regions, whether throughout or in particular areas include:

Table 9: Birds of particular concern within the Raritan Region.

Common Name	Scientific Name	Common Name	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*	Black-billed cuckoo	*Coccyzus erythropthalmus*
Chimney swift	*Chaetura pelagica*	Prairie warbler	*Dendroica discolor*
Cerulean warbler	*Dendroica cerulea*	Eastern whip-poor-will	*Antrostomus vociferus*
Golden eagle	*Aquila chrysaetos*	Kentucky warbler	*Oporornis formosus*
Prothonotary warbler	*Protonotaria citrea*	Red-headed woodpecker	*Melanerpes erythrocephalus*
Rusty blackbird	*Euphagus carolinus*	Wood thrush	*Hylocichla mustelina*

Source: USFWS IPaC Database: https://ipac.ecosphere.fws.gov/location/index

Jamaica Bay Region

Important Bird Areas within this Planning Region include Jamaica Bay, Prospect Park, and a small portion of West Hempstead Bay/Jones Beach West (Audubon 2022b). Birds of particular concern that may be observed within these Planning Regions, whether throughout or in particular areas are presented below. Note this is not an exhaustive list, as at least 49 birds of particular concern species were identified on the USFWS IPaC database, some of which are also listed in previous Planning Region Sections.

Table 10: Birds of particular concern within the Jamaica Bay Region

Common Name	Scientific Name	Common Name	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*	American oystercatcher	*Haematopus palliates*
Black scoter	*Melanitta nigra*	Black skimmer	*Rynchops niger*
Black-legged kittiwake	*Rissa tridactyla*	Brown Pelican	*Pelecanus occidentalis*
Dovekie	*Alle alle*	Surf scoter	*Melanitta perspicillata*
Long-tailed duck	*Clangula hyemalis*	Purple sandpiper	*Calidris maritima*
Red-breasted Merganser	*Mergus serrator*	Red-throated loon	*Gavia stellata*
Roseate tern	*Sterna dougallii*	Short-billed dowitcher	*Limnodromus griseus*
Thick-billed murre	*Uria lomvia*	Wilson's storm-petrel	*Oceanites oceanicus*

Source: USFWS IPaC Database: https://ipac.ecosphere.fws.gov/location/index

Long Island Sound Region

Important Bird Areas within this Planning Region include the Little Neck Bay to Hempstead Harbor, Pellham Bay Park, and Huckleberry Island (Audubon 2022b). Birds of particular concern that may be observed within these Planning Regions, whether throughout or in particular areas are presented below. Note this is not an exhaustive list, as at least 42 birds of particular concern species were identified on the USFWS IPaC database, some of which are also listed in previous Planning Region Sections.

Table 11: Birds of particular concern within the Long Island Sound Region

Common Name	Scientific Name	Common Name	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*	American oystercatcher	*Haematopus palliates*
Black scoter	*Melanitta nigra*	Black skimmer	*Rynchops niger*
Black-legged kittiwake	*Rissa tridactyla*	Brown Pelican	*Pelecanus occidentalis*
Golden eagle	*Aquila chrysaetos*	Surf scoter	*Melanitta perspicillata*
Long-tailed duck	*Clangula hyemalis*	Purple sandpiper	*Calidris maritima*
Red-breasted Merganser	*Mergus serrator*	Red-throated loon	*Gavia stellata*
Red-necked phalarope	*Phalaropus lobatus*	Short-billed dowitcher	*Limnodromus griseus*
Razorbill	*Alca torda*	Pomarine jaeger	*Stercorarius pomarinus*

Source: USFWS IPaC Database: https://ipac.ecosphere.fws.gov/location/index

Marine Mammal Protection Act Species

The Marine Mammal Protection Act (MMPA) of 1972 establishes a national policy to prevent marine mammal species and population stocks from declining beyond the point where they cease to be significant functioning element of the ecosystems of which they are a part. The NOAA, USFWS, and Marine Mammal Commission share responsibility for implementing the MMPA (NOAA 2022). All marine mammals, such as whales, dolphins, porpoises, seals, sea lions, walruses, polar bears, sea otters, manatees, and dugongs, are protected under the MMPA, some of which are also protected under the ESA (NOAA 2022). Similar to the ESA and MBTA, and with a few exceptions, the MMPA prohibits the “take” of marine mammals, including harassment, hunting, capturing, collecting, or killing. Additionally, the MMPA makes it illegal to import marine mammal products into the United States without a permit (NOAA Fisheries 2022).

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, Raritan Region, Jamaica Bay Region, and Long Island Sound Region

Marine mammals reported in and surrounding the Planning Region, the Long Island Sound and south shore of Long Island include whales (sperm, north Atlantic right, blue, fin, humpback, sei), dolphins (bottlenose, common, pilot, Risso’s), porpoises (harbor), sea otters, and seals (harbor, gray, harp) (NYSDEC 2020).

Humpback whales have been sighted up the Hudson River as far north as the George Washington Bridge, potentially attributed to the Hudson River’s improving water quality. Humpback whales’ main food sources are krill, plankton, bunker fish, and Atlantic menhaden which are present in the Bight and lower portions of the Hudson River estuary (Nature.org 2022). Dolphins are often spotted off the south shores of Long Island in coastal waters, harbors, and bays (NYSDEC 2022). Harbor porpoises are the only porpoise species that are observed in the area, often in bays, estuaries, and within the Long Island Sound (NYSDEC 2022). Threats to marine mammals include water quality, marine debris, noise, vessel strikes, entrapment or entanglement in fishing gear, and climate change (NYSDEC 2022).

Sea Turtles

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, Raritan Region, Jamaica Bay Region, and Long Island Sound Region

Four species of sea turtles can be found in the lower part of the Study Area including green (threatened), Kemp's ridley (endangered), leatherback (endangered), and loggerhead (threatened) sea turtles. Warmer waters starting in late spring and early summer provide more suitable temperatures for sea turtle presence, typically between the months of May through November, and particularly within the coastal bays, Long Island Sound (NYSDEC 2022), and Jersey shore. In 2018, Kemp's ridley sea turtles were observed nesting on the Rockaway Peninsula within the Gateway National Recreation Area (NPS 2018). Due to concerns for extreme high tides, the NPS excavated the nests and incubated the recovered eggs from those nests. Later that year, 96 Kemp's ridley sea turtle hatchlings were released at West Beach (NPS 2018). Sea turtles, including the Kemp's ridley, are under threat of human and environmental disturbances, such as vessel strikes, marine water pollution (e.g. plastics), climate change (e.g. cold-stunning), illegal harvesting, and entrapment in fishing gear (NYSDEC 2022 and NPS 2018).

Essential Fish Habitat (EFH) and EFH-Designated Species

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended, was first passed in 1976 for the purpose of preventing overfishing, rebuilding overfished stocks, increase long-term economic and social benefits, ensure safe and sustainable supply of seafood, and protect habitat that fish need to spawn, breed, feed, and grow to maturity (NOAA Fisheries 2022). The MSA Reauthorization Act of 2007 amended the MSA to include annual catch limits and accountability measures, promote market-based management strategies (e.g. catch shares), strengthened peer-reviewed science, and enhance international cooperation to address illegal, unregulated, and unreported fishing (NOAA Fisheries 2022). The Sustainable Fisheries Act of 1996, as amended, strengthened the requirements to prevent overfishing and rebuilding overfished fisheries, set standards for fishery management plants to specific objectives and measurable criteria of stock status, added national standards for fishing vessel safety, fishing communities, and bycatch, new requirements for fishery management councils to identify and describe Essential Fish Habitat (EFH), to protect, conserve and enhance EFH, to designate Habitat Areas of Particular Concern, and establish a federal EFH consultation process that advises federal agencies to avoid, minimize, mitigate, or offset adverse effects to EFH (NOAA Fisheries 2022). A list of EFH designated species and associated habitat within the NYNJHAT Study Area are listed on Table 12. Refer to Appendix A3 for additional information.

Table 12: Essential Fish Habitat designated species and associated habitat in the NYNJHAT Study Area.

Species	Scientific Name	EFH within the Study Area				Habitat Association
		Egg	Larvae	Juvenile	Adult	
New England Finfish Species						
Atlantic Cod	*Gadus morhua*	S	S	N/A	S	Egg/Larvae: Pelagic Adult: Demersal/Structure Oriented
Atlantic Herring	*Clupea harengus*	N/A	M, S	M, S	M, S	Pelagic
Monkfish	*Lophius americanus*	X	X	N/A	X	Egg/Larvae: Pelagic Adult: Demersal
Ocean Pout	*Macrozoarces amercanus*	S	N/A	N/A	S	Demersal

Species	Scientific Name	EFH within the Study Area				Habitat Association
		Egg	Larvae	Juvenile	Adult	
New England Finfish Species						
Pollock	*Pollachius pollachius*	N/A	N/A	S	S	Pelagic
Red Hake	*Urophycis chuss*	M, S	M, S	M, S	M, S	Egg/Larvae: Pelagic Juvenile/Adult: Demersal
Silver Hake	*Merluccius bilnearis*	X	X	N/A	X	Demersal/Pelagic
Windowpane Flounder	*Scophthalmus aquosus*	M, S	M, S	M, S	M, S	Egg: Pelagic Larvae/Juvenile/Adult: Demersal
Winter Flounder	*Pseudopleuronectes americanus*	M, S	M, S	M, S	M, S	Demersal
Witch Flounder	*Glyptocephalus cynoglossus*	N/A	X	N/A	N/A	Pelagic
Yellowtail Flounder	*Limanda ferruginea*	S	S	S	S	Egg/Larvae: Pelagic Juvenile/Adult: Demersal
Mid-Atlantic Finfish Species						
Atlantic Butterfish	*Peprilus triacanthus*	S	M, S	M, S	M, S	Pelagic
Atlantic Mackerel	*Scomber scombrus*	S	S	S	S	Pelagic
Black Sea Bass	*Centropristis striata*	N/A	N/A	M, S	M, S	Demersal/Structure Oriented
Bluefish	*Pomatomus saltatrix*	X	X	M, S	M, S	Pelagic
Scup	*Stenotomus chrysops*	S	S	S	S	Demersal
Summer Flounder	*Paralichthys dentatus*	N/A	M, S	M, S	M, S	Demersal
Spanish Mackerel	*Scomberomorus maculates*	N/A	N/A	N/A	X	Pelagic
Invertebrate Species						
Atlantic Sea Scallop	*Placopecten magellanicus*	S	S	S	S	Egg/Juvenile/Adult: Demersal/Somewhat Structure Oriented Larvae: Demersal/Pelagic
Longfin Inshore Squid	*Loligo pealeii*	S	N/A	S	M, S	Egg: Demersal/Somewhat Structure Oriented Juvenile/Adult: Pelagic

Species	Scientific Name	EFH within the Study Area				Habitat Association
		Egg	Larvae	Juvenile	Adult	
New England Finfish Species						
Ocean Quahog	*Artica islandica*	N/A	N/A	N/A	X	Demersal
Highly Migratory Species						
Bluefin Tuna	*Thunnus thynnus*	N/A	N/A	X	N/A	Pelagic
Skipjack Tuna	*Katsuwonus pelamis*	N/A	N/A	N/A	X	Pelagic
Skate Species						
Clearnose Skate	*Raja eglanteria*	N/A	N/A	X	X	Demersal
Little Skate	*Leucoraja erinacea*			X	X	Demersal
Winter Skate	*Leucoraja ocellata*			X	X	Demersal
Shark Species						
Common Name	**Scientific Name**	**Neonate**		**Juvenile**	**Adult**	**Habitat Association**
Common Thresher Shark	*Alopias vulpinus*	X		X	X	Pelagic
Dusky Shark	*Carcharhinus obscurus*	S		S	N/A	Pelagic
Sand Tiger Shark	*Carcharias taurus*	M, S		M, S	N/A	Pelagic
Sandbar Shark	*Carcharhinus plumbeus*	M, S		M, S	M, S	Demersal
Smoothhound Shark Complex (Atlantic Stock)	*Mustelus canis*	X		X	X	Demersal
Spiny Dogfish	*Squalus acanthias*	N/A		S (sub-adult female)	S	Pelagic/Epibenthic
White Shark	*Carcharodon carcharias*	X		X	X	Pelagic
Blue Shark	*Prionace glauca*	X		X	X	Pelagic

S = includes the seawater salinity zone (salinity ≥ 25 parts per thousand [ppt])
M = Includes mixing water / brackish salinity zone (0.5 ppt < salinity < 25.0 ppt)
F = Includes tidal freshwater salinity zone (0.0 ppt < salinity < 0.5 ppt)
X = Designated Essential Fish Habitat but no salinity zone specified
N/A = not applicable

2.2.4 Special Status Areas

The following Sections discuss the existing conditions of special status areas including, but not limited to, wetlands, floodplains, designated critical habitat and critical environmental areas, Coastal Zone Management

Act and Coastal Barrier Resource Act areas, NPS land, wildlife refuge land, and commercial and recreational fishing areas.

Wetlands

Wetlands are defined as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are transitional areas between open water and dry land and are often found along bays, lakes, rivers, and streams (USACE 2022b). Executive Order 11990, Protection of Wetlands, states that Federal agencies must avoid undertaking or providing assistance for new construction in wetlands unless there is no practical alternative to such construction and the proposed action includes all practicable measures to minimize harm to the wetland.

The USFWS maintains Federally listed wetlands records on the National Wetlands Inventory Mapper online database, New York State maintains State-listed wetlands records on the NYSDEC Environmental Resource Mapper, and the State of New Jersey maintains State-listed wetlands records on the NJDEP NJ-GeoWeb online database. Federal and/or State wetland code classifications include, but are not limited to, those listed in parathesis below (e.g. PFO1R). Note: there is no attempt to define the limits of proprietary jurisdiction of any federal, state, or local government, or to establish the geographical scope of the regulatory programs of government agencies.

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Federally listed wetlands located within these Planning Regions, as observed on the National Wetlands Inventory Mapper include areas of freshwater forested/shrub wetland habitats (PFO1R/C/4R, PSS1R/E) and freshwater emergent wetlands (PEM1E/5E/C) scattered along and near the Hudson River, particularly in areas that are less developed (USFWS 2022).

The Hudson River is classified as a riverine habitat system from Troy to Poughkeepsie, New York, and changes classification to an estuarine and marine deepwater habitat with adjacent tidal wetlands from Poughkeepsie to where it eventually converges with the Upper New York Bay, extending out to Lower New York Bay, Raritan Bay, and eventually the Atlantic Ocean (USFWS 2022).

In 2007, an inventory along the Hudson River documented approximately 7,000 acres of tidal wetlands from Troy, New York to the George Washington Bridge connecting Fort Lee, New Jersey to Washington Heights, New York (USACE 2020a).

State listed wetlands located within these Planning Regions, as observed on the NYSDEC Environmental Resource Mapper, are scattered throughout and include several areas of freshwater wetland habitats along the Hudson River from Troy, New York to around Tarrytown, New York, where the frequency of state-listed freshwater wetland habitats becomes less frequent as observed further north along the Hudson River. In the more urban environments within and surrounding New York City, state-listed freshwater wetlands are observed in Yonkers at Van Cortlandt Park, but observations are less frequent extending into Manhattan (NYSDEC 2022). The Hudson River is the only area in New York State with more than 500 acres of tidal freshwater marsh (USACE 2020a). Tidal wetland salt marsh is found near shore of the lower Hudson River, largely dominated by marsh plants that are adapted to saline conditions and provides habitat for fish and animals (NYSDEC 2022)

Hackensack/Passaic Region

Federally listed wetlands and State listed wetlands are scattered throughout the Hackensack/Passaic Region. Estuarine and Marine wetlands (E2EM5Pd/Pd6/P6/Px6, E2US3N) dominate much of the Secaucus, Rutherford, and Ridgefield area. Freshwater (PEM5/5R/SS1R, PSS1/FO1Sd), freshwater forested/shrub (PFO1S, PSS1Rd, PFO1Sd), riverine (R1UBV), freshwater pond (PUBVx, PUBHx) wetlands are sparsely scattered throughout.

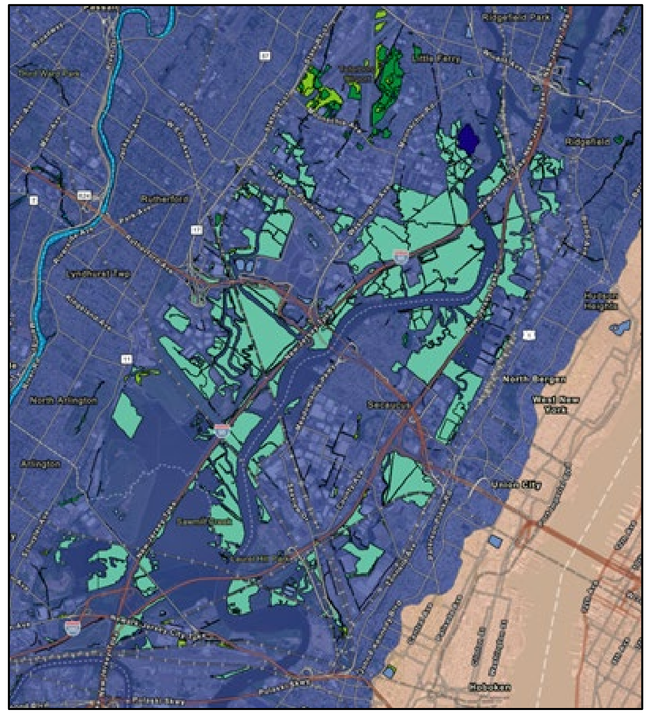


Figure 9: Federally listed wetlands in the Hackensack/Passaic Region, shown in green.
(Source: USFWS 2022)

New Jersey State-listed wetlands are similar locations to the Federally listed wetlands, with classifications including disturbed wetlands (modified), phragmites dominate coastal wetlands, saline marsh (high and low), disturbed tidal wetlands, deciduous scrub/shrub and herbaceous wetlands.

A large area of the Meadowlands contains degraded wetlands that support numerous species, many of which are rare or vulnerable. This area is similar to other urban wetland complexes, such as Jamaica Bay Wildlife Refuge in New York City, a component of Gateway National Recreation Area. The mix of wetlands and uplands gives rise to a diversity of plant and animal life, and the marshes and swamps of the Meadowlands provide critical habitat for many species, several of which also rely on upland habitat (Kiviat et al 2004).

Upper Bay/Arthur Kill Region

Federally listed wetlands are scattered throughout, with larger wetland clusters reported in the Ashbrook Reservation including freshwater forested/shrub wetland (PFO1E/d), riverine (R2UBH), and freshwater emergent (PEM1F) and Lenape Park including freshwater forested/shrub (PFO1C/A), riverine (R2UBH), and freshwater pond (PUBHx). A large cluster of estuarine and marine wetland (E2EM1Nh/5P6, E2SS1Ph, E2USN6,) is observed along the Arthur Kill between Port Ivory, West Carteret, and Greenridge New York. The State Island Industrial Park includes areas of freshwater forested/shrub (PFO1E, PSS1/EM1F), freshwater emergent (PEM1F, PEM5F), and a few freshwater ponds (PABV, PABHh, PUBH). Along and near the shorelines of Newark Bay, the Kill Van Kull, Upper New York Bay, areas of estuarine and marine wetlands (E2USN, E2SS1P, E2USN, E2EM1P, E2EM5P), freshwater forested/shrub (PSS1E), and freshwater emergent (PEM1F) are intermixed with the urban environment and scattered throughout.

New Jersey State-listed wetlands share similar footprints to Federally listed wetlands, except in fewer locations. The largest clusters of State-listed wetlands are observed in the Ash Brook Reservation (deciduous wooded, deciduous scrub/shrub, herbaceous, wetlands, wetlands right-of-way), West Carteret (saline marsh (low), herbaceous, phragmites dominate coastal, deciduous wooded, and deciduous scrub/shrub wetlands), Lenape Park (deciduous wooded wetlands), and Woodbridge (saline marsh (high and low), disturbed tidal wetlands, managed wetland in maintained lawn greenspace, and deciduous wooded wetlands). A few small areas of wetlands are observed in Elizabeth near the Newark Liberty International Airport and Elizabeth Marine Terminal (phragmites dominate interior wetlands, saline marsh (high), and herbaceous wetlands) and along the Arthur Kill and northern portion of Newark Bay and Upper New York Bay. New York State-listed wetlands are observed throughout Staten Island, many of which overlap with the footprints of Federally listed wetlands. The largest clusters of wetlands are observed south of Port Ivory, Staten Island Industrial Park, Travis, New Springville, Great Kills, Fresh Kills, and Woodrow.

Lower Bay Region

Federal, New Jersey, and New York listed wetlands are prevalent throughout the Lower Bay Region, several of which share similar or adjacent footprints. The largest contiguous clusters of Federal and New Jersey State listed wetlands are observed along the many tributaries throughout the Region, including Federal freshwater emergent (PEM5R, PEM1/SS1Eh), riverine (R5UBH, R1UBV), freshwater forested/shrub (PFO1R/C), freshwater pond (PUBHh/x), lake (L1UBHh), estuarine and marine (E2EM1P, E2US2M/N), and State deciduous wooded, freshwater tidal marshes, phragmites dominate coastal, and mixed scrub/shrub wetlands. The largest areas of wetlands are observed along Naval Weapons Station Earle, observed as Federal freshwater forested/shrub (PF04/1Dd), riverine (R4SBC), freshwater emergent (PEM1/SS1Ed) and State mixed wooded (deciduous dominate), deciduous scrub/shrub, coniferous scrub/shrub, and disturbed wetlands. Another large cluster of wetlands is observed in Cheesequake State Park identified predominately as Federal estuarine and marine (E2EM1Pd), and State saline marsh (low). New York State-listed wetlands are observed throughout the eastern portion of Staten Island, many of which overlap with the footprints of Federally listed wetlands. The largest clusters are observed in Ocean Breeze Park, Great Kills Park, Lemon Creek Park, Blue Heron Park, Bunker Ponds Park, Wolfes Pond Park, and Conference House Park.

Raritan Region

Federally listed wetlands are scattered throughout the Raritan Region. Larger clusters of wetland complexes are observed in the northern, southeastern, and southwestern portions of the Planning Region. A large wetland complex of approximately 1,000 acres, located in Edison Township, provides habitat for waterfowl, wading birds, mammals, and fish (USACE 2020b) observed as freshwater forested/shrub (PFO1Ed, PSS1E), freshwater emergent wetland (PEM1/SS1Ed) and riverine (R4SBC/x) habitat. Several large and contiguous clusters of wetlands are observed between South Old Bridge, Sayerwood South, Spotswood Manor, Old Bridge, and Morganville, identified predominately as freshwater forested/shrub (PFO1C), intermixed with riverine (R4SBC), freshwater emergent (PEM1Eb), and freshwater ponds (PUBHh).

State listed wetlands share similar footprints to Federally listed wetlands, observed scattered through the Region. Large clusters are observed in Edison (deciduous wooded, deciduous scrub/shrub, mixed scrub/shrub, and disturbed wetlands), South Old Bridge, Sayreville, Sayerwood South, Spotswood Manor, Old Bridge, and Morgansville identified predominately as deciduous wooded with mixed wooded wetlands (deciduous dominate and coniferous dominate).

Jamaica Bay Region

Federally listed wetlands are located within Jamaica Bay, the Gateway National Recreation Area, Jamaica Bay Wildlife Refuge, and to the east of John F. Kennedy International Airport identified as estuarine and marine wetland (E2EM1N/P/5P, E2US2N) and a few areas of freshwater emergent wetlands (PEM1E, PEM1A), freshwater forested/shrub wetland (PSS1C) and riverine (R2UBH). State listed freshwater wetlands within this Planning Region are observed in a few areas including a small area in Averne at the Dubos Point Wildlife Sanctuary and to the north of John F. Kennedy International Airport at Baisley Pond Park and Brookville Park (NYSDEC 2022).

Jamaica Bay was once a shallow, sandy system with channels networking through extensive salt marsh islands surrounded by fringing wetlands, however freshwater wetlands of Jamaica Bay are estimated to be comprised of less than 1% of their historic coverage (USACE 2020b). Remaining salt marshes within Jamaica Bay are at risk of disappearing due to a combination of urban encroachment and RSLC where marshes typically would continue to grow by moving up higher elevations but are restricted by the highly urban environment surrounding Jamaica Bay (NPS 2022). An estimated 220 acres of salt marsh were lost from 1994 to 1999 at a rate of 47 acres per year, and determined that if not addressed, are at risk of disappearing by the year 2025 (USACE 2021). The New York City Department of Environmental Protection and NYSDEC requested USACE assistance with implementing restoration projects within Jamaica Bay. As a result, marsh restoration efforts have occurred such as the Yellow Bar Hassock marsh project which restored approximately 45.5 acres of salt marsh. Additional marsh island restoration was recommended in the May 2020 Hudson Raritan Estuary Ecosystem Restoration Feasibility Study Report, which was authorized by the U.S Congress in the Water Resources Development Act of 2007 (USACE 2021).

Long Island Sound Region

Federally listed wetlands within the Long Island Sound Region are scattered throughout. The northern shore of Northwestern Nassau County and north shore of the Long Island Sound primarily includes areas of estuarine and marine (E2EM1P) wetlands, with a few areas of freshwater forested/shrub (PFO4C, PSS1F, PFO1E), riverine (R2UBH), freshwater emergent (PEM1Ax), freshwater pond (PUBHx) and a few lakes (L1UBHh).

State listed freshwater wetlands are located in a few areas within this Planning Region including Little Neck, College Point, Harrison, New Rochelle, and White Plains. Tidal wetland salt marsh is found near shore of Long Island largely dominated by marsh plants that are adapted to saline conditions and provides habitat for fish and animals (NYSDEC 2022)

The New York City Parks Department of Parks and Recreation describes the wetlands status of the Bronx River Watershed:

> *"Development, fill and altered drainage have destroyed all but a small fraction of the historic tidal and riverine wetlands of the Bronx. Many of these existing wetlands have been significantly changed by invasive exotic species, fragmentation, pollution and dumping and altered hydrology, such increased stormwater and disconnection from the flood plain. Still, these few wetlands continue to provide important habitat for vegetation, birds, and other aquatic life. These remaining wetlands, their functions in the watershed, and our effect on them through our management of the landscape in the watershed are receiving increasing attention today. There have already been several projects to try to protect, improve the function of, and expand wetlands in the Bronx, and these wetland restoration efforts are continuing today"* (NYC Parks 2022b).

Floodplains

The Federal Emergency Management Agency (FEMA) provides an online public source for flood hazard information. The FEMA maintains and updates data through the Flood Insurance Rate Map and risk assessments, utilizing data statistics for river flow, storm tides, hydrologic/hydraulic analyses, rainfall, and topographic surveys. The FEMA online Flood Mapper is found at https://msc.fema.gov/portal/home (FEMA 2022).

Executive Order 11988 *Floodplain Management* was issued in 1977 to ensure Federal Agencies "assert leadership in reducing flood losses and losses to environmental values served by floodplains; avoid actions located in or adversely affecting floodplains unless there is no practicable alternative; take action to mitigate loses if avoidance is not practicable;" and to establish "a process for flood hazard evaluation based upon the 1% floodplain base flood standard of the National Flood Insurant Program (NFIP). It also direct[s] Federal agencies to issue implementing procedures; provide[s] a consultation mechanism for developing the implementing procedures; and provide[s] oversight mechanism" (FEMA 2021). FEMA's implementing guidelines for Executive Order 11988 utilizes an eight-step process for identifying and assessing impacts to floodplains. Refer to Chapter 8 for more information regarding how the NYNJHAT Study is implementing the eight-step process (Engineering Regulation 1165-2-26). For context in the following Sections, and area with 1% chance of annual flood (Zone AE) is known as the "100-year floodplain" or "base floodplain", and an area with 0.2% chance of annual flood (Zone X, where shaded on the FEMA Fire Insurance Rate Map) is known as the "500-year floodplain". Any area that is outside the 0.2% floodplain is also referred to as Zone X, or Zone C, but are unshaded on The FEMA Fire Insurance Rate Map.

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The FEMA floodplains within these Regions are primarily concentrated along the Hudson River. The Hudson River is reported as an area of 1% chance of annual flood (Zone AE), as is the Harlem River and East River in Manhattan. From Troy, New York and extending to the southern tip of Manhattan are a few areas of 0.2% annual chance of flood (Zone X, shaded) and/or Regulatory Floodways (Zone AE) scattered throughout (FEMA 2022).

Hackensack/Passaic Region

The FEMA floodplains are predominantly concentrated in southeastern and western areas of this Planning Region, with, comparatively, smaller areas of floodplains scattered throughout along the low-lying areas, rivers, and tributaries. Most of the low-lying areas north of Newark, within and west of Jersey City, Hoboken, Secaucus, Little Ferry, the Teterboro Airport, and the waterfronts of Union City, West New York, Hudson Heights, Fairview, Cliffside Park, and Edgewater are largely within areas of 1% chance of annual flood (Zone AE). This include the majority of the Meadowlands in Hackensack (an area that is also largely wetlands). Areas with 0.2% chance of annual flood are scattered throughout. Fairfield and Little Falls, New Jersey contain a large area of 1% chance of annual flood (Zone AE), intermixed with areas of 0.2% chance of annual flood (Zone X, shaded) along and to the north and southwest of the Passaic River where it bends around Two Bridges and the Willowbrook Mall (FEMA 2022).

Upper Bay/Arthur Kill Region

The FEMA floodplains within this Planning Region are largely in Newark, Elizabeth, and Bayonne along Newark Bay, Upper Bay, the Kill Van Kull, and Arthur Kill, comprised mostly as an area of 1% chance of annual flood (Zone AE) with areas of 0.2% chance of annual flood (Zone X, shaded) scattered throughout, but most prevalent at the Newark Liberty International Airport. The Rahway River and its branches that extend through Essex, Union, and Middlesex Counties, and connects to the Arthur Kill to the south of Tremley Point, is designated as a Regulatory Floodway (Zone AE). Ash Brook Reservation, Lenape Park, Iselin, and Woodbridge also contain areas of 1% chance of annual flood (Zone AE) mostly intermixed with areas of 0.2% chance of annual flood (FEMA 2022).

Lower Bay Region

The FEMA floodplains throughout the Lower Bay Region consist of areas of 1% chance of annual flood (Zone AE), and areas of 1% chance of annual flood due to velocity or wave hazard (Zone VE). Zones AE and VE are predominately present along the coastline of New Jersey and Staten Island, expanding inland along low-lying areas, connected channels, and tributaries. The areas exhibiting largest Zone AE coverage include Cheesequake State Park, Union Beach, Keansburg, Rumson, and Long Branch, New Jersey where the 1% chance of annual flood extends inland further than some of the surrounding areas. The FEMA floodplains with 0.2% chance flood hazard (Zone X, shaded) accompany many of the inland boundaries of the Zone AE areas. Regulatory floodways (Zone AE), including the Raritan River and tributaries, and a few Special Flood Hazard Areas (Zone AE) are scattered throughout.

Raritan Region

The FEMA floodplains within the Raritan Region are mostly concentrated along the Raritan River between Sayreville and Perth Amboy, with a large area of 1% annual flood chance (Zone AE) along the northern shore of the Raritan River. Other areas of 1% annual chance of flood are observed along the low-lying areas to the north of Edison, New Jersey, east of Manville, to the south of Sayreville, New Jersey, and in Pigeon Swamp State Park. The Raritan River and its tributaries are designated as a Federal Floodway (Zone AE). Areas of 0.2% annual flood chance (Zone X, shaded) are scattered throughout the region along the Raritan River and Zone AE areas (FEMA 2022).

Jamaica Bay Region

The FEMA floodplains within the Jamaica Bay Region are concentrated along the coast and from Rockaway Point to Far Rockaway, Seagate, Bridgton Beach, within the Gateway National Recreation Area dominating much of Rulers Bar Hassock, the perimeter of Floyd Bennett Field, Bridgton Beach, the shoreline and low-lying areas of Bergen Beach, Shirley Chisholm State Park, much of the Jamaica Bay Wildlife Refuge, the south and east perimeter of John F Kennedy International Airport, and from Wavecrest to Valley Stream, New York are predominantly areas of 1% chance annual flood (Zone AE), with areas of 0.2% chance annual flood (Zone X, shaded) intermixed throughout (FEMA 2022).

Long Island Sound Region

The FEMA the northern and southern shoreline of the Long Island Sound and additionally the perimeter of Rikers Island, entirety of LaGuardia Airport, the low-lying areas extending from LaGuardia Airport to the intersect of Van Wyck Expressway and Grand Central Parkway, Throgs Neck, Pelham Bay Park, Port Washington, Larchmont, Mamaroneck, Rye, and Port Chester. These areas are predominately 1% chance of annual flood (Zone AE), with several areas of 0.2% chance of annual flood scattered and intermixed throughout (FEMA 2022).

Figure 10: FEMA floodplains within the Long Island Sound Region, shown in purple.

Wild and Scenic Rivers

Wild and Scenic Rivers Act was enacted by the U.S Congress in 1968 to preserve and protect certain rivers with scenic, natural, cultural, and recreational values for the enjoyment of present and future generations (Public Law 90-542; 16 U.S.C. 1271 et seq.).

New York has approximately 73.4 miles out of approximately 51,790 miles of river designated as wild and scenic and New Jersey has 262.9 miles out of approximately 6450 miles of river designated as wild and scenic (NWSRS 2022).

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, Raritan Region, Jamaica Bay Region, and Long Island Sound Region

None of the designated wild and scenic rivers fall within the NYNJHAT Study Area.

Designated Critical Habitat

Designated Critical Habitat is defined as habitat needed to support the recovery of threatened and endangered listed species under the ESA. Although an area may be designated as Critical Habitat, that does not necessarily also designate that area as a Critical Environmental Area, Marine Protected Area, Wildlife Refuge, wilderness reserve, preservation, or other conservation area (NOAA Fisheries 2022).

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, Raritan Region, Jamaica Bay Region, and Long Island Sound Region

No USFWS Designated Critical Habitat has been identified in any of the Planning Regions. NOAA ESA Critical Habitat has been identified within the Lower Hudson/East River, Mid-Hudson, and Capital District Planning

Regions for Atlantic Sturgeon. No other Planning Regions contain NOAA ESA Critical Habitat. Additional information regarding USFWS designated species and NOAA designated species can be found in Appendix A1 and A2, respectively.

Critical Environmental Areas (State)

A State designated Critical Environmental Area (CEA) is defined by NJDEP (known as Critical Environmental Sites in New Jersey) as a habitat critical to threatened, endangered or other rare wildlife, and by NYSDEC under 6 NYCRR 617.14(g) as:

"a geographic location within exceptional or unique character with respect to one or more of the following:

1. *A benefit or threat to human life;*
2. *A natural setting such as fish and wildlife habitat, forest and vegetation, open space, and areas of important aesthetic or scenic quality;*
3. *Agricultural, social, cultural, historic, archaeological, recreational, or educational values; or,*
4. *An inherent ecological, geological, or hydrological sensitivity that may be adversely affected by any change."*

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, Raritan Region, Jamaica Bay Region, and Long Island Sound Region

Within the Lower Hudson/East River Planning Region, the east side of the Hudson River from Yonkers to the town of Peekskill is designated as a New York State CEA for exceptional or unique character. The entirety of the Jamaica Bay Region is designated as a New York State CEA for the protection of ecosystems and wildlife. The northern Long Island Sound in Westchester County is designated as a CEA for exceptional or unique character. One Special Groundwater Protection Area is located in Nassau County, in the area of Lake Success. There are several New Jersey Critical Environmental Sites located throughout the regions including: the Lower Bay Region located along the coastline from Highlands Beach south to Long Branch Beach, on the coast of Highlands, landward of Sandy Hook, from south of the Sandy Hook Bridge extending north to Atlantic Highlands harbor, on the west side of Atlantic Highlands harbor and continues west until Normandy Road and west of the Atlantic Highlands in the area of Belford harbor. Several other CEAs are located within the New Jersey Planning Regions in waterfront areas, along the Raritan River and in other areas of significance.

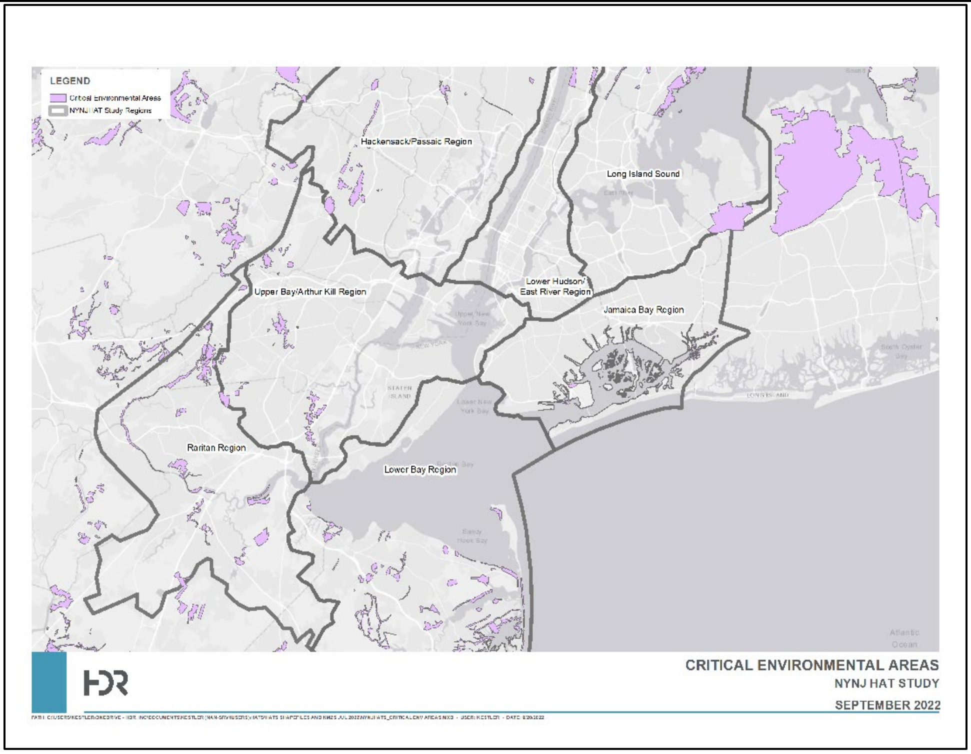


Figure 11: Critical Environmental Areas within the NYNJHAT Study Area

Marine Protected Areas

Marine Protected Areas (MPA) are defined as a park or other “clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (NOAA 2022x). Depending on the type of MPA, depends on the level of protection to that area; for example, a marine reserve is the most protective type of MPA in which removing or destroying natural or cultural resources is prohibited (NOAA 2022x). NOAA maintains an online publicly available mapper of U.S. MPA boundaries, on the NOAA MPA Center website: https://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/mpaviewer/

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

There are four MPAs within these Planning Regions, labeled Hudson River National Estuarine Research Reserves located near Coxsackie, Annandale-on-Hudson, Bear Mountain, and Sparkill, New York (NOAA 2020). These reserves are managed by NYSDEC and NOAA. The primary conservation focus of these areas is for natural heritage and commercial fishing is restricted.

Upper Bay/Arthur Kill Region

There is one MPA within this Planning Region, identified as Liberty State Park in Jersey City, New Jersey. NJDEP manages this park with a primary conservation focus on natural heritage. Commercial fishing is prohibited, and recreational fishing is restricted (NOAA 2020).

Lower Bay Region

There are four MPAs within this Planning Region, two of which are identified as portions of the Gateway National Recreation Area at Sandy Hook, New Jersey and along the eastern shore of Staten Island. The NPS manages these MPAs with a primary conservation focus on natural heritage. Commercial and recreational fishing is restricted. The third MPA is identified as Cheesequake State Park. NJDEP manages this MPA with a conservation focus on natural heritage. Commercial fishing is prohibited, and recreational fishing is restricted. The fourth MPA is identified as Swimming River Natural Area located near Tinton Falls, New Jersey. NJDEP manages this MPA with a conservation focus on natural heritage. Commercial fishing is prohibited, and recreational fishing is restricted (NOAA 2020).

Jamaica Bay Region

One MPA is identified within this Planning Region, identified as the Gateway National Recreation Area in Jamaica Bay. The NPS manages these MPAs with a primary conservation focus on natural heritage. Commercial and recreational fishing is restricted (NOAA 2020).

Hackensack/Passaic Region, Raritan Region, and Long Island Sound Region

There are no MPAs within these Planning Regions.

Coastal Zone Management Act Areas

The Coastal Zone Management Act (CZMA) was enacted in 1972 and is administered by the NOAA to manage the Nation's coastal resources, including the Great Lakes (NOAA 2022x). CZMA, as amended, declares a national policy to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for current and succeeding generations. NOAA maintains federally mapped CZMA boundaries, the NYSDOS Office of Planning and Management maintains New York State mapped CZMA boundaries present within New York State, and NJDEP maintains mapped Coastal Area Facility Review Act (CAFRA) boundaries present within the State of Jersey. For additional information, refer to Appendix A4. Presence and/or absence of Federal and State CZMA/CAFRA boundaries are discussed in the following Planning Region Sections:

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The entirety of the New York and New Jersey shoreline of the Hudson River, extending south from Troy, New York to where the River converges with the Upper Bay between New Jersey and New York is designated as a Federal CZMA boundary (NOAA 2013).

The entirety of the New York shoreline of the Hudson River, extending from Troy, New York to where the river converges with the Upper Bay is also designated as a state CZMA boundary (NYSDOS 2022).

No New Jersey State CAFRA boundaries are present within these Planning Regions; however, there are areas within this Planning Region that are subject to the regulations set forth in the Waterfront Development Law (N.J.S.A 12:5-3) and as such, are subject to CZMA.

Hackensack/Passaic Region

There are no federal or state CZMA/CAFRA boundaries present within this Planning Region; however, there are areas within this Planning Region, such as the Hackensack Meadowlands District, that are subject to the regulations set forth in the Waterfront Development Law (N.J.S.A 12:5-3) and as such, are subject to CZMA.

Upper Bay/Arthur Kill Region

The entirety of the Arthur Kill from Perth Amboy extending to the north and along the southern extent of Newark Bay through the Kill Van Kull and encompassing the entirety of the Upper New York Bay is designated as a federal CZMA boundary (NOAA 2013).

New York State CZMA boundaries are present along northern Staten Island, extending from the shore of the Kill Van Kull, extending to the east and south along the Upper New York Bay to Lower New York Bay, where it crosses over into the Lower Bay Planning Region. Near Oakwood Heights Station and the western boundary with the Lower Bay Region, CZMA continues, extending north and wrapping around Deere Park and along the southern extent of Willowbrook to Freshkills Park where it turns north to Granteville and ultimately connects back to the Kill Van Kull. New York State CZMA boundary is also observed along Shore Road and western boundary of Fort Hamilton (NYSDOS 2022).

No New Jersey State CAFRA boundaries are present within this Planning Region; however, there are areas within this Planning Region that are subject to the regulations set forth in the Waterfront Development Law (N.J.S.A 12:5-3) and as such, are subject to CZMA.

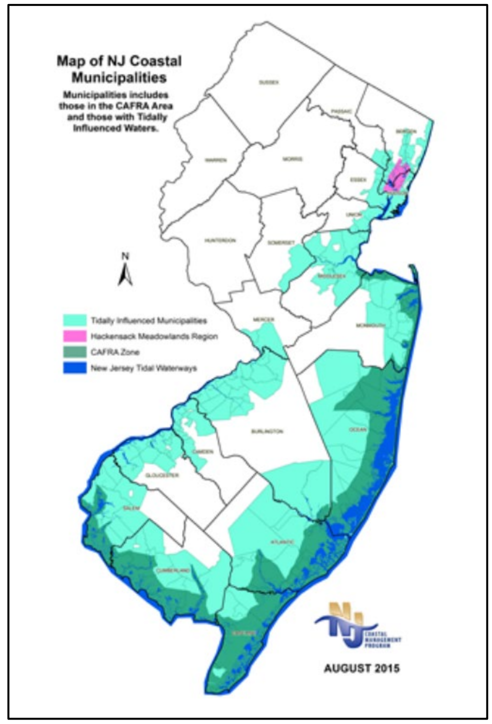


Figure 12: Map of the New Jersey Coastal Municipalities subject to the Waterfront Development Law.

Lower Bay Region

The entire coastline of New Jersey and New York within this Planning Region is designated a Federal CZMA boundary, including the southeastern to northeastern shore of Staten Island, along the Belt Parkway in Brooklyn (adjacent to the Jamaica Bay Planning Region) and entire northern shore of New Jersey from Laurence Harbor to Long Branch (NOAA 2013).

The New York State CZMA boundary extends from the Upper Bay/Arthur Kill Region boundary along the eastern shoreline of Staten Island to the south passing by Ocean Breeze Park, Miller Field, and Great Kills Park before turning west through Oakwood Heights Station (NYSDOS 2022).

The coastline of the Lower Bay Region is designated as a New Jersey State CAFRA boundary, extending from Old Bridge Township to the east along the northern New Jersey shore of Raritan Bay to Sandy Hook, and extending south from Sandy Hook to the southernmost extent of the Lower Bay Region to Long Branch (NJDEP 2022). Additionally, there are areas within this Planning Region that are subject to the regulations set forth in the Waterfront Development Law (N.J.S.A 12:5-3) and as such, are subject to CZMA.

Raritan Region

There are no federal or state CZMA/CAFRA boundaries are present within this Planning Region; however, there are areas within this Planning Region that are subject to the regulations set forth in the Waterfront Development Law (N.J.S.A 12:5-3) and as such, are subject to CZMA.

Jamaica Bay Region and Long Island Sound Region

The entire coastline of Brooklyn including Seagate, Coney Island, Brighton Beach, Manhattan Beach, Jamaica Bay, Far Rockaway and the entire coastline of Long Island Sound including Pellham Bay, Throgs Neck, Rikers Island, Queens, Port Washington are designated a Federal CZMA boundary (NOAA 2013).

A New York CZMA boundary is observed extending from Fort Hamilton along Shore Road and wrapping around to 92nd Street, Battery Avenue, and Poly Place where it extends mostly parallel along the Belt Parkway before turning north along 25th Street to 86th Street, and ultimately extending back to nearly parallel with the Belt Parkway/Shore Parkway. The New York State CZMA boundary wraps around Jamaica Bay to the north of Gateway National Recreation Area and John F. Kennedy International Airport to Valley Stream, where it turns south to Far Rockway in a non-linear trajectory (NYSDOS 2022).

Coastal Barrier Resources Act Areas

The Coastal Barrier Resources Act (CBRA) was enacted in 1982 to prohibit most Federal expenditures and financial assistance within CBRA designated areas, and to encourage the conservation of storm-prone and dynamic coastal barriers that have historically been subsidized for development on coastal barriers, resulting in the loss of natural resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year (USFWS 2022). Approximately 1.4 million acres of land encompass the 588 System Units and 2.1 million acres of land encompass 282 Otherwise Protected Areas designated under CBRA throughout the United States and associated territories along the Atlantic, Gulf of Mexico, Great Lakes, U.S. Virgin Islands, and Puerto Rico coasts, including associated aquatic habitats (USFWS 2022). CBRA established the John H. Chafee Coastal Barrier Resources System (CBRS) which defines CBRA System Units and Otherwise Protected Areas.

A CBRA System Unit is primarily comprised of privately owned areas, or area held for conservation and/or recreation. Most Federal expenditures and financial assistance, including Federal flood insurance, are prohibited within System Units unless the action is covered under and exemption (USFWS 2019). Exceptions to the CBRA System Unit restrictions include General Exception 16 U.S.C. §3505(a)(2) (maintenance or construction of improvements of existing federal navigation channels), and specific exceptions 16 U.S.C. §3505(a)(6)(A) (projects for the study, management, protection, and enhancement of fish and wildlife resources and habitats) and 16 U.S.C. §3505(a)(6)(G) (nonstructural projects for shoreline stabilization).

A CBRA Otherwise Protected Area is a category of coastal barriers that is primarily protected for conservation and/or recreation. Otherwise Protected Areas contain a “P” at the end of the unit number. The only Federal spending prohibited in Otherwise Protected Areas is related to Federal flood insurance (USFWS 2019).

The USFWS maintains an online mapping tool for official (and proposed draft) maps of CBRS Units and Otherwise Protected Areas: https://www.fws.gov/program/coastal-barrier-resources-act/maps-and-data. Refer to Appendix A7 for additional information. Presence and/or absence of CBRA designated areas are discussed in the following Planning Region Sections:

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, and Raritan Region

There are no CBRA designated areas located within these Planning Regions.

Lower Bay Region

The Lower Bay Region contains four CBRA designated System Units and six Otherwise Protected Areas. Two of the four System Units are located along the southern Raritan Bay shore, one near Laurence Harbor (NJ-02) and the other near Union Beach (NJ-04). The remaining two System Units are located along the New Jersey Atlantic Coast, one near Rumson (NJ-04A) and the other between Sea Bright and Monmouth Beach (also listed as NJ-04A).

One of the six Otherwise Protected Areas is located in New York at the furthest extent of Breezy Point, a portion of the Otherwise Protected Area located within the Jamaica Bay Region present within the Gateway National Recreation Area. The largest Otherwise Protected Area in the Lower Bay Region is identified at Gateway’s Sandy Hook Unit (NJ-01P), also present within the Gateway National Recreation Area on the New Jersey side of Raritan Bay. The remaining four Otherwise Protected Areas within this Planning Region include one near the Raritan

Bay Waterfront Park (NJ-15P), east of Laurence Harbor (NJ-02P) nearly bisecting the center of a System Unit (NJ-02), one north of Cliffwood Beach (NJ-03P), and one near Keyport (NJ-16P).

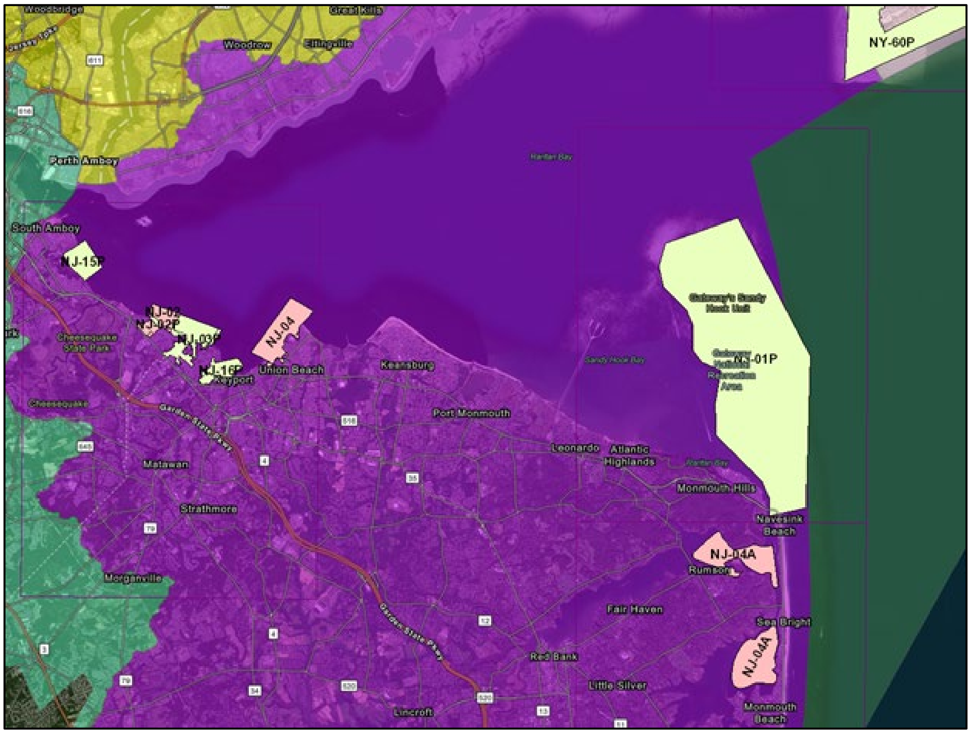


Figure 13: CBRA designated areas located within the Lower Bay Region, shown in yellow and pink. (Source: USFWS 2022 and USGS 2022)

The USFWS has proposed draft boundary revisions to the Otherwise Protected Area at Gateway's Sandy Hook Unit and the two System Units located to the south of Sandy Hook (NJ-04A near Rumson, and NJ-04A between Sea Bright and Monmouth Beach).

Jamaica Bay Region

The Jamaica Bay Region contains one CBRA designated area, identified as an Otherwise Protected Area (NY-60P) located within the Gateway National Recreation Area and encompasses much of Jamaica Bay, the Jamaica Bay Wildlife Refuge, Shirley Chisholm State Park, and Floyd Bennett Field. This Otherwise Protected Area boundary extends from Breezy Point along the shoreline through Jacob Riis Park, north along the bay side through Cross Bay Bridge and is bound by John F. Kennedy International Airport (northeast), Hamilton Beach (north), and the Belt Parkway (northwest-west).

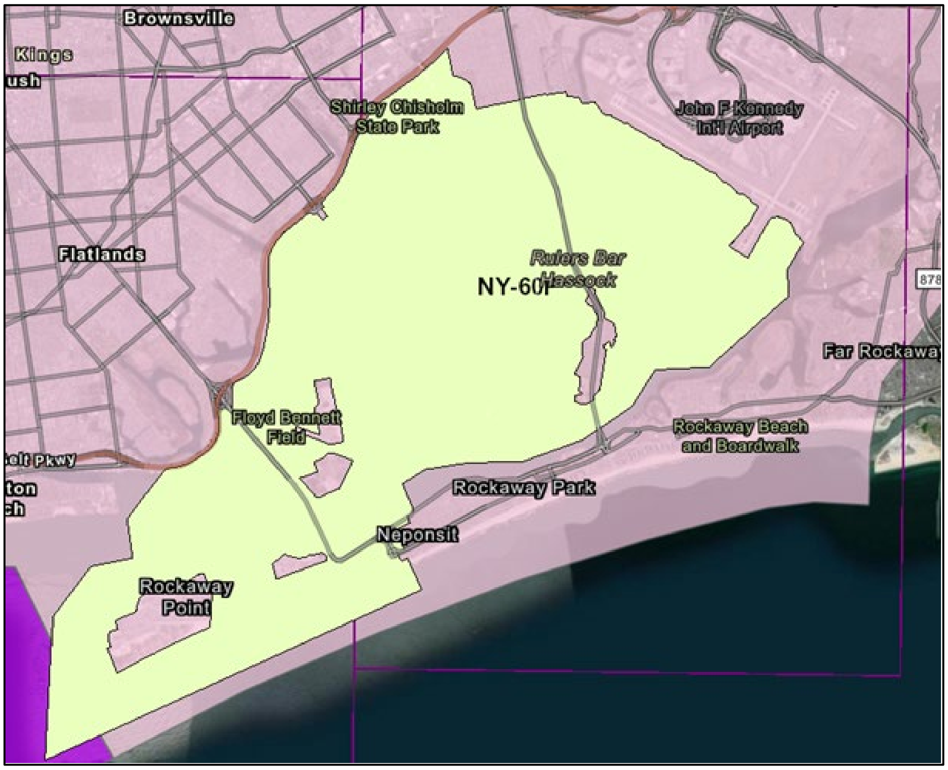


Figure 14: CBRA designated area located within the Jamaica Bay Region, shown in yellow. (Source: USFWS 2022 and USGS 2022)

The USFWS has proposed draft boundary revisions to the Otherwise Protected Area at the Gateway National Recreation Area (NY-60P) that would extend the boundary slightly to the north of Breezy Point, along the southern extend of Jamaica Bay (north of Rockaway Park) and to the east of John F Kennedy International Airport.

Long Island Sound Region

One CBRA designated System Unit and one Otherwise Protected Area is located within the Northwestern Nassau County area, to the east of the Long Island Sound Region. The System Unit is located west of Sands Point (NY-03) and the Otherwise Protected Area is located to the north of Sands Point (NY-04P). The USFWS has proposed draft boundary revisions to the Otherwise Protected Area located north of Sands Point (NY-04P) that would extend the boundary slightly to the west and slightly to the southeast.

National Park Service Land

There are many NPS owned and operated properties throughout the Study Area. The list includes individual sites, monuments, memorials and historic parks. There are also four National Heritage Areas (NHAs) located within the Study Area.

Capital District Region, Mid-Hudson Region, and Long Island Sound Region

In the Mid-Hudson Region there are three NPS properties: the Vanderbuilt Mansion National Historic Site, the Home of Franklin D. Roosevelt National Historic Site, and the Eleanor Roosevelt National Historic Site, all located in Hyde Park, NY. Within the Capital District Region there are two NPS properties: the Kate Mulaney National Historic Site and the Thomas Cole National Historic Site. In Long Island Sound there are two NPS properties: the Saint Paul's Church National Historic Site and the Sagamore Hill National Historic Site.

Maurice D. Hinchey Hudson River Valley National Heritage Area. The Maurice D. Hinchey Hudson River Valley National Heritage Area was designated by the U.S Congress in 1996 to recognize the importance of the history and the resources of the Hudson River Valley to the nation. The 150-mile-long Hudson Valley NHA extends north from the lower Hudson Valley at Yonkers to the Albany Capital District and encompasses the counties of Albany, Rensselaer, Columbia, Greene, Ulster, Dutchess, Orange, Putnam, Westchester, and Rockland, and the Village of Waterford in Saratoga County. There are now more than 100 designated Heritage Sites of the Maurice D. Hinchey Hudson River Valley NHA. Those along the Hudson are significant for their association with several themes: Architecture, Arts, Artist & the Hudson River School; Corridor of Commerce; environment; Freedom & Dignity; Landscapes & Gardens; and Revolutionary War (Hudson River Valley National Heritage Area n.d.). The Hudson River Valley National Heritage Area includes several NPS properties that are within the Study Area including the Home of Franklin D. Roosevelt National Historic Site and the Saint Paul's Church National Historic Site.

Erie Canal National Heritage Corridor. Designated by the U.S. Congress in 2000, the Erie Canalway National Heritage Corridor spans 524 miles across New York State. The eastern terminus of the Erie Canalway is located in the Capital District Region of the Study Area. The designation specifically recognizes the canal for its role in shaping the American economy and settlement, as an embodiment of the Progressive Era emphasis on public works, and as a nationally significant work of early 20th century engineering and construction. The NYS Canal System has also been designated an NHL (Erie Canalway National Heritage Corridor 2022).

Lower Hudson/East River Region

Amidst a highly urban setting the Lower Hudson/East River Region contains a variety of NPS properties. In the Manhattan Borough alone there are five NPS properties. Castle Clinton National Historic Monument is located at the southern tip of Manhattan and represents both the growth of New York City and the nation. Constructed between 1808 and 1811, the West Battery (Castle Clinton) was one of four fortifications built to defend New York Harbor for the War of 1812. The African Burial Ground National Monument, located in lower Manhattan, is the oldest and largest known excavated burial ground in North American for both freed and enslaved Africans. The Stonewall National Monument, located in Greenwich Village, is the site of the Stonewall Uprising on June 28, 1969 which marked a milestone in the LGBTQ+ civil rights movement. At 28 East 20th Street is the Theodore Roosevelt Birthplace National Historic Site which was the boyhood home of the President and moving further uptown, the General Grant National Memorial is the final resting place of President Ulysses S. Grant and his wife Julia and is the largest mausoleum in North America. And finally, in St. Nicholas Park in Upper Manhattan is the Hamilton Grange National Memorial site, the country estate built by Alexander Hamilton in 1802 which commemorates his life, role in establishing the United States of America, and his contributions to developing New York City (NPS 2022).

The NPS organizes several of the properties mentioned above including Castle Clinton and the African Burial Ground along with others into a group of sites called the National Parks of New York Harbor that together represent over 400 years of American history. Among the other parks included in the grouping are Governors Island National Monument and the Gateway National Recreation Area.

In addition to the sites listed above the Lower Hudson/East River Region intersects with the Appalachian National Scenic Trail and the Washington-Rochambeau Revolutionary Route National Historic Trail.

Upper Bay/Arthur Kill Region, Raritan Region, and Hackensack/Passaic Region

Within the Hackensack/Passaic Region there are two NPS properties, the Paterson Great Falls National Historic Park and the Thomas Edison National Historic Park. Governors Island National Monument lies at the confluence of the Hudson and East Rivers in New York Harbor within the Arthur Kill/Upper Bay Region. Two fortifications, Fort Jay and Castle Williams, were erected on the island between 1796 and 1811 as part of the First and second Systems of Fortifications. Governors Island served as an early outpost to protect New York City from enemy naval attack and its fortifications were integral parts of a larger coastal defense network. The island is also part of a Larger National Historic Landmark District.

The Statue of Liberty National Monument in New York Harbor includes both Liberty Island and Ellis Island. The Statue of Liberty National Monument is also situated within the Arthur Kill/Upper Bay Region. Dedicated in 1886, the colossal 305 feet tall Statue is considered a masterpiece of the human spirit in its design and execution (UNESCO Criterion i). The statue is a symbol of the migration of people from many countries into the United States in the late 19th and the early 20th centuries (UNESCO Criterion vi). Within the boundaries of the property are located all the elements necessary to understand and express the outstanding universal value of the Statue of Liberty. Ellis Island served as the largest and most active immigration station from 1892 to 1924. It was incorporated into the Statue of Liberty National Monument in 1965.

Crossroads of the American Revolution Heritage Area. Much of the Planning Region in New Jersey overlaps with the Crossroads of the American Revolution National Heritage Area, a 2,155 square mile area of New Jersey including 212 municipalities in 14 counties (Bergen, Passaic, Morris, Essex, Hudson, Union, Somerset, Middlesex, and Monmouth). The Crossroads of the American Revolution National Heritage Area is recognized as having played a crucial role in the American Revolution due to its strategic location near the center of the American Colonies (Crossroads of the American Revolution 2021).

Lower Bay Region and Jamaica Bay Region

The Gateway National Recreation Area (GNRA) spans 27,000 acres from Sandy Hook in New Jersey to Breezy Point in New York City. Established in 1972, the park serves as a gateway from the ocean into America's largest port, New York Harbor. It consists of three park units in two states: Jamaica Bay, Sandy Hook, and Staten Island. The park contains a diversity of resources related to defense, recreation, aviation, maritime safety, public recreation, and natural resource protection. The Sandy Hook Unit includes the Fort Hancock and Sandy Hook Proving Ground National Historic Landmark, the site of the oldest surviving lighthouse in the country. The Jamaica Bay Unit of the GNRA is made up of Floyd Bennett Field, Jamaica Bay Wildlife Refuge, Canarsie Pier, Breezy Point, Fort Tilden, and Jacob Riis Park (NPS 2018). The Staten Island Unit of GNRA consists of Great Kills Park, Miller Field, Fort Hancock and Fort Wadsworth (NPS 2018). GNRA features important sections of estuarine wetland habitat and freshwater forested/shrub wetland habitat (USFWS 2018). In addition to natural and cultural resources GNRA's General Management Plan identifies fundamental resources and values as key among the parks attributes. These are defined as the features, systems, processes, experiences, stories, scenes, sounds, smells, opportunities for visitor enjoyment and others that are critical to achieving the park's purpose and maintaining its significance (NPS 2014).

Figure 15: The Gateway National Recreation Area.

In 2009, GNRA released the report Long-Term Research Management Under a Changing Climate. This report documents many challenges faced by the park as a result of climate change, including increasing ecosystem resilience and protecting cultural and recreational resources from damage and loss. According to the report, there are four impacts of climate change that will most affect Gateway. These include RSLC, temperature changes, precipitation changes, and extreme weather events. Gateway is located primarily on the coastlines of major bodies of water, so RSLC is of particular concern as it will threaten cultural and natural resources. Infrastructure located adjacent to shorelines will be in the most immediate danger, while ecosystems and habitats that exist in a delicate balance of water and land are also vulnerable. Anticipated temperature and precipitation changes disrupt balance while threatening visitors and infrastructure at the parks. Extreme weather events such as coastal storms, droughts, and wildfires have the potential to be more frequent and intense which will impact the Park’s resources as well. The NPS and the City of New York have created a partnership to plan for the future of New York City in an era of climate change. Adaptive management approaches to account for factors beyond park borders such as surrounding development, air quality, pollution, climate change, and political conditions are all quoted as goals of this partnership (NPS 2021).

Managing the impacts of Hurricane Sandy has been a catalyst for NPS to reevaluate traditional strategies and encouraged them to intervene in habitat creation and the park's responsibility to protect neighboring communities from future weather events. A new Science and Resilience Institute at Jamaica Bay coordinates local stakeholders in the region to share knowledge, planning efforts and progress, and taps global expertise in resilience planning and urban ecology to enrich local efforts (NPS 2015). It is assumed that access to NPS resources would be limited or blocked as a result of future coastal storm damage, as was the case in the aftermath of Hurricane Sandy. The storm caused damage to many of these sites, including significant damage to the Statue of Liberty and Ellis Island. Approximately 75% of Liberty Island and 100% of Ellis Island was inundated by storm surge. The Statue of Liberty was closed to its millions of annual visitors until July 4, 2013 (Allen 2013). Other sites were closed due to limited transportation access to staff and visitors.

Wildlife Refuge Land

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Raritan Region, and Long Island Sound Region

No Wildlife Refuge Lands are identified within these Planning Regions. The Great Swamp National Wildlife Refuge is located to the west of the Upper Bay/Arthur Kill and Raritan Region and Oyster Bay National Wildlife Refuge is located to the east of the Long Island Sound Region. Wildlife sanctuaries, preserves, and management areas within these Planning Regions include the Vosburgh Swamp Wildlife Management Area, Rogers Island Wildlife Management Area, Beacon Native Wildlife Sanctuary, Constitution Marsh Audubon Center and Sanctuary, Alonzo F Bonsal Wildlife Preserve, Ernest L Oros Park, Thomas Pell Wildlife Sanctuary, and Harding Bird Sanctuary.

Upper Bay/Arthur Kill Region and Lower Bay Region

The William T. Davis Wildlife Refuge is located in Staten Island to the west of Heartland Village and encompasses approximately 430 acres, including a diverse landscape of salt meadow, low marsh, forested uplands, rock outcrops, a swamp forest, and small spring-fed ponds. These habitat types have attracted an abundance of birds, where over 117 bird species have been recorded (NYC Parks 2022).

Jamaica Bay Region

The Jamaica Bay Wildlife Refuge, established as part of the Gateway National Recreation Area, was the country's first national park and remains an important feature of this Planning Region. The refuge includes over 12,600 acres of aquatic habitat, salt marshes, freshwater and brackish water ponds, upland fields and woods, and open bay and islands (NPS 2014) and is centered around an artificial impoundment created to replicate the historically abundant freshwater habitats of the region. The Jamaica Bay Wildlife Refuge and surrounding parkland is dominated by an open water/tidal wetland complex that serves as an island of habitat within the urbanized estuary (USACE 2020b).

Figure 16: The Jamaica Bay Wildlife Refuge.

The Jamaica Bay Wildlife Refuge is the only wildlife refuge in the National Park System and is also home to many native reptiles, amphibians, small mammals, over 60 species of butterflies, and one of the largest populations of horseshoe crabs in the Northeast (USACE 2019). Approximately 332 migrating and resident bird species, including snow goose, brant, several duck species, and raptors such as Cooper's hawk and peregrine falcon, have been sighted in the Jamaica Bay Wildlife Refuge, as it serves as one of the most significant bird sanctuaries in the northeastern United States (Audubon 2022). The refuge provides recreational opportunities including scenic vistas, birding, environmental education, national recreation area maintenance, and ranger operations (USACE 2019).

Additionally noted are two designated wildlife sanctuaries are located within Jamaica Bay, including Brant Point Wildlife Sanctuary and Dubos Point Wildlife Sanctuary.

2.2.5 Commercial and Recreational Fishing

Recreational fishing opportunities in New Jersey are abundant for a wide variety of fish species including freshwater American shad, black crappie, brown bullhead, carp, channel catfish, chain pickerel, landlocked salmon, largemouth bass, muskellunge, northern pike, largemouth, smallmouth, and striped bass, sunfish, tiger muskie, walleye, white catfish, white perch, and yellow perch, as well as saltwater fish, crab, and clamming including striped bass and blue claw. The NJDEP Division of Fish and Wildlife offers information on over 400 publicly accessible recreational fishing locations throughout the State (NJDEP 2022).

Recreational fishing areas in New York State and New York City are also abundant for a wide variety of fish species including freshwater trout, black bass, northern pike, pickerel, walleye, crappie, yellow perch, sunfish, and saltwater striped bass, American eel, hickory shad, American shad, river herring (alewife and blueback herring north of the George Washington Bridge), yellowtail founder, winter flounder, crab, lobster, shellfish, and whelk (NYSDEC 2022).

Commercial fishing in the State of New Jersey includes over 100 species of finfish and shellfish, with six major commercial fishing ports located in the southern portions of New Jersey in Atlantic City, Barnegat Light, Belford, Cape Map, Point Pleasant, and Port Norris, all of which are outside of the NYNJHAT Study Planning Regions (NJ DOA 2022).

Commercial fishing in New York State is an important staple of New York's culture and economy, for many target species including summer flounder, scup, black sea bass, striped bass, bluefish, spiny dogfish, horseshoe crab, menhaden, lobster, and whelk (NYSDEC 2022).

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Near the New Jersey shoreline of the Hudson River within the Lower Hudson East River Region there is at least one recreational fishing area identified as Woodcliff Lake in North Hudson County Park Pond (carp, catfish, channel catfish, largemouth bass, sunfish, trout, yellow perch) (NJDEP Division of Fish and Wildlife 2022). Despite fish consumption advisories due to polychlorinated biphenyl contamination, the Hudson River is used for commercial and recreational fishing, as well as hunting and trapping along the riverbanks (USACE 2020a.) Consumption advisories are in effect for an approximate 200-mile stretch of the River from Hudson Falls to the Battery in New York City (Hudson River Trustees 2015). New York State tidal Hudson River and tributaries recreational fishing include fish species of black bass, striped bass, and American Eel (with license), seasonal, consumption, and harvest requirements and/or limitations depending on species and location (NYSDEC 2022). Recreational fishing opportunities throughout other portions of these regions include Central Park, Van Cortlandt Lake, and the Croton River (NYSDEC 2022). At least 12 recreational fishing areas along the Hudson River in the Capital District Region, four areas in the Mid-Hudson Region, and five areas in the Lower Hudson/East River Region are listed on the New York State Public Fishing Recommended Sites and include species such as smallmouth bass, largemouth bass, sunfish, yellow perch, crappie, tiger musky, northern pike, walleye, carp, channel catfish, and striped bass. Anglers fishing for migratory marine species must enroll in the recreational marine fishing registry (NYSDEC 2022).

Hackensack/Passaic Region

Recreational fishing locations throughout the northern portion of Essex County, Passaic County, and the southern portion of Bergen County include Dundee Lake (carp, catfish, musky/northern pike, sunfish), Barbour Pond (carp, catfish, channel catfish, largemouth bass, pickerel, sunfish, trout), Oradell Reservoir (carp, catfish, largemouth bass, pickerel, smallmouth bass, sunfish, yellow perch), Overpeck Lake (carp, catfish, largemouth bass, sunfish), and Otto Pehle Pond (carp, channel catfish, largemouth bass, sunfish) (NJDEP Division of Fish and Wildlife 2022). Recreational fishing is frequently observed throughout the Region along publicly accessible river and tributary waterfronts, piers, and shorelines.

Fishing advisories were first issued for the lower Passaic River in 1982 for striped bass, American eel, bluefish, white perch and white catfish, and the prohibition of sale of stiped bass and American eel from the lower Passaic River, due to polychlorinated biphenyls contamination found in the river. In the years following the NJDEP added additional advisories and prohibitions on the consumption and sale of all fish and shellfish from the Passaic River mouth to Dundee Dam (in addition to Newark Bay, the Hackensack River to Oradell Dam, the Arthur Kill, and the Kill Van Kull), the sale and consumption of striped bass and blue crabs (Newark Bay, Arthur Kill, Kill Van Kull, and tidal Hackensack River), a ban on crab harvest (lower Passaic and Newark Bay) due to the presence of dioxin contamination associated with the Diamond Alkali Superfund Site. Since 1985 the State of New York has issued similar advisories for the Arthur Kill, Kill Van Kull, and Newark Bay including both once-a-month consumption notices and do-not-eat advisories for at least 14 species (USFWS et al 2020). Despite fish and shellfish consumption advisories, the Passaic River and Hackensack River have been utilized for recreational fishing (USFWS et al 2020). The U.S. EPA recently proposed the Lower Hackensack River be added to the Superfund National Priorities List due to contaminated sediment, threatening areas of recreational fishing and ecologically sensitive environments including wetlands. The do-not-eat and/or harvest bans in the Lower Hackensack River include blue crabs, American eel, and white perch. Consumption limit advisories have been placed on white catfish and striped bass (USEPA 2022).

The Hackensack Meadowlands supports an active recreational fishery. Target species include blue crab, striped bass, American eel, white catfish (*Ameiurus catus*), white perch, carp, pumpkinseed, and brown bullhead (*Ictalurus nebulosus*) (USACE 2020b).

Upper Bay/Arthur Kill Region and Lower Bay Region

Several recreational fishing locations are present throughout southern Essex and Union Counties including the Orange Reservoir (carp, largemouth bass, sunfish, yellow perch), Orange Park Pond (carp, catfish, crappie, sunfish), Diamond Mill Pond (carp, catfish, channel catfish, largemouth bass, sunfish, trout), Nomahegan Pond (carp catfish, channel catfish, largemouth bass, pickerel, sunfish, trout). Recreation fishing locations within Monmouth County include Garvey's Pond (catfish, largemouth bass, sunfish, trout), Poricy Pond (carp, catfish, largemouth bass, pickerel, sunfish), Shadow Lake (carp, catfish, crappie, largemouth bass, pickerel, sunfish, yellow perch), and Thompson Park Lake (catfish, crappie, largemouth bass, sunfish, yellow perch) (NJDEP Division of Fish and Wildlife 2022). Recreational fishing is frequently observed throughout the Region along publicly accessible river and tributary waterfronts, piers, and shorelines.

As discussed in the Hackensack/Passaic Region Section above, despite fish and shellfish consumption advisories Newark Bay, the Arthur Kill, and Kill Van Kill have been utilized for recreational fishing from bridges, piers, and waterfront parks (USFWS et al 2020) as well as private vessels and party/charter boats. Target species include bluefish, weakfish, black sea bass, winter flounder, summer flounder, and striped bass (USACE 2020b). The deeper open-water habitats of these regions and the New York Bight contain target species of commercial and recreational importance, including the winter flounder and black sea bass (USACE 2022).

Commercial fisheries within the New York Bight include species such as scallops, squid, clam, black sea bass, Atlantic herring, mackerel, lobster, butterfish, crab, American eel, among many other species (NMFS 2021).

Raritan Region

Several recreational fishing locations are present throughout Middlesex County including Kennedy Park Pond (carp, catfish, largemouth bass, sunfish), Westons Mill Pond (catfish, largemouth bass, pickerel, sunfish, yellow perch), DeVoe Lake (catfish, largemouth bass, pickerel, sunfish), Lake Manalapan (catfish, channel catfish, crappie, largemouth bass, pickerel, sunfish, trout, yellow perch), Bissets Pond (largemouth bass, sunfish), Carteret Park Pond (largemouth bass, sunfish) and Lake Papaianni (catfish, largemouth bass, sunfish, trout) (NJDEP Division of Fish and Wildlife 2022). Recreational fishing is frequently observed throughout the Region along publicly accessible river and tributary waterfronts, piers, and shorelines.

The Raritan River is considered a self-sustainable and diverse fishery with tributaries to the Millstone River and Delaware and Raritan Canal, as well as Carnegie Lake, Spruce Run Reservoir, and Budd Lake. More than 21 target species have been documented in the Raritan River including bass, panfish, walleye, northern pike, muskie, and channel catfish (Crouse et al 2014).

Jamaica Bay Region

In the Jamaica Bay Planning Region, recreational fishing from the shorelines occurs in New York City or state parks and in areas of Gateway National Recreation Area (parts of Floyd Bennett Field, Breezy point, Canarsie Pier, Dead Horse Bay, Fort Tilden, and Jacob Riis Park). Recreational species that occur in the Jamaica Bay Planning Region include bluefish, tautog, weakfish, black sea bass, winter flounder, summer flounder, and striped bass (USACE 2020b). Recreational fishing in lakes and ponds within this Planning Region include Prospect Park Lake (largemouth bass, sunfish, yellow perch, crappie, chain pickerel, carp) and Baisley Pond (largemouth bass, sunfish, crappie, carp) (NYSDEC 2022).

Long Island Sound Region

Recreational fishing locations within the Bronx and northern Queens County include Crotona Park, Kissena Lake (largemouth bass, sunfish, yellow perch, crappie, carp), Meadow Lake (sunfish, carp), Oakland Lake (largemouth bass, sunfish), and Willow Lake (sunfish, carp) (NYSDEC 2022). Much of Long Island Sounds recreational and commercial fishing, including aquaculture sites, spans beyond the NYNJHAT Planning Region with many locations observed throughout the entirety of Long Island Sound, extending further in the estuary and seaward from both the Connecticut and New York shorelines (ORR 2022). Target species include finfish, lobsters, clams, oysters, squid, scup, and silver hake among many other species (Commercial Fishing 2022). At least four recreational fishing areas within the estuary were observed including in Little Neck Bay, Manhasset Bay, Prospect Point, and Hempstead Harbor (ORR 2022).

2.3 PHYSICAL ENVIRONMENT

The Physical Environment includes a discussion of the existing conditions for topography, surface waters, water quality, land use, cultural resources, hazardous, toxic, and radioactive waste, navigation, noise, environmental justice, other social effects, and other relevant environmental and human resources within Planning Region not listed under the Natural Environment. Due to the size of the Study Area, existing conditions are organized by Planning Region, or a combination of Planning Regions where appropriate based on similar conditions. Relevant data from recent USACE reports within the Study Area were incorporated, and other available data sources supplemented this assessment. Additional information on existing conditions within the Planning Region, can be found in the USACE *Hudson River Habitat Restoration Ecosystem Restoration Integrated Feasibility Report and Environmental Assessment,* the USACE *Hudson-Raritan Estuary Ecosystem Restoration Integrated Feasibility Report and Environmental Assessment,* the USACE *East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Integrated Hurricane Sandy General Reevaluation Report and EIS, and* the USACE *Harbor Deepening Channel Improvements Navigation Study Integrated Feasibility Report and Environmental Assessment*. These documents are listed in the References Section of this Report. Refer to the online NYNJHAT Study StoryMap to explore publicly available environmental resource data sets and mappers of environmental resources within the Planning Region that were considered in preparation of this Integrated FR/Tier 1 EIS.

2.3.1 Physical Resources

The following Sections discuss the physical resources relevant within the Study Area, including the topography and geology, surface water resources, sediment, and land use.

Topography and Geology

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The Hudson River Valley is a north-south trending linear lowland that extends from New York City to the Adirondack Mountains and is situated between the Valley and Ridge physiographic province and the New England physiographic province. The Valley and Ridge physiographic province is a series of northeast-southwestern trending synclines and anticlines comprised of Early Paleozoic sedimentary rock, where limestone and shale make up the majority of the low-lying valleys, and sandstone and conglomerates form the ridges (NPS 2018). The New England physiographic province is characterized as a mountainous area of significant relieve, made up of highly deforms Precambrian and Paleozoic metamorphic rocks including gneisses, schists, slates, quartzite, and marble. Overtime, erosion has exposed large areas of coarsely crystalline Paleozoic granite in portions of this province (NPS 2021). The USACE *Hudson River Habitat Restoration Feasibility Study Report* describes the topography and geology of the Hudson River Valley within these Planning Regions as follows: the topographic gradient of the Hudson River Valley slightly changes elevation of 5 feet in a span of 155 miles and is bound by the Catskill Mountains (west) and Taconic Mountains (east). This Section of the Hudson River Valley is predominantly underlain by Ordovician shale and sandstone with some chert and siltstone. Some Cambrian shale, conglomerate, and limestone are also present. A major topographic feature of the central portion of this region is the Hudson Highlands, the cliffs of which rise directly from the river. Bedrock from just south of Albany to Kingston the Hudson River Valley is relatively narrow and steep-walled. South of Kingston the valley widens, the river deepens, and the Catskill Mountains withdraw to the west. The most common rocks underlying the valley from Kingston to just below Poughkeepsie are Ordovician graywacke, shale, siltstone, chert, and argillite of the Austin Glen, Indian River, Mt. Merino, and Normanskill Formations. At Cornwall-on-the-Hudson the river valley narrows into a deep steep-sided gorge or fjord with water depths up to 200 feet. Here the river enters the rugged low mountains of the Hudson Highlands. The rocks of the Highlands are predominantly erosion resistant Precambrian and Cambrian metamorphic rocks. Just south of the Highlands, the river passes through the Cortlandt Complex of intrusive rocks. After passing through the Hudson Highlands the river widens again. As in the Highlands, most of the valley is submerged, forming an estuary. From Stony Point, NY south the river follows the contact between the Triassic rocks of the Newark Basin and the Lower Paleozoic/Precambrian rocks of the Manhattan Prong until it reaches the Hudson Raritan Estuary (USACE 2020a).

Hackensack/Passaic Region and Upper Bay/Arthur Kill Region

These Planning Regions are located within the Piedmont physiological province of New Jersey. The Piedmont Province encompasses approximately 1,600 square miles, spanning across 10 counties, including Bergen, Essex, Hudson, Union, Middlesex, and is primarily a low rolling plain divided by higher ridges underlain by slightly folded and faulted sedimentary rocks of Triassic and Jurassic age and igneous rocks of Jurassic age (NJDEP 2003). The Piedmont Lowlands, near the Hackensack and Passaic Rivers, and Newark Bay consists of a moderately low-lying area of wide valleys and small hills. The soils in the Piedmont are fertile and arable, combined with easily developable terrain, makes the area suitable for agricultural and industrial needs. The region is also characterized by ridges of igneous rock and traprock interrupting the rolling sedimentary sandstones, shales, and deep red soils (USACE 2020b). Bedrock in the Meadowlands is comprised of shale, sandstone, diabase, and hornfels, overlain by clay bluffs and shale and sandstone cliffs along the edges. The wetlands are located at elevations of approximately 0 to 3 meters and are comprised of mineral and organic wetland soils throughout most of the Meadowlands. Upland soils are either landfills or highly altered (Kiviat et al 2004).

Lower Bay Region

The Lower Bay Region is located within the Coastal Plain physiological province which encompasses approximately 4,667 miles, spanning across eleven counties, and the majority of the State of New Jersey from its northernmost extent in Middlesex County to the southernmost extent of the State in Cape May County. The Coastal Plain is comprised of unconsolidated deposits of the upper Lower Cretaceous to Miocene age containing a trough from the Piedmont boundary near Raritan Bay to Monmouth Junction where the trough forms into a saddle around 80 feet above mean sea level. The Coastal Plains highest elevation is observed in this Region at Crawford Hill, at 391 feet above mean sea level (NJDEP 2003). The portions of Staten Island within this Planning Region is comprised of igneous, metamorphic, and sedimentary bedrock ranging from Upper Proterozoic to Lower Jurassic age overlain by unconsolidated Upper Cretaceous Raritan Formation or upper Pleistocene Wisconsinan glacial drift deposits. Holocene shore and salt marsh deposits overlying upper Pleistocene deposits are present along the shore and low-lying areas of western Staten Island. Serpentine bedrock, consisting of greenish ultrabasic crystalline rock and Manhattan Schist are also reported in portions of Staten Island (Ecology and Environment, Inc. 2009).

Raritan Region

The Raritan Region is partially located within the Piedmont Physiological Province and partially in the Coastal Plain Physiological Province, described in the previous Planning Region Sections. In the Raritan Region, the Piedmont portions are mostly flat with some rolling topographic gradients while the Coastal Plan portions are predominantly flat with few gently rolling topographic gradients. The northeastern portions are comprised of terminal moraine, boulders, gravel, sand and clays. Meltwater from ice trapped in the moraine from the southern margin of the continental ice sheet carried sand and gravel southwest forming the Plainfields (NJDEP 1980).

Jamaica Bay Region and Long Island Sound Region

The Jamaica Bay Region is in the Atlantic Coastal Plain physiographic province, located on the southwestern shore of Long Island, and is enclosed by the Rockaway Peninsula (USACE 2020b). Topography in Jamaica Bay varies between natural and man-made physiographic features, containing several basins, creeks, salt marsh islands, and island bars within the interior of the Bay. The Long Island Sound Region is also within the Atlantic Coastal Plain physiographic province, located in northwestern Long Island and the eastern portions of Manhattan extending up to White Plains, New York. The terminal moraines and the north shore of Long Island are composed primarily of stratified glacial drift with some till. The area between the moraines and the south shore of Long Island is primarily covered by outwash deposits. Central and South Long Island are of glaciofluvial origin, with Pleistocene deposits overlaying gently dipping, metamorphic, Paleozoic, or Precambrian-age rocks (USACE 2019).

Surface Waters

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The Hudson River is the most dominant surface water feature in these regions, originating at Lake Tear of the Clouds in the Adirondack Mountains at an elevation 4,322 feet above mean sea level, and extending south approximately 315 miles to New York City, New York. Many tributaries are present throughout these regions, several of which drain to the Hudson River from portions of Connecticut, Massachusetts, New Jersey, and Vermont (USACE 2020a). The Hudson River channel runs linear north-south except for a few sharp bends observed in the Hudson Highlands. From Troy to Newburgh, the river is generally less than three quarters of a mile wide. The river widens at Newburgh Bay, narrows again through the Hudson Highland Gorge, becomes its widest through the shallow bays of Haverstraw Bay and the Governor Mario Cuomo Bridge and subsequently remains narrow until converging with the upper New York Harbor (USACE 2020a). The Hudson River primarily flows south but is tidally influenced with dual flow directions, extending north as far as Troy, New York (USACE 2022a).

Located in the Lower Hudson/East River Region is the East River, a tidal strait connecting Long Island Sound and Upper Bay. The Hudson River and the East River connect in the Upper Bay near Jersey City, New Jersey and Manhattan and Brooklyn, New York; however, the Hudson River first converges with the East River via the Harlem River further north near Inwood, New York. The Bronx River watershed and a portion of the Northern Long Island watershed both drain into the East River. (USACE 2020a).

Figure 17: Surface waters within the Hackensack/Passaic Region. (Source: USACE 2020b)

Hackensack/Passaic Region

Dominant surface water features in the Hackensack/Passaic Region include the Hackensack and Passaic Rivers, and surrounding tributaries, which drain portions of the densely populated Bergen, Passaic, Hudson, Essex, and Union Counties, New Jersey, including the cities of Paterson and the northern part of Newark. A small portion of Rockland County, New York is also included in this Planning Region (USACE 2020b). Both the Passaic River and Hackensack River flow south, into Newark Bay, located in the Upper Bay/Arthur Kill Region, and through Newark Bay ultimately connects to the Upper New York Bay. The Hackensack and Passaic Rivers receive water from tributaries and stormwater drains in the surrounding Counties, including Bergen, Passaic, Hudson, Essex, and Union County, ultimately discharging into Newark Bay. Stormwater runoff and filling wetlands to control mosquito populations have contributed to water quality degradation and alterations to native flora and fauna species in the area (USACE 2020b).

Surface water contamination in this region has been a concern of stakeholders for decades related to the historical industrial and highly urban nature of the area. Several studies have been conducting over the last several decades to assess effects to human health and the environment. The U.S. EPA designated the Passaic River's upper 17-miles and lower 8-miles as operable units of the Diamond Alkali Superfund Site, currently undergoing remedial action, portions of the Hackensack River, and Newark Bay (where these rivers drain to). Recently, the U.S. EPA has proposed the Lower Hackensack River from Oradell Dam to the mouth of the River at Newark Bay, be added to the Superfund National Priorities List for sediment contamination related to a long history of industrial activity in Bergen and Hudson County (USEPA 2022). Refer to Appendix A9 for additional information.

Upper Bay/Arthur Kill Region

The Upper Bay/Arthur Kill Region consists of several bays, rivers, and channels. Surface waters within the Planning Region primarily include the mouths of the Passaic and Hackensack Rivers, Newark Bay, Kill Van Kull, Arthur Kill, Hudson River and Upper Bay. The Passaic and Hackensack Rivers flow south and converge in Newark Bay, where surface water continues to drain south, eventually into Raritan Bay. The Hudson River extends north into the Capital Region, Mid-Hudson Region, and Lower Hudson/East River Region. The Kill Van Kull is a tidal strait that connects the Upper Bay with Newark Bay flowing from east to west. All surface water in the area ultimately drains into the Atlantic Ocean to the east (USACE 2022). As mentioned previously in the Hackensack/Passaic Region Section, Newark Bay is listed as an operable unit of the Diamond Alkali Superfund Site, discussed in more detail in Appendix A9. These waterways are within a heavily developed and industrial area and contain deepwater navigation channels that allow for transport of cargo to and from the Ports of New York and New Jersey (USACE 2022). The Gowanus Canal is a prominent site within the Upper Bay Planning Region. The canal is a 100-foot wide, 1.8-mile long canal in a highly developed Section of Brooklyn, NY, that has become one of the most contaminated water bodies in the country. Contaminants found in high levels include polycyclic aromatic hydrocarbons, polychlorinated biphenyls, mercury, lead, and copper. In 2010, this site was added to the U.S. EPA Superfund List. A plan has been put in place to dredge the contaminated soil and then cap the area (USEPA 2018).

Lower Bay Region

The New Jersey portions of this Planning Region and western Staten Island are located in the Arthur Kill-Upper Bay watershed and eastern and southern Staten Island are located in the Raritan Bay-Lower Bay watershed. Major surface waters of this Planning Region include the Raritan Bay and associated tributaries along the shores of New Jersey and Staten Island. The mouth of the Raritan River converges with Raritan Bay near South Amboy, New Jersey. Great Kills Harbor is located to the southwest of Great Kills Park (NYSDEC 2022). The Lower Bay portion of the Harbor complex is comprised of extensive shallow flats with scattered areas of deeper waters, including borrow areas and pits. The relatively shallow bottoms exclusive of the navigation channels cover 77% of the total area (38 percent is <15 feet and 39% is 15 – 25 feet deep). Major waterbodies in this area provide a combination of marine and estuarine habitats that support diverse ecological communities (USACE 2004a) and are hydrologically connected to the Upper Bay and Hudson River, Jamaica Bay, and the Atlantic Ocean.

Raritan Region

The largest surface water feature of this Planning Region is the lower approximate six miles of the Raritan River from where it meets Raritan Bay. The Raritan River Basin spans an area of approximately 1,100 square miles and while it is recognized as a wildlife corridor, source of drinking water, and recreational attraction; agricultural and urban stormwater runoff and WWTP discharges affect the rivers water quality (Rutgers 2021). The tidally influenced Raritan River shore is lined with residential and industrial development (USACE 2020b). Tributaries to the Raritan River in this Planning Region include Green Brook,

Jamaica Bay Region

Jamaica Bay is a saline to brackish, nutrient-rich estuary covering almost 40 square miles. The bay has a mean depth of 13 feet, a tidal range averaging five feet, and a residence time of about 33 days (USFWS 1997). The bay opens into Lower Bay and the Atlantic Ocean via the Rockaway Inlet. Rockaway Inlet is a high current area that is 0.63 miles wide at its narrowest point, with an average depth of 23 feet (USFWS 1997). Eight natural tributaries discharge into Jamaica Bay including Sheepshead Bay, Paerdegat Basin, Fresh Creek, Hendrix

Creek, Spring Creek, Shellbank Basin, Bergen Basin, and Thurston Basin. Jamaica Bay has been greatly influenced by the anthropogenic activities to the extent that tributaries in the traditional sense, now consist of receiving basins, sewersheds, and canals. The sources of water in Jamaica Bay are from WWTPs, combined sewage outfall (CSO), storm sewers, groundwater, precipitation, and tidal exchange through Rockaway Inlet. The most important hydrologic input to the bay remains the semidiurnal tides. However, contributions from natural tributaries, now mostly filled or diverted by urbanized development, have been replaced in importance through outflows from WWTPs, CSO, and stormwater runoff (USACE 2019). The Atlantic Ocean is located to the adjacent South of this Planning Region.

Long Island Sound Region

The Long Island Sound is connected to the Upper Bay via the East River, a tidal strait. Tributaries in this region include the Bronx River, Flushing Creek, Westchester Creek, Hutchinson River, Mamaroneck River, and Byram River. There are major estuarine wetland systems in Little Neck Bay, Sections of the coastline in Sands Point on Long Island, Hen Island and Milton Harbor, Mamaroneck River and its tributaries, and Pelham Bay Park (USFWS 2018). This Planning Region is made up of the Bronx River watershed and a portion of the Northern Long Island watershed, which drain into the East River. Many of the tributaries of the East and Harlem Rivers have been channelized and redirected through culverts. The upper East River still has bays and creek mouths, but with sparse remnants of tidal wetland and upland habitats (USACE 2020b).

Sediment

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Most unconsolidated sediment deposits found in the river valley are the result of glacial and postglacial depositional episodes. Differences in local patterns of deglaciation are responsible for the present location of the various glacial deposits. North of Kingston the river bottom sediments are predominantly sands and sandy silts. A deposit of Quaternary glacial and alluvial deposits conceals the bedrock at Hudson, NY. Clean sands are common in this area. From Saugerties, NY to Kingston the bottom sediments become finer. Between Kingston and Peekskill few streams enter the River and the sediment deposits are generally fine grained. Sediment studies have shown that the river is not carrying coarse grained sediments through the Highlands Gorge. The sediments from Haverstraw Bay to the New Jersey - New York State boundary are clayey silts or sandy clayey silts. From this point south the sediments coarsen appreciably. The coarse fraction of the sediments is probably locally derived, although some may be supplied by the flood tide from New York Bay (USACE 2020a).

A history of unregulated polychlorinated biphenyls (PCB) discharges from two General Electric manufacturing plants occurred between 1947 and 1977 north of the Troy Lock and Dam, resulting in contaminated sediments and PCB impacts to River biota including striped bass, and other commercially and recreationally significant target species (Limburg et al 1986). It has been estimated that approximately 1.3 million pounds of PCBs were discharged into the Hudson River from the GE plants impacting River sediments and wetlands. As a result, 200-miles of the Hudson River was designated as a Superfund Site by the U.S. EPA in 1984. Modeling has showed PCBs were transported throughout the entire Hudson River estuary, including Newark Bay (Suszkowski and Lodge, 2008). Currently remedial action and dredging of contaminated sediments is underway by GE under the oversight of the U.S. EPA. Refer to Appendix A9 for additional information.

Hackensack/Passaic Region

Sediment of the Passaic River's lower 8-miles is characterized as silt material with pockets of silty sand. Upstream sediment deposits are characterized as sand and gravel with smaller areas of silt (www.ourpassaic.org). Those upstream silt and silty-sand deposits make up approximately less than 33% of the riverbed, while the surficial fine-grained sediment of the lower 8-miles of the Passaic River make up approximately 85%; with areas of detritus (gravel/sand/silt produced by erosion or organic matter produced by decomposition) in the river identified primarily as microorganic leaf and sticks (www.ourpassic.org). The lower

8-miles of the Passaic River is an operable unit of the Diamond Alkali Superfund Site, discussed in more detail in Appendix A9.

Sediments in the lower Hackensack River is comprised of silt, clay, sand, mud, and gravel, confirmed through sampling events conducted in 1988 and 2003 to not have changed significantly over the duration of 15 years (Konsevick et al 2010). The Hackensack River Sediment quality in the lower Hackensack River is described as follows:

> *"Based on sediment guidelines published by NOAA in 1995, the estuary is in "poor" ecological condition; the average concentration of one contaminant, mercury, exceeds the ERM (…the median concentration of a contaminant observed to have adverse biological effects in the literature values examined). It is also apparent that enrichment of mercury and other metals occurs in the Hackensack River north of the mouth of Berry's Creek, a major tributary known for its legacy of industrial contamination"* (Konsevick et al 2010).

On September 7, 2022, the U.S. EPA announced that the lower Hackensack River has been added to the Superfund Site National Priorities List due to contaminated sediment in the River within New Jersey's Bergen and Hudson counties, discussed in more detail in Appendix A9.

Upper Bay/Arthur Kill Region

Sediment characteristics vary widely over the area as a result of complex flow patterns. Newark Bay sedimentology reflects the deposition of sediments from river input at the northern end, and tidal input at the southern end. Sediments within Newark Bay tend to be a fine-grained combination of silts, clays, and sands, with larger-grained materials present in the southern end of the bay due to materials introduced by tidal activity. Upper New York Bay has the most complex distribution of sediments. Currents vary substantially, and a high degree of input is biogenic or anthropogenic. Sediments in Upper New York Bay vary from coarse sands and gravels in high-energy areas to fine-grained silts and clays in low-energy areas. Lower New York Bay sediments in the area just south of the Narrows are characterized by gravelly sands underlying the main channel, with finer-grained sands, clays, and silts to the east and west of the channel. Extensive deposits of sand characterize the northern part of Lower New York Bay (USACE 2022). A variety of contaminants are found in the sediments of the Harbor. Contaminants detected in sediment samples have included: polycyclic aromatic hydrocarbons, pesticides, polychlorinated biphenyl (PCB) congeners, metals, and dioxin/furans. Similar to sediment type, the quality of sediments varies substantially, depending on what area is sampled. Typically, water bodies adjacent to or downstream from areas that have a history of industrial activity, especially prior to the introduction of environmental regulations in the 1970s, show the greatest potential for contaminated sediments. Sediment quality has been assessed extensively over the past several decades for contaminant concentrations related to the surrounding, and upgradient, highly urban and industrial operations historically prevalent throughout the Region. Several recent studies and data sources have demonstrated that contaminants of varying concentrations are under 20% average median contamination has trended cleaner in the past few decades and the overall harbor is expected to decrease its median concentration levels as a result of, to name a few examples, natural attenuation recovery processes, historical and recent deepening and maintenance dredging of navigation channels, and following a CERCLA remedial action associated with the Diamond Alkali Superfund Site (NBSA 2019, Lodge et al 2015, and USFWS et al 2020). Some model simulations have also indicated that sediment contaminant levels will continue to decrease over time even if current contaminant loads in Newark Bay were to remain constant (Lodge et al 2015 and USACE 2022).

Lower Bay Region

Most of the sediment in this area are marine deposited sedimentary sands, gravels, and clays. The sedimentary deposits of the Inner Coastal Plains that were deposited during the Cretaceous Period are separate from the Outer Coastal Plain to its southeast by a belt of hills called Cuestas (USFWS, 1997). The Lower Bay area has sediments made up mostly of sand varying in grain size. Lower New York Bay sediments in the area just south of the Narrows are characterized by gravelly sands underlying the main channel, with finer-grained sands, clays, and silts to the east and west. Extensive deposits of sand characterize the northern part of the Lower New York Bay (USACE, 1999).

Raritan Region

Sediments in the Raritan River are characterized as mostly sand and gravel from Bound Brook extending east, where sediments eventually transition to higher mud and organic material composition as they approach Raritan Bay (Rodenburg et al 2012). The Raritan River has a long history of contamination concerns related to nearby urban industrial uses, particularly the many known contaminated sites located in the vicinity of the River. The portion of the River in which fresh water and salt water converges is anticipated to resuspend contaminates bound in organic matter that settles in sediment, which are anticipated to shift with the tides within the River (Rodeburg et al 2012).

Jamaica Bay Region

Sediments in Jamaica Bay are comprised of an approximately even ratio of mud and sand (USACE 2020b), and largely lacking inorganic mineral sediment (sand, silt, and clay) which salt marshes depend on for structure (Reynolds 2018). Jamaica Bay is threated by poor sediment quality derived from a combination of sewage inputs, landfill leaching, industrial activity, and runoff from roads and urban development (USFWS 1997). Prior to pollution regulations, large quantities of contaminates, including heavy metals, pesticides, PCBs, dichlorodiphenyltrichloroethane (DDT), and dioxin, were discharged into waters of Jamaica Bay (USACE 2019). During a 30-year span, levels of most of these contaminants have decreased on average by about an order of magnitude (Steinberg et al 2004). This decrease is due mainly to the implementation of control measures required by the Clean Water Act; however, contaminants tend to adhere to organic compounds and settle in sediment, which have been present throughout Jamaica Bay (Steinberg et al. 2004).

Long Island Sound Region

Sediments within this Planning Region vary depending upon location as a result of the complex flow patterns existing in the Long Island Sound. Surficial sediments include both glacial and postglacial deposits, with the most recent glaciation period ending about 21,000 years ago. Surficial glacial deposits include till and stratified drift. Postglacial deposits consist of sand, marsh deposits, and estuarine silt (USACE 2020b). Contaminate data collected between 1956 and 1997 throughout the Long Island Sound and New York Bight indicates the potential presence of varying concentrations of 4,4' DDT, PCBs, phenanthrene, dieldrin, and pyrene within the Long Island Sound Region, and New York Bight (Mecray, E. L. et al 2003).

Land Use

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The Capital District Region, Mid-Hudson Region, and northern portion of the Lower Hudson/East River Region are comprised of a mix of manmade structures, road and railroad networks, large homogenous impervious surfaces, agricultural land, and several clusters of wooded and dense vegetation. In the southern portions of the Lower Hudson/East River Region, notably starting around Stony Point, larger and more contiguous areas of impervious surfaces are present (GIS LandCover 2022). Numerous populated cities and townships of varying sizes are located along the Hudson River. Within the Planning Region, the Hudson River's northern extent is flanked by the cities of Albany and Troy. Numerous smaller communities are located along both banks of the river to the southern Rockland-Westchester County lines. To the south, the greater New York Metropolitan area, with an estimated population of nearly 8 million people, dominates the shoreline of the estuary. As a result of the large population and need to protect property and land, over 10,100 acres of shoreline are engineered or hardened to limit erosion of sediment into the channel and prevent bank retreat (USACE 2020a).

Hackensack/Passaic Region

The Hackensack/Passaic Region is heavily urban environment comprised of manmade structures, road and railroad networks, large homogenous impervious surfaces such as parking lots/structures, office buildings, and residential houses, with some clusters of wooded vegetation throughout (GIS LandCover 2022). Predominant land uses consist of commercial, industrial, and residential development. Surface waters are withdrawn from the Hackensack and Passaic Rivers by three power plants and three sewage treatment plants are also located in this region (USACE 2020b). The lower 1.7 miles of the Lower Passaic River is dominated by commercial petroleum facilities. The upstream reaches of the lower Passaic River predominantly support recreational uses. The Hackensack Meadowlands are a dominant feature within this region, measuring approximately 19,730 acres. The New Jersey Meadowlands District contains residential, commercial, industrial, and landfill areas, as well as large expanses of tidal wetlands and open space (USACE 2020b).

Upper Bay/Arthur Kill Region

Land use along the shoreline of the Upper Bay/Arthur Kill Planning Region is primarily commercial and industrial, with few non-industrial uses. Degraded water quality limits the waterways within this Planning Region to primarily transportation-related uses. Scattered among the shipping terminals and marinas are parklands or public promenades, some vacant disturbed land, and small residential areas. Waterfront parks, including Liberty State Park, provide recreational and open spaces, although most of the shore is lined by bulkheads. Along the western shore of Newark Bay are the Port Newark and the Port Elizabeth Marine Terminals (USACE 2020b). Much of the remaining portions of the Region is comprised of a heavily developed urban environment including human made structures, major road/rail networks, large homogenous impervious surfaces such as parking lots/structures, office buildings, industrial facilities, the Newark Liberty International Airport, storage tank farms, landfill (Fresh Kills) and residential housing, with some clusters of wooded and/or grass vegetation throughout (GIS LandCover 2022).

Lower Bay Region

The Lower Bay Planning Region is dominated by an urban environment developed with industrial, commercial, and residential land uses. Sandy Hook's shoreline is interspersed with public and private marinas, sandy beaches, and riprap shorelines (USACE 2020b). Private and public beaches are scattered throughout the region, located in Monmouth County, New Jersey, and on Coney Island and Staten Island, New York. The surface waters in this Planning Region are used for commercial shipping, recreational boating, and fishing or shellfishing (USACE 2020b).

A few areas of farmland crops are noted inland in this Planning Region. Beaches, including private and public, are observed from Gateway National Recreation Area Sandy Hook Unit extending south through Navesink Beach, Sea Bright, Monmouth Beach, and East Long Branch. Gateway National Recreation Area contains wooded and beach vegetation (GIS LandCover 2022).

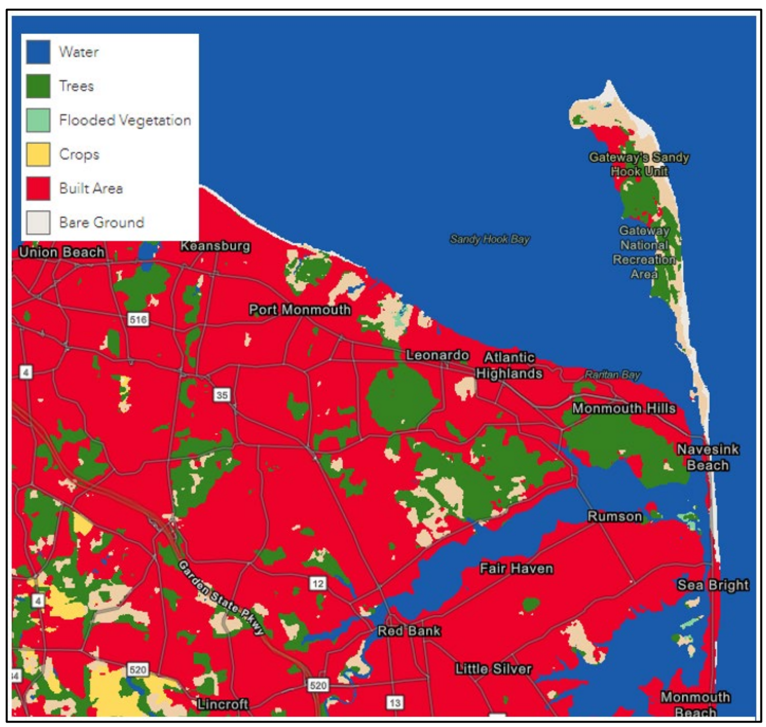


Figure 18: Land Use within the Lower Bay Region.

Raritan Region

Much of the urban Raritan Region land use is dominated by an urban environment of human made structures, major road/rail networks, large homogenous impervious surfaces such as parking lots/structures, office buildings, and residential housing with some clusters of wooded and/or grass vegetation and fewer pockets of agricultural uses (GIS LandCover 2022). The Lower Raritan River shoreline is comprised of residential and industrial development. Land use over time has changes from predominantly industrial properties with bulk-head shorelines and piers to mixed industrial, commercial, and residential properties. Further upstream of the Raritan River contains agricultural lands, with isolated pockets of tidal wetlands along the shoreline. Additionally noted along the shoreline of the Raritan River is a landfill, the former Raritan Arsenal, and the Sayreville and Werner generating stations, with water uses of recreational navigation and water/jet skiing and fishing (USACE 2020b). Recreational and public park access include Pigeon Swamp State Park, Ireland Brook County Park, and Davidsons Mill Pond County Park.

Jamaica Bay Region

Predominant land uses on the northern shore of Jamaica Bay are developed commercial, industrial, and residential. The shorelines of Jamaica Bay are flanked by heavily developed lands, including the Belt Parkway, John F Kennedy International Airport, and several landfills. Along the waterfront, land and water uses include marinas, marine parks, parkland, vacant disturbed land (wetlands and uplands), tidal wetlands, and residential land. Public parks and open space present in the Planning Region include Floyd Bennett Field, Prospect Park and Spring Creek Park. Rockaway Peninsula, in the southern part of the Jamaica Bay Planning Region, is distinct from the northern shores of the Planning Region. Developed as a summer resort in the 1830s, Rockaway Peninsula is predominantly a residential area from its border with Nassau County on the east to Rockaway Point on the west (USACE 2020b).

Long Island Sound Region

Much of the urban Long Island Sound Region land use is dominated by an urban environment of human made structures, major road/rail networks, large homogenous impervious surfaces such as parking lots/structures, office buildings, and residential housing with some clusters of wooded and/or grass vegetation and intermittent pockets of open areas covered in homogenous grasses with little or no tall vegetation and areas of exposed soil or rock. LaGuardia Airport and Rikers Island, a New York City prison complex, are present along/within the East River (GIS LandCover 2022).

2.3.2 Hydrological Resources

The following Sections discuss the hydrological resources relevant within the Study Area, including bathymetry, hydrology, tides, sediment transport, and water quality.

Bathymetry

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Prior to colonial settlement much of the Study Area was comprised of a shallow system with water depths less than 20 feet at mean low water (USACE 2020b). The completion of the Erie Canal in 1825 made passage between the Great Lakes Region and the Atlantic Ocean possible and eventually required deepening the natural channel of the Hudson River and its estuary (USACE 2020b). The Hudson River Valley from south of Albany to Kingston is relatively narrow and steep-walled. At Cornwall-on-the-Hudson the river valley narrows into a deep steep-sided gorge with water depths up to 200 feet. Extending from there the river enters the rugged low mountains of the Hudson Highlands. Just south of the Highlands, the river widens again. As in the Highlands, most of the Hudson River Valley is submerged, forming an estuary. Starting around Stony Point, New York and extending south, the river follows the contact between the Triassic rocks of the Newark Basin and the Lower Paleozoic/Precambrian rocks of the Manhattan Prong until it reaches the Upper New York Harbor. The river gradient for over 150 miles from the Troy Lock and Dam to the Battery, New York City, is small, roughly only 5 feet change while the river bottom at Albany is at sea level (USACE 2020a, Limburg et al., 1986, Cooper et al., 1988).

Hackensack/Passaic Region, Upper Bay Region, Lower Bay Region, and Raritan Region

The lower Hudson River Estuary was naturally deep enough to accommodate most vessels in 1825; however, as the need for more goods grew, and wooden boats were replaced with larger steel ships, a series of navigation improvement projects were advanced to accommodate these larger vessels. In 1891, a 30-foot deep passage was dredged through the Lower Bay, followed by an extensive deepening to 40 feet completed in 1914 (Parkman, 1983). During World War II, the network of channels and supporting berthing areas were deepened to almost 45 feet and expanded into the Upper, Raritan, and Newark Bays (Parkman, 1983). Since then, navigation channels have been maintained or deepened throughout the Planning Region’s rivers and bays, resulting in over 250 miles of established channels, and associated berthing areas. In 2000, the U.S Congress authorized the deepening of the main shipping channels within these Planning Regions to 50 feet, and again in 2022 to 55 feet, to meet shipping needs and ensure New York-New Jersey Harbor’s long-term economic viability (USACE 2020b and USACE 2022).

Jamaica Bay

Dredging and filling in Jamaica Bay over the past century has significantly altered the bathymetry of Jamaica Bay (USACE 2019). The average depth of Jamaica Bay is approximately 13 feet deep with dredged navigation channels reaching up to 50 feet deep (NYCDEP 2007). Jamaica Bay also has numerous deep borrow pits, exceeding forty feet in depth in some locations which are located at the bayside margins of both Floyd Bennett Field and John F. Kennedy Airport. Other borrow pits include the Norton Basin and Little Basin Borrow Pits; as well as offshore borrow areas including the East Rockaway Inlet Rockaway Emergency Contract 1C Borrow Area, and the USACE Borrow Areas A-West and A-East (USACE 2019).

Long Island Sound Region

Bathymetry within Long Island Sound Region generally varies from approximately 0 to 82 feet (25 meters) below mean sea level, depending on location within the Region. Surrounding Rikers Island, bathymetry is observed to range to depths up to 39 feet on the south side of the Island and up to, on average, 55 feet with deeper pockets of up to 66 feet on the north side. A navigation channel runs parallel to the shore of Stony Point to Hunts Point exceeding 82-foot depths in some locations (Navonics 2022). Flushing Bay is generally more shallow than seaward portions of the Long Island Sound Region, exhibited depths up to 5-6 feet in much of the Bay, with the exception of the Flushing Creek Channel that runs linear northwest-southeast into the southernmost anchorages of the Bay. This channel exhibits average depths of 17 feet. Around Throgs Neck, bathymetry is observed to steeply advance to 40 feet below men sea level near shore on the southern side with a gentler gradient on the north side to 12 feet below mean sea level nearshore (Navonics 2022).

Inland Hydrology

The nine NYNJHAT Planning Regions are based on hydrologic unit codes (HUCs) from the Watershed Boundary Dataset of the United States Geological Survey (USGS). HUCs are divisions and subdivisions of the United States, based on the area drained by one or more waterbodies, or section thereof, depending on the hierarchical level of the unit. These units range from the largest two-digit unit down to the smallest 12-digit unit (with portions of the United States being further divided into 14- and 16-digit units) (USGS 2013).

Topographic gradients generally dictate surficial and shallow groundwater flow patterns, where hydrogeologic gradients typically follow, under normal ambient conditions, towards the nearest major body of water (e.g. Atlantic Ocean); however, inland hydrology of urban environments are heavily influenced by impervious surfaces, stormwater runoff, drains and discharge points, CSO, WWTP discharges, culverts, drainage basins, retention ponds, navigation channelization, groundwater use, and other human-influenced hydrological alternations.

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The Capital District is based on the 8-digit HUC for the Middle Hudson, Mohawk, and Hudson-Hoosic subbasins; the Mid-Hudson Region is based on the 8-digit HUC for the Hudson-Wappinger subbasin and the Rondout subbasin; and the Lower Hudson River/East River Region is based on the 8-digit HUC for the Lower Hudson subbasin in the Watershed Boundary Dataset (USGS 2018). Surface waters flow from land into the Hudson River through hundreds of tributaries (rivers and streams) from the north, east, and west. Groundwater flows underground to the Hudson River from aquifers (Hudson River Watershed Alliance 2022). This entire system is referred to as the Hudson River Watershed, which encompasses almost 13,400 square miles (Hudson River Watershed Alliance 2022). The Hudson River, from its origin at Lake Tear of the Clouds in the Adirondack Mountains, primarily flows south but is a tidally influenced estuary with dual flow directions extending from the New York Harbor to the north as far as Troy, New York (USACE 2022).

Hackensack/Passaic Region, Upper Bay Region, Lower Bay Region, and Raritan Region

The Hackensack/Passaic Region is based on the 8-digit HUC for the Hackensack-Passaic subbasin; the Upper Bay Region is based on the 10-digit HUC for the Arthur Kill-Upper Bay watershed and the Rahway River watershed; the Lower Bay Region is based on the 10-digit HUC for the Raritan Bay-Lower Bay watershed and the Navesink River-Shrewsbury River watershed, and the 8-digit HUC for the Mullica-Toms subbasin; and the Raritan Region is based on the 8-digit HUC for the Raritan subbasin (USGS 2018). Much of these regions have a similar hydrologic character.

The Passaic and Hackensack Rivers primarily flow south from their origins in Medham, New Jersey and Rockland County, New York, respectively. Upstream and upgradient surface water and groundwater aquifers migrate into these river systems, both of which are influenced in the urban-dominated areas by industrial and municipal discharges and stormwater runoff. Both the Passaic and Hackensack Rivers are tidally influenced, including the lower approximate 17-miles of the Passaic River from Newark Bay to Dundee Dam and lower brackish estuary of the Hackensack River (USACE MESIC 2022 and Montclair State University 2022).

The entire Raritan River Basin encompasses approximately 1,100 square miles within the State of New Jersey. The Raritan River originates in Branchburg, New Jersey flowing east towards the Raritan Bay. Several surface water tributaries drain into the River, including Green Brook, Lawrence Brook, Millstone River, and the South River (Rutgers 2021). The Raritan River is also influenced by urban and agricultural stormwater runoff and WWTP discharges. Tidal influences in the Raritan River are present from Raritan Bay to Calco Dam in Bound Brook, New Jersey (Rodenburg et al 2012).

Raritan Bay receives surface water and groundwater influx from heavily urban areas in New Jersey and New York, as well as from connected rivers (Raritan River, Arthur Kill, Hackensack and Passaic Rivers), bays (Newark Bay via the Arthur Kill and Kill van Kull, New York Bay, Jamaica Bay), and the Atlantic Ocean.

Jamaica Bay Region

The Jamaica Bay Region is based on the 8-digit HUC for the Southern Long Island subbasin (USGS 2018). Jamaica Bay is described by the New York City Department of Parks as “an 18,000-acre wetland estuary surrounded by the Rockaway Peninsula…Brooklyn…and Queens… Comprising an area almost equal to that of Manhattan, the bay consists of numerous islands, a labyrinth of waterways, meadowlands and freshwater ponds” (NYSDEC 2022). While Jamaica Bay is primarily undeveloped, it’s bound upland by a heavily urban environment that influences the Bay with stormwater runoff, CSO, and WWTPs via the immediate shoreline as well as several point source locations including Mill Basin, Paerdegat Basin, Fresh Creek, Hendrix Creek, Spring Creek, Bergen Basin, Thurston Basin, and Head of Bay which have numerous outfalls, including CSO (AECOM 2018).

Long Island Sound Region

The Long Island Sound Region is based on the 8-digit HUC for the Bronx, Saugatuck, Long Island Sound, and Northern Long Island subbasins (USGS 2018). The Long Island Sound is influenced by surface water and groundwater influx from a heavily urban environment of New York City Metropolitan Area, as well as from Long Island, Connecticut, and the Atlantic Ocean. The Sound connects to the Atlantic Ocean by two pathways: a southern route following the East River to Upper Bay to Raritan Bay and an eastern route extending the entire length of Long Island to Montauk, New York. Several rivers (Bronx, Hutchinson), creeks (Westchester, Hammond), and bays (Little Neck, Manhasset, Flushing, Hempstead) within this Planning Region either drain into or are influenced by the Sound. In total, the Long Island Sound encompasses approximately 1,400 square miles, and while much of the New York City portion utilizes a drinking water supply transferred from upstate New York, Nassau and Suffolk Counties utilize groundwater as a drinking water supply (Franke et al 1972), which can influence local hydrology.

Coastal Hydrology, Currents, and Circulation

Generally, coastal hydrology, currents, and circulation are influenced by the rise and fall of the tides, wind, and thermohaline (water density that is controlled by differences in temperature and salinity) (NOAA 2022). Currents form from tides in oceans, along shorelines, and within coastal bays and estuaries, are referred to as tidal currents and are considered predictable as they form in regular patterns (NOAA 2022). Surface currents driven by wind are typically measured in knots or meters per second. Thermohaline circulation occurs both at the surface and below surface, usually at a slower pace than tidally influenced currents and surface currents, as a function of water density where warmer waters lower in salinity form shallow currents and as those currents cool, they fall below surface forming a deeper and more saline currents (NASA 2022).

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The Hudson River currents are influenced by the same variables that affect the tides. The times of slack water and the velocities and durations of flood and ebb are subject to extensive changes; the times of strengths are less likely to be affected. Near the Troy Lock and Dam, the current does not flood and the velocity of the downstream flow during ebb tide is 0.7 knots. These values are for the summer when the freshwater discharge is at a minimum (USACE 2020a). The interaction between saltwater and freshwater is a key feature of the estuary. Dense salt water from the ocean flows up the river where it meets less dense fresh water flowing downstream. Where the two mix, a diffuse wedge of intruding saltwater forms (USACE 2020a). One of the most substantial factors that has caused hydraulic changes to the estuary is the decrease in natural freshwater flow due to culverts, dams, and reservoirs within the watershed in comparison to other surface water systems within the Planning Region (USACE 2020b).

Hackensack/Passaic Region, Upper Bay Region, Lower Bay Region, and Raritan Region

Circulation patterns within the Newark Bay Complex and throughout the estuary are influenced by winds, freshwater inflow, and gravitational circulation, with strong winds exhibiting a greater effect on circulation (Chant 2006). As noted in the *Hydrodynamics of the Newark Bay/Kills System*:

> *"[w]ithin the navigation channel of Newark Bay, classic estuarine gravitational circulation occurs, with daily averaged currents (the current averaged over several tidal cycles) directed seaward near the surface and landward near the bottom. The same estuarine circulation pattern occurs in the Kill van Kull and the southern portion of the Arthur Kill. However, in these tidal straights this pattern is not as pronounced during periods with a large range in tidal height (e.g., Spring tides)"* (Chant 2006).

Under typical conditions, wind influenced current patterns tend to flow landward during low freshwater discharge from the Passaic River (Figure 19), while strong winds tend to drive current directions landward (influenced by western winds) or seaward (influenced by eastern winds) as shown on Figure 19.

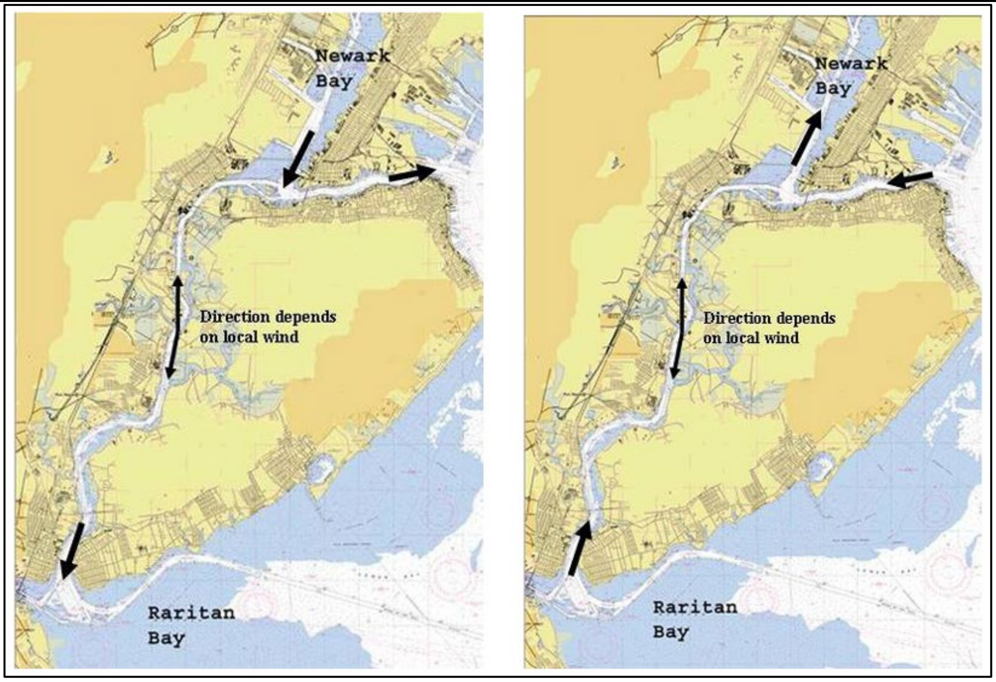


Figure 19: Current direction influenced by wind under typical conditions.
(Chant 2006)

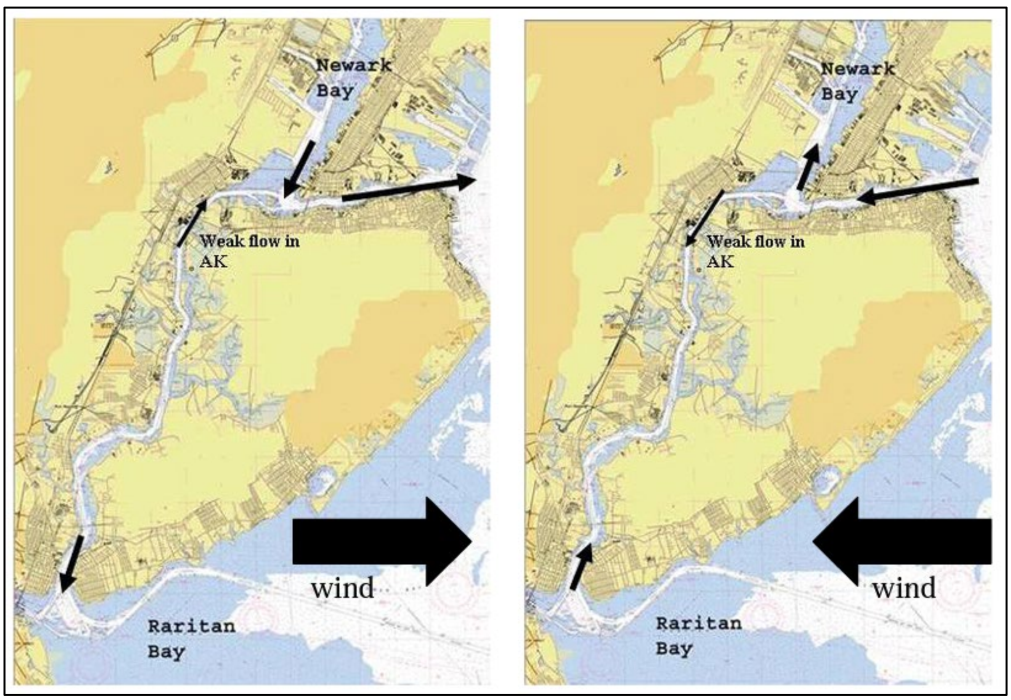


Figure 20: Current direction influenced by strong wind.
(Chant 2006)

Jamaica Bay

Due to the length and orientation of Rockaway Inlet, the Jamaica Bay area is largely sheltered from ocean waves. The majority of waves in Jamaica Bay are locally generated due to wind/water surface interaction or produced by vessels navigating the interior channels. The wind climate varies from calm and light to potentially dangerous winds of a winter nor'easter or a late summer hurricane. The wind, waves, and currents have significant bearing on the sustainability of the marsh within Jamaica Bay. To varying degrees, the stability of the vegetative cover and the conservation of sediment depend on these coastal processes. The wave climate may be considerably different from year to year, resulting in different erosion rates from year to year (USACE 2019).

Long Island Sound Region

A unique characteristic of Long Island Sound that influences its coastal hydrology, currents, and circulation, is the open connection to the Atlantic Ocean at its easternmost expanse and also at its westernmost extent via the East River and Hudson River estuary:

"…*brackish water from the Hudson Estuary is allowed into the Sound and a reverse flow of saltier water is injected into lower New York Harbor…" Although, "[t]he direction and magnitude of the net transport of water between the East River and Long Island Sound has been a controversial matter*" (Vieira 2000).

Due to the complex nature of Long Island Sounds currents and limited background data readily available, mariners have largely relied on local knowledge and tidal predictions (Haire 2021). The tidal currents of Long Island Sound form in rushes to the west with incoming tides, and conversely to the east with outgoing tides, depending on tidal range. Easterly winds may raise water levels higher than predicted averages, increase the time between high water and outgoing flow, and prevent water release during ebb causing high tides to be higher than normal conditions may predict (Muller 2019).

A study conducted in the Long Island Sound Region estimated the long-term residual volume flux through Throgs Neck/Willets Point from the Long Island Sound into the East River measured slower surficial flows (260 meters cubed per second) as compared to more than double bottom flows (570 meters cubed per second) towards the East River, with a net residual volume flux of approximately 310 meters cubed per second (Vieira 2000). Additionally, the geomorphology of Long Island Sound's basin and sill structure directly influences the residual circulation within the Sound (Vieira 2000).

Tides, Tidal Exchange, and Tidal Range

Tidal Constituents are forces that contribute to the tides. The two tidal constituents are Earth's rotation and the gravitational force of the sun and moon. Because of the proximity of the moon to Earth, the gravitational pull is greater than that of the sun and this is the main attribute to tides, tidal exchange, and tidal range (NOAA 2022). Tidal range is known as the difference between a high and low tide. The Study Area encompasses an estuarian waterbody with freshwater sources throughout, mixing with salt water from the nearby Atlantic Ocean.

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region, Long Island Sound Region

The tide in these regions is semi-diurnal, meaning that two high tides and two low tides occur every twenty-four hours, making the Hudson River one of the few major tidally influenced rivers of the North Atlantic coast (USFWS, 1997). This stretch of river is naturally turbid, with limited primary productivity and moderate to high salinity levels (USACE 2020b). Tidal range and flow within the estuary are affected by freshwater flow from riverine sources, wind speed and direction, and variations in the lunar cycle or ocean storms (USACE 2020a). With the rise and fall of tide comes changes in the direction of flow. In general, a rising tide is accompanied by a *flood* current flowing north towards Troy, a falling tide by an *ebb* current flowing seaward (NYSDEC, n.d.). The average tidal range is greatest at the Battery, in southern Manhattan and Troy, NY (4.4 feet) and is least at West Point, NY (2.5 feet) (Limburg et al., 1986). The change in current flow twice each day is affected by strong winds from the south or north that can push water into or out of the estuary, obscuring the true tidal regime (Barnthouse et al., 1988). Both the channel's irregular bottom and depth of the river affects the mixing of salt and freshwater, resulting in a salinity gradient both vertically and horizontally. Measurements of vertical gradients of salinity show that during low flow conditions, salt water and fresh water are generally well mixed, while under high flow conditions, freshwater tends to override the denser saltwater layer. Parallel shallow areas may receive less salt water, have delayed mixing and experience reduced ranges in salinity (Limburg et al., 1986). Within the Long Island Sound, which connects to the East River, the currents caused by tides are known to be of significant speeds, up to five knots in places. As a consequence, navigation in and around the many narrow channels and bays of the Sound can be complex and challenging.

Hackensack/Passaic Region, Upper Bay Region, Lower Bay Region, and Raritan Region

The principal gateway of tides into these Planning Regions is through the Lower Bay region where the Ambrose Channel is located as the entrance of vessels entering the Port of New York and New Jersey (Marmer, pg. 17). A semi-diurnal tidal fluctuation is experienced within these regions with relatively strong tidal currents that generate vertical turbulent mixing and partially mixes the water column along the separation between the two layers. The upstream edge of this separation is called the salt front (USACE 2020b). The Upper Bay region begins at the entrance to the Hudson River and has connections to Newark Bay and the Arthur Kill channel, via the Kill Van Kull. The Upper Bay exchanges brackish water with the Long Island Sound, via the East River. Within the regions outlined above, the range of tidal fluctuation in surface elevation is about five feet. In Newark Bay, tidal elevation influence has been seen propagating upstream as far as the barrier at Dundee Dam under low freshwater (Upper Passaic River) flow conditions (USACE 2020b).

Jamaica Bay

Tides in the Jamaica Bay Planning Region are also dominantly semidiurnal at an average of about 5 feet. The MHW level and MLW level relative to North American Vertical Datum 88 (NAVD88) in the Jamaica Bay reach, are +2.4 feet and -3.07 feet, respectively (USACE 2019). There is a small diurnal modulation averaging 0.5 Feet (0.15M) existing within this area, meaning that one high tide a day is slightly higher than the other, and one low tide is lightly lower than the other (Sanderson et al. 2016). Tides incoming from the Atlantic Ocean within the Jamaica Bay planning reach have a generally weak tidal currents and average in maximum velocities of 3.1 and 2.3 knots at flood tide, respectively at Rockaway Inlet and East Rockaway Inlet. USGS observations of flow speeds at the USGS Rockaway Inlet gauge are generally 1.0 knots or less during neap tide periods and 1.7 knots or less during spring tide periods (Arcadis 2016b).

Sediment Transport

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

A 1999 study (Geyer et al 2001) on sediment transport in the Hudson River estuary discussed findings that supported a prior study conducted in 1969, stating that:

> *"…under normal flow conditions estuaries tend to import sediment from the seaward direction. The observations also indicate that the direction of sediment flux is controlled by the river flow while its magnitude is controlled by the spring-neap variation in tidal amplitude. Sediment export from estuaries is expected to occur when spring tides coincide with strong river outflow. During the 1999 observations, the peak river flow occurred during neap tides, and there was virtually no export of sediment from the estuary. The trapping of sediment within the estuary observed in 1999 is consistent with the long-term morphological equilibrium of the estuary, which is evident from historical bathymetric data extending over the last 150 years. Major sediment export events must occur episodically, in order to maintain the estuary at a roughly uniform depth. The events most likely to accomplish the major episodes of sediment export are large freshet events that occur during spring tides."*

An assessment of sediment transport in the Hudson River estuary as a result of extreme storm events found that Tropical Storms Irene and Lee caused approximately 5 times the long-term annual average of sediment input into the Hudson River (Ralston et al 2013). The newly transported sediment remained within the river's tidal freshwater for over a month after the storms, with approximately one fifth of that new sediment reaching the saline estuary. Further, modeling results indicated that high sediment concentrations were attributed to bed resuspension from the storms (Ralston et al 2013). Refer to the Section on SAV for for a summary of suspected sediment transport related impacts of prior storms within the Hudson River.

Hackensack/Passaic Region, Upper Bay/Arthur Kill Region and Lower Bay Region

The estuarine circulation pattern described in previous resource sections affects the resuspension, deposition, and transport of solids in the Lower Passaic River. The stratification and the tidal currents work together to move sediment and associated contaminants both upstream and downstream within the estuary, transporting contaminants multiple miles downstream and upstream of their original discharge points while tending to smooth out contaminant concentration gradients along the Lower Passaic River. While the net transport of sediment at any given time is highly dependent on the balance of fresh water and tidal flows, over the long-term, there is a net transport of sediment from the Lower Passaic River to Newark Bay (USACE 2020b).

The Remedial Investigation Report for the Passaic River Superfund Site describes conditions of sediment transport within the Passaic River (ourpassaic.org):

> *"Presence of the coarser sediment size upstream of RM8.3 is likely due to a combination of winnowing due to high river velocities in the narrower river bed cross section and the proximity of bedrock and potential sand and gravel sources to the bed of the river in the upstream regions. Conversely, the wider channel and slower velocities below RM8.3 have resulted in widespread deposition of silt in both the channel and the shoals. Exposed fine-grained sediment deposits (the silt category by side scan sonar) comprise more than 85% of the surveyed areas in the lower 8.3 miles of the river bed, and more than 95% of the surface area when silt or silt-plus-sand categories are included."*

*Sediment dynamics in the Upper and Lower Bays of New York Harbor (*Coch, N.K., 2016), describes sediment transport characteristics with the Upper Bay/Arthur Kill and Lower Bay Regions:

> ***"****A long-term geologic and oceanographic study has provided the first holistic picture of sediment dynamics in the estuaries of SW New York state. Oceanographic data indicates that the east (Brooklyn) part of the Upper Bay is flood dominant, while the western (Staten Island) side is ebb-dominant. Bedform analysis indicates a net northerly (flood) orientation on the eastern side of the Lower Bay. The west side, in contrast, has fine sediment similar to that supplied by the Hudson River to the Upper Bay. The numerous sand borrow pits on the nearshore shelf also reflect a difference in net flow. The eastern pits are filled with shelf sands while the western ones are filled with mixtures of fine Hudson derived sediments and shelf sands. These patterns suggest flood dominant transport of shelf sands from the Lower Bay into the Upper Bay and ebb dominant supply of Hudson-derived fine material into the Lower Bay on the western side. The shelf and Hudson River Estuary are not the only suppliers of sediment to New York Harbor. The East River and Harlem Rivers have supplied significant amounts of coarse sediment to the northern part of the Upper Bay. This continued until massive stream changes in the 19th Century cut off sediment supply. The East and Harlem River sediments were deposited in a delta extending south and west of the Battery in Manhattan. Part of the relict East River material is now being reworked and moved northward by flood dominant nontidal flow along the eastern shore of the Hudson."*

Raritan Region

Ongoing research on sediment and contaminant transport in the Raritan River Estuary has observed:

> *"The import and export of sediment in the Raritan River Estuary varies in relation to the tide. Heavier tidal changes lead to the import of sediment while neap tides, when there is little change between low and high tide, lead to the export. Sediment can trap contaminants, like arsenic and mercury, which are then spread among nearby ecological systems. Although the estuary system appears to show a net import of sediment on an annual basis, the sediment transport is frequent in both directions."* (Rutgers 2021)

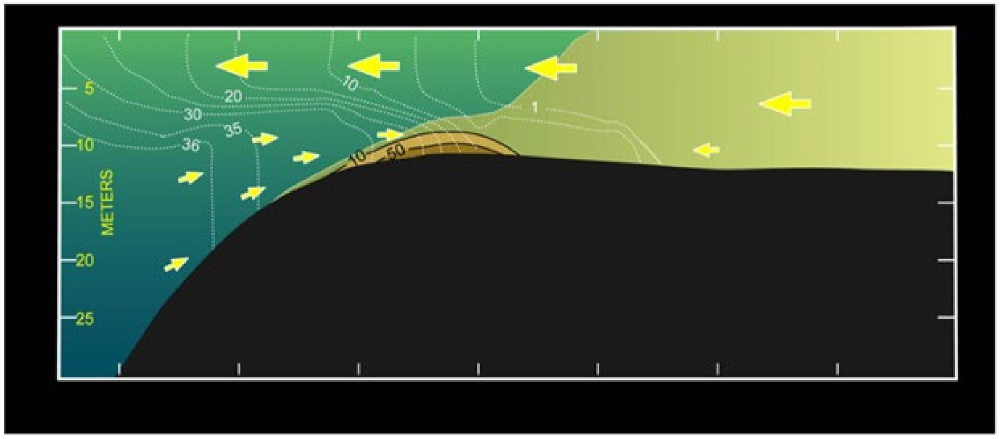


Figure 21: Depiction of Estuarine/Ocean Exchange Sediment Transport.
Source: Chant 2007

A Study titled: *Availability of Chemical Sediment and Water Quality Data for the Tidal Raritan River* (Rodenburg et al 2012) has observed:

> *"in the [estuarine turbidity maximum], contaminants that are bound to the organic matter in sediments tend to be resuspended and moved back and forth with the tides, but the particles have a difficult time escaping completely."*

Jamaica Bay

With respect to sediments within the Jamaica Bay Planning Reach, movement is restricted due to the narrow restriction of Rockaway Inlet and little to no sediment input from the watershed (due to the urbanized land uses). At the entrance to Rockaway Inlet, the prevailing currents slow as they enter the mouth of Jamaica Bay and turn to the east to again slow. This continual slowing of water movement reduces sediment transport throughout the Jamaica Bay Planning Reach. Consequently, sediments at the mouth of Jamaica Bay are primarily coarse sands and the remainder of the bay is finer silt sediments (USACE 2019).

Erosion results in slumping, undercutting, and inward retreat of peat from bank ledges along island peripheries and tidal creeks, and widens tidal channels. Remnant borrow pits and channels in the Bay, some as deep as 60 feet, are sometimes oxygen-deficient (hypoxic), affecting habitat suitability for fish and wildlife. These depressions may act as sediment sinks, trapping fine, organic sediment that otherwise may have been deposited on the surrounding wetlands, and may alter the hydrodynamics of Jamaica Bay by increasing the residence time of water as much as three-fold (Hartig et al., 2002; USFWS, 1997; USACE 2020b).

Long Island Sound Region

Sediments vary depending upon location as a result of the complex flow patterns existing within the Long Island Sound (USACE 2020b). A USGS assessment found that fine-grained sediment deposition has been observed in the central and western portions of the Long Island Sound, where accumulation occurs from relatively weak bottom tidal currents; however fine-grained sediment deposits were found to be discontinuous in areas where bottom currents caused sediment winnowing and bypassing (USGS Fact Sheet 041-98). Sidescan-sonar patterns indicated that *"sea-floor sediments are moved and deposited in the Long Island Sound estuary…provid[ing] a predictive framework for those concerned with the management and utilization of the sea floor in this urbanized area"* (USGS Fact Sheet 041-98).

Both the East River and Bronx Rivers function as tidal straits, that were historically found to provide significant amounts of coarse sediment into the Upper Bay until around the 19th century when alterations, including the construction of the Harlem Ship Canal and landfilling, altered the waterway and resulted in halting coarse sediment supply (Coch et al 2016). A study conducted in 2015 found that little sediment is passing down the East River; however erosion caused by tidal currents were found to be pulling coast sediment north along the east side of the Hudson River (Coch, et al 2015).

2.3.3 Water Quality

Major waterbodies throughout the entire Planning Region are subject to Water Quality concerns including depleted Dissolved Oxygen (DO), presence of pathogens, contaminants, and nutrient pollution. Contamination sources vary between waterway, but generally are from known contaminates sites, including Superfund designated sites, WWTP effluents, CSO, and stormwater runoff. Additional information regarding known contaminated sites within the Planning Region can be found in Appendix A9.

NJDEP and NYSDEC have established classification systems for the best intended uses of surface water quality within the area (Surface Water Quality Standards, New Jersey Administrative Code 7:9B; Water Quality Regulations, 6 NYCRR parts 700-705). These classifications are based on the extent to which these surface waters will attain the Clean Water Act goals of aquatic life support and swim ability, and the designated uses outlined by the state. Designated uses are generally based on a set of numeric and narrative water quality criteria. The classification for the major waterbodies in the NYNJHAT Study Area are shown below.

This Section will specifically discuss quantitative and qualitative water quality data taken from various sources. Reference is specifically made to the Harbor-Wide Water Quality Monitoring Report (HWQMR) 2021 completed by the Hudson River Foundation as a part of the NY/NJ Harbor and Estuary Program. The report contains data on DO, Pathogenic Bacteria (fecal coliform and Enterococcus), Nitrogen, and Chlorophyll-a that was collected from 2010-2017 in many of the waterbodies in the Study Area. That data is discussed frequently throughout this discussion. The HWQMR utilized the U.S. EPA's nationally recognized standards for DO, Nitrogen, Fecal coliform, and Chlorophyll-a to compare the recorded values. It is important to note that these values are as follows:

- DO: there are two threshold values for hypoxia: acute hypoxia, the DO level at which marine life has a greater potential to die, is indicated when water has less than 2.3 milligrams of DO per liter (mg/L); and chronic hypoxia, the continuous level at which DO hinders growth of marine life and is indicated by DO levels less than 4.8 mg/L.
- Nitrogen: levels of total nitrogen exceeding 1.2 milligrams per liter (mg/L) is considered to be poor, and levels found equal to, or less than 0.4 mg/L is considered to be good.
- Chlorophyll-a: a threshold of greater than 20 micrograms per liter (µg/L) to indicate poor quality while considering values of less than 5 µg/L as supportive of healthier habitats for fish survival and propagation.
- Fecal Coliform: fecal coliform levels should not exceed a geometric mean of 200 cfu/100mL and that no more than 10% of all samples taken in a 30-day period exceed 400 cfu/100 mL (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Hudson River

Salinity. The interaction between salt and freshwater is an important characteristic of the Hudson River Estuary. Dense saltwater from the ocean flows upstream where it meets less dense fresh water that is flowing downstream. The point of mixture forms a saltwater diffusion wedge. This mixing creates a salinity gradient measured in parts per thousand that is generally grouped into three distinct salinity zones: polyhaline (18-30 ppt), brackish (0.5-18ppt), and tidal fresh (<0.5 ppt; Limburg et al., 1986). The boundaries of the zones varies with daily and seasonal changes in the tide. Under average runoff conditions, the limit of the saltwater intrusion can typically be found 50-60 miles north of the Battery, between West Point and Newburgh, NY. Seasonal patterns in freshwater flow cause salt water to push upriver in the summer and early fall and move southward in the spring and winter months. During periods of high freshwater flow, the salt front can be pushed downstream to the Bronx (HRM 15), while during drought periods the salt front is recorded reaching Poughkeepsie, NY area (HRM 75) (USACE 2020a).

Dissolved Oxygen. DO levels in the Hudson River are typically highest during the end of winter and early spring months due to the river's decreased water temperature and salinity levels. In the summer, at increased water temperature, lower levels of DO are detected due to a lower saturation point throughout the estuary. DO levels throughout the river vary greatly dependent on location and go through peaks and valleys, and ebbs and flows. Levels of DO are typically low near the NYC area due to biological oxygen demand (BOD) associated with effluent flows from WWTPs. Typical DO levels here are between 5 and 14 mg/L (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

Essential Nutrients (Phosphorous and Nitrogen). Phosphorus enters the Hudson River estuary from sources including organic detritus, non-point source runoff, and WWTP effluents. Phosphorous inputs are greater near the mouth of the river near NYC/NJ metropolitan area in the form of CSO and WWTP effluents. This allows the lower estuary to easily meet the Phosphorous demand for algae and microscopic plant growth that form the base of the estuarian food chain. Phosphorous in this area is not predicted to be a limiting factor for biological productivity. Upriver in the freshwater portions of the estuary, phosphorous may be a limiting factor depending on the season, especially in the late summer months. Nitrogen sources for the Hudson River estuary include precipitation, decomposition of organic matter, surface and groundwater discharge and nitration fixation_(Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

Contamination/ Pathogens. WWTPs located adjacent to the Hudson River and its tributaries discharge treated effluent into the waterways. In the lower estuary, CSO discharge untreated effluent that the overflowing system cannot handle during storm events, contributing a pulse of nutrients and toxic materials to the water (USACE 2020a).

The fecal coliform summer discreet measurements in the Lower Hudson River ranged from 1 cfu/100mL to 22,000 cfu/100mL between 2010 and 2017 according to the HWQMR. With an average of 112 discrete samples per recreational season (June-September) per year, the average geomean for fecal coliform in this region is 55 cfu/100mL (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

East River (Class 1: Fishing and Boating) and Harlem River (Class 1: Fishing and Boating)

Salinity. Salinity levels in the East River are reported to fluctuate a small amount between approximately 22.11 and 27.43. The small fluctuation can be attributed to the fact that the East River has limited freshwater input (Li and Meseck).

Dissolved Oxygen. DO levels in the East and Harlem Rivers are not overly depleted, and fish in this region are not consistently stressed. In 2012, there were uncharacteristically low levels of DO recorded. Between 2010 and 2017, the percent of time DO samples were less than 4 mg/L was between 0-28% for surface DO and 0-22% for bottom DO (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

Nitrogen and Chlorophyll-a. In the HWQMR, between 2010 and 2017, the summer means for total nitrogen were reported to range between 0.39 and 2.62 mg/L, fluctuating in and out the threshold for healthy levels. Chlorophyll-a in this region showed concentrations below 5 µg/L, which indicates conditions for healthy habitat for fish survival.

Contamination/ Pathogens. Major contamination sources in the East and Harlem Rivers include CSO, contaminated sediments, industrial point source discharges, municipal discharges/WWTPs, spills/unpermitted discharges, and stormwater runoff. According to the HWQMR the average geomean for fecal coliform in this region is 70.7 cfu/100mL (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

Hackensack/Passaic Region

Hackensack River (NJ Class SE2: Fishing and Fish Propagation)

Salinity. Salinity in the Hackensack River ranges from 0 to about 24 parts per thousand (C. Woolcott, personal communication, 2004). Salinity is generally highest in late summer and fall and lowest in spring (Kraus & Bragin 1988). Tidal circulation has been modified by the Oradell Dam at the upper end of the estuary and by ditches, dikes, tide gates, dams, roadbeds, fill, and subsequent breaching of a few water-control structures. These structures drained freshwater from many areas, impounded other areas, or prevented brackish water intrusion. Until the late 1960s, most of the sewage discharged into the Hackensack River was untreated, according to a study by the Interstate Sanitation Commission (Crawford, Bonnevie, Gillis & Wenning 1994). There are now 7 sewage treatment plants, 32 combined sewer overflows and 12 emergency overflows in the Meadowlands District (Day et al., 1999). The annual range of dissolved oxygen is 1.0 to 15.5 milligrams per liter (Day et al. 1999) in the Hackensack River. Lead, mercury, zinc, chromium, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons, petroleum hydrocarbons, and dichlorodiphenyltrichloroethane (commonly known as DDT) metabolites contaminate the soils, submerged sediments, water column, and aquatic life of the Meadowlands, in some places reaching levels considered hazardous under federal regulatory standards (USACE 2020b).

Dissolved Oxygen. According to HWQMR the percent of time DO samples were less than 4 mg/L was between 15-34% for surface DO and 13-29% for bottom DO. The percent of time DO samples were less than 5 mg/L has been between 30-53% for surface DO and 31-67% for bottom DO. The Meadowlands Environmental Research Institute (MERI) also monitors approximately 14 sampling stations in this region since 2010 and has two continuous monitoring stations to measure DO at the River Barge Park Marina and Kearny, adjacent to the NJ Transit Lower Hack Bridge. Samples from MERI and the NJHDG show similar conditions for DO in the lower portions of the river, near the Meadowlands District. However, the data collected by MERI at the River Barge Park Marina, in the upper portions just above the Meadowlands District near NJHDG's station 14, show slightly lower levels of DO indicating more severe conditions. Both data sources reach the same overall conclusion the Hackensack River exhibits below desirable DO levels when compared to the SE2 criteria and more so when compared to EPA's guidance that desirable DO levels are 4.8 and 2.3 mg/L (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

Nitrogen and Chlorophyll-a. Between 2010 and 2017, the summer means for total nitrogen ranged between 1.41 and 2.51 mg/L, though daily values fluctuated over time and data was not available in 2015. Total nitrogen levels between 0.4 and 1.2 mg/L is indicative of fair conditions, and water quality would improve with nitrogen levels equal to or below 0.4 mg/L. Chlorophyll-a levels in this region shows an upward increase beginning in 2015, potentially increasing the rate of algal growth (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

Contamination/ Pathogens. The industrialized nature of the land adjacent to, and the Hackensack River itself, has left the area subject to a long history of pollution. The state reports impairments to aquatic life and fish consumption, though secondary contact recreation is deemed supported. Large portions of this region are impaired due to benzo[a]pyrene, chlordane in fish tissue, DDT in fish tissue, dieldrin, dioxin (including 2,3,7,8-TCDD), heptachlor epoxide, mercury in fish tissue, PCBs in fish tissue, and CSO (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

The HWQMR reported that the average geomean for fecal coliform in the Hackensack River is 80 cfu/100mL.

Lower Passaic River/ Newark Bay

Salinity. Salinity in Newark Bay, especially near the bottom of the water column, is high relative to the freshwater inflow to the Lower Passaic River at Dundee Dam, but it varies in response to freshwater flow and wind (Chant and Wilson 2004; Chant 2005). During low flow periods, the salinity in Newark Bay is over 20 p(ppt), whereas the salinities at the mouth of the Lower Passaic River are typically five ppt lower than Newark Bay. The salinity drops significantly as the freshwater river flow increases, i.e. during periods of higher flow. Within the Lower

Passaic River, the density contrast between the freshwater river flow and more saline water in Newark Bay interacts with the tidal input to form a partially stratified estuary. Denser saline water from Newark Bay extends upstream underneath the less dense freshwater surface layer. The tidally averaged velocity profile near River Mile (RM) 5 showed a clear residual upstream velocity near the bottom and a strong downstream velocity near the top, which is characteristic of estuarine circulation (USACE 2020b).

Dissolved Oxygen. The Lower Passaic River and Newark Bay have been with the threshold for fair amount of DO from 2010 to 2017, though some daily values were recorded below 4 mg/L during the time period. The percent of time DO samples were less than 4 mg/L was between 2-14% for surface DO and 0-15% for bottom DO. The percent of time DO samples were less than 5 mg/L has been between 7.7-22% for surface DO and 3-48% for bottom DO. This is an indication of healthy levels of DO without high fish stress (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Nitrogen and Chlorophyll-a. Between 2010 and 2017, the summer means for total nitrogen ranged between 2.35 and 3.27 mg/L. Total nitrogen levels between 0.4 and 1.2 mg/L is considered indicative of fair conditions, and water quality would improve with nitrogen levels equal to or below 0.4 mg/L. Chlorophyll-a in this region shows daily fluctuation over the eight-year period, going above and below the healthy indicative thresholds. (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021)

Contamination/ Pathogens. Major contamination sources that degrade water quality in the Lower Passaic River and Newark Bay include chemical leaks and spills, CSO, contaminated sediments, industrial post source discharge, landfills, municipal discharge and sewage, unpermitted discharges, and urban runoff. The Lower Passaic River, designated as a Superfund site, has borne a heavy burden of pollution from a long history of industrialization that has leached dioxin (including 2,3,7,8- TCDD), PCBs, arsenic, benzo[a]pyrene (PAHs), dieldrin, heptachlor epoxide, chlordane, and DDT in the waterbody. These trace contaminants are also found in fish tissue in this area. In addition to these impairments, the Lower Passaic River and Newark Bay are also affected by floatables, depleted DO, high phosphorus levels, high TSS, and basic pH levels. The U.S. EPA currently reports that aquatic life, fish consumption, public bathing, recreation, and shellfishing are impaired throughout the region (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

Upper Bay/Arthur Kill Region

Salinity. The Upper Bay represents the confluence of oceanic waters and the East River tidal strait, Kill Van Kull, and mouth of the Hudson River. These are tidally influenced waters with salinity concentrations that vary due to tidal exchange.

Arthur Kill (NY Class SD: Fish Survival and NJ Class SE2&3: Fishing and Fish Propagation/Fish Migration) / Kill Van Kull (NY Class SD: Fish Survival and NJ Class SE3: Fishing and Fish Migration)

Dissolved Oxygen. Fish in this region are not stressed due to lack of DO. The percent of time DO concentrations were less than 4 mg/L was between 0-10% for surface DO, and between 0-16% for bottom DO as report by the HWQMR.

Nitrogen and Chlorophyll-a. Between 2010 and 2017, the summer means for total nitrogen ranged between 0.68 and 1.4 mg/L, within the U.S. EPA’s thresholds for healthy levels. Chlorophyll-a in this region show decreasing values largely ranging below the 20 μg/L recommended threshold (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau 2021).

Contamination/ Pathogens. Sources for contamination in the Kills include CSO, municipal discharges/sewage, industrial discharges, stormwater runoff, spills/unpermitted discharges, contaminated sediments, chemical leaks and spills, and landfills. The state reports impairments to aquatic life, fish consumption, public bathing, recreation, and shellfishing. Due to its narrow geography and CSO between Staten Island and the coast of New Jersey, The Kills are a hotspot for pathogen loading into the waterways. Both channels are adjacent to industrial uses and former landfills, highly trafficked by commercial vessels, and have a history of unpermitted spills. The Kills are impaired due to dissolved oxygen depletion, floatables, PCBs, benzo[a]pyrene (PAHs), chlordane, DDT, dieldrin, dioxin (including 2,3,7,8-TCDD), heptachlor epoxide, hexachlorobenzene, and mercury. PCBs, chlordane, and DDT have been reported in fish tissue within this region. The average geomean for fecal coliform in this region is 53 cfu/100mL (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Upper New York Bay (NJ Class SE2: Fishing and Fish Propagation and NY Class SB: Bathing)

Dissolved Oxygen. Fish in the Upper New York Bay region are not stressed as suggested from the DO data collected from for the HWQMR. The percent of time DO measurements were less than 4 mg/L threshold was between 0-3.6% for surface DO, and between 0-9.1% for bottom DO (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Nitrogen and Chlorophyll-a. Between 2010 and 2017, the summer means for total nitrogen ranged between 0.56 and 1.15 mg/L within the U.S. EPA's outlined healthy concentrations, according to the HWQMR. Chlorophyll-a in this region has shown decreasing values since 2010 (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Contamination/ Pathogens. Major factors influencing water quality in this region include CSO, municipal discharges/sewage, industrial point source discharge, stormwater runoff, legacies of contaminated sediments, and tidal exchange with connecting waterbodies. There is also active CSO in this region, from both states. This region is impaired due to chlordane, copper, PCBs, Benzo[a]pyrene (PAHs), DDT, dieldrin, dioxin (including 2,3,7,8-TCDD), heptachlor epoxide, hexachlorobenzene, and mercury. Legacy contaminants such as PCBs, chlordane, DDT, and mercury were all found in fish tissue within this region. According to the HWQMR, the average single sample value for fecal coliform in this region is 336 cfu/100mL, well above the swim ability threshold (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Lower Bay Region

Salinity. The Lower Bay Region is characterized by freshwater sources meeting tidally influenced, salty waters. The salinities within this region vary greatly because of this. The Raritan Bay receives inputs from the Raritan River and Newark Bay and its tributaries via the Arthur Kill. Sandy Hook Bay receives inputs from the Navesink and Shrewsbury Rivers, which are wide tidal rivers (USACE 2020b).

Raritan Bay/ Sandy Hook Bay/ Lower New York Bay

Dissolved Oxygen. Fish in this region are not consistently stressed as shown by the recorded DO levels in the HWQMR that were less than 4 mg/L between 0-8.2% for surface DO, and between 0-10% for bottom DO (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Nitrogen and Chlorophyll-a. Between 2010 and 2017, the summer means for total nitrogen ranged between 0.56 and 1.03 mg/L, within the EPA's threshold for healthy concentrations. Chlorophyll-a in this region fluctuated over the eight-year period with discrete sample concentrations ranging above the 20 μg/L recommended threshold (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Contamination/ Pathogens. Major contamination sources in the Lower Bay Region include CSO, stormwater runoff, spills/unpermitted discharges, contaminated sediments, on-site waste treatment systems (such as septic systems or similar decentralized systems), and tidal exchanges with surrounding waterbodies. The majority of this region is impaired due to PCBs, benzo[a]pyrene (PAHs), chlordane, DDT, dieldrin, dioxin (including 2,3,7,8-TCDD), dissolved oxygen, total coliform, and pH. PCBs, chlordane, and DDT have been found in fish tissue within this region (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

The New York waters of Lower New York Bay are classified as I around Gravesend Anchorage and as SB further offshore in the vicinity of Ambrose Channel. SB marine waters are suitable for primary contact recreation (e.g., swimming). Fecal coliform summer discreet measurements ranged from 1 cfu/100mL to 2,000 cfu/100mL over the eight-year period as reported in the HWQMR. The average geomean for fecal coliform in this region is 8 cfu/100mL (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Raritan Region

In this region, the water column is often stratified, with the heavier saltwater lying below the lighter fresh water. This is a region of strong currents due to the interplay of the salt and fresh water and the tides, which can resuspend sediment. Also in this region, dissolved material in the river water flocculates (forms ever larger particles) when it encounters the salt wedge. The combination of these two processes form the highly organic sediment bed and also keep the total suspended solids (TSS) high (Rodenburg et al 2012).

Lower Raritan River (NJ Class SE1: Shellfish and Bathing)

Dissolved Oxygen. Fish in this region are not consistently stressed as indicated in the HWQMR by the recorded DO levels that were less than 4 mg/L was between 0-12% for surface DO and 0-16% for bottom DO (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Nitrogen and Chlorophyll-a. Between 2010 and 2017, the summer means reported in the HWQMR for total nitrogen ranged between 2.39 and 4.27 mg/L (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Contamination/ Pathogens. The economic prosperity that the Raritan brought to the region was threatened in the 1920s by uncontrolled and accelerated industrial toxic waste disposal in the river. This was further exacerbated by unregulated sewage outflows with growing populations in the area. In 1997, the Raritan was the 14th most polluted river in the United States. It had over 200 identified contaminated sites within its watershed, 24 of them being federally managed Superfund sites. Fish within the lower Raritan River have been known to have the following contaminants found in their tissues: Chlordane, DDT, mercury, and PCBs. Other issues plague the water including: benzoa pyrene, chlordane, DDT, dieldrin, dioxin, Enterococcus bacteria, heptachlor epoxide, mercury, Polychlorobenzines, arsenic, benzene, phosphorous, TSS, temperature, and pH. Sampling data reported in the HWQMR showed the geometric means for Enterococcus were above the threshold for allowable primary contact recreation in most years between 2010 and 2017 (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Jamaica Bay Region

Salinity. Jamaica Bay itself drains an area of approximately 132 square miles within the larger Southern Long Island watershed. The bay is a saline to brackish, nutrient-rich estuary covering almost 40 square miles (USACE 2020b).

Dissolved Oxygen. DO levels in Jamaica Bay varied daily throughout the eight-years evaluated in the HWQMR, but summer means are found to be above the 4-5 mg/L recommended threshold. This causes fish in this are to be consistently stressed (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Nitrogen and Phosphorous. While nitrogen and phosphorus are characteristically limiting nutrients in estuarine ecosystems, their quantities within Jamaica Bay are exaggerated by WWTP inputs. As such, nutrient loading can lead to eutrophication. High nitrogen levels can also decrease root production in salt marsh plants, and in turn decrease their ability to accumulate organic material and hold sediments within tidal marshes. High nitrogen levels also increase microbial decomposition, reducing the accumulation of organic matter and limiting the ability of saltmarshes to maintain an elevation that keeps pace with RSLC (USACE 2020b).

Contamination/ Pathogens. Almost the entire Jamaica Bay watershed is urbanized such that Jamaica Bay receives pollution from point and non-point sources around the bay including CSO effluent, surface run-off, leachate from landfills, and other sources. Specifically, 240–340 million gallons per day of treated sewage effluent flow into Jamaica Bay from four WWTPs (GNRA 2013). This continues to be a major source of pollution, including treatment byproducts such as chlorine, and heavy metals and other contaminants that are not eliminated by water treatment facilities (NPCA 2007a). In addition, large rain events can overwhelm the sewer system capacity, resulting in untreated wastewater and raw sewage (USACE 2020b).

Long Island Sound Region

Bronx River/ Western Long Island Sound

Salinity. The salinity of Long Island Sound averages between 27 and 32 ppt, but varies depending on proximity to freshwater tributaries, and generally there is a gradient of increasing salinity from west to east (Cornell Cooperative Extension Marine Program 2021). The headwaters of the Bronx River are at Davis Brook and the Kensico Dam and extend to the mouth between Hunts Point and Clason Point along the East River. The northern portion of the river upstream of East Tremont Avenue is freshwater. South of this point, the river is tidally influenced and generally brackish (NYC DEP 2022).

Dissolved Oxygen. Fish in this region are consistently stressed as indicated by the samples reported in the HWQMR. From 2010 to 2017, the percent of time DO samples were less than 4 mg/L was between 1-20% for surface DO and 11-40% for bottom DO. The percent of time DO samples were less than 5 mg/L has been between 22-52% for surface DO and 45-58% for bottom DO (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Nitrogen and Chlorophyll-a. According to the HWQMR, between 2010 and 2017, the summer means for total nitrogen ranged between 0.76 and 1.11 mg/L. Total nitrogen levels between 0.4 and 1.2 mg/L is indicative of fair conditions. Water quality is expected to improve with nitrogen levels equal to or below 0.4 mg/L. Chlorophyll-a in this region shows great fluctuation over time, with high levels beginning in 2014. Concentrations of chlorophyll-a during the summer season, where blooms are often, were found to be above 20 µg/L which indicate conditions for increased algal bloom growth, and decreased quality for fish spawning (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

Contamination/ Pathogens. Major factors influencing water quality in this region include CSO, municipal discharges/sewage, industrial point source discharge, stormwater runoff, spills/ unpermitted discharges, streambank erosion, habitat alteration, and flow alterations from water diversions. The state reports impairments to aquatic life, fish consumption, public bathing, recreation, and shellfishing. Use of these public resources has been lost due to low dissolved oxygen, fish passage barriers, floatables, pathogens, and nitrogen (Da Silva, Dujardin, White, Christiana, Pirani, Strehlau, 2021).

The average geomean for fecal coliform in this region is 65 cfu/100mL as reported by the HWQRM, under the swim ability threshold.

2.3.4 Regional Ecosystems (NYBEM)

The New York Bight Ecological Model (NYBEM, sounds like “nigh-bem) is a suite of numerical models developed to articulate and quantity mechanisms of environmental effects of propose CSRM alternative plans in the region; specifically, the NYNJHAT and New Jersey Back Bays Feasibility Studies. The primary focus of the NYBEM relates to aquatic systems is challenging due to the large spatial scale of the Study, variable data availability, potential effects of management actions over long time scales. The NYBEM assesses changes in habitat quantity and quality associated with changing hydrodynamic conditions in six major ecosystem types: freshwater tidal (fres.tid), estuarine intertidal (est.int), estuarine subtidal (est.sub), marine intertidal (mar.int), marine subtidal (mar.sub), and marine deepwater (mar.deep). Detailed model descriptions are available via online documentation (https://mvr-gis.github.io/NYBEM-Report/), all model code is contained within a “package” for the

R Statistical Software language (https://github.com/MVR-GIS/nybem/), and the details of application to the NYNJHAT Study are summarized in Appendix A11.

NYBEM was developed following a five-step process that is discussed in greater detail in Appendix A11. In addition, four workshops with technical stakeholders informed all aspects of model development.

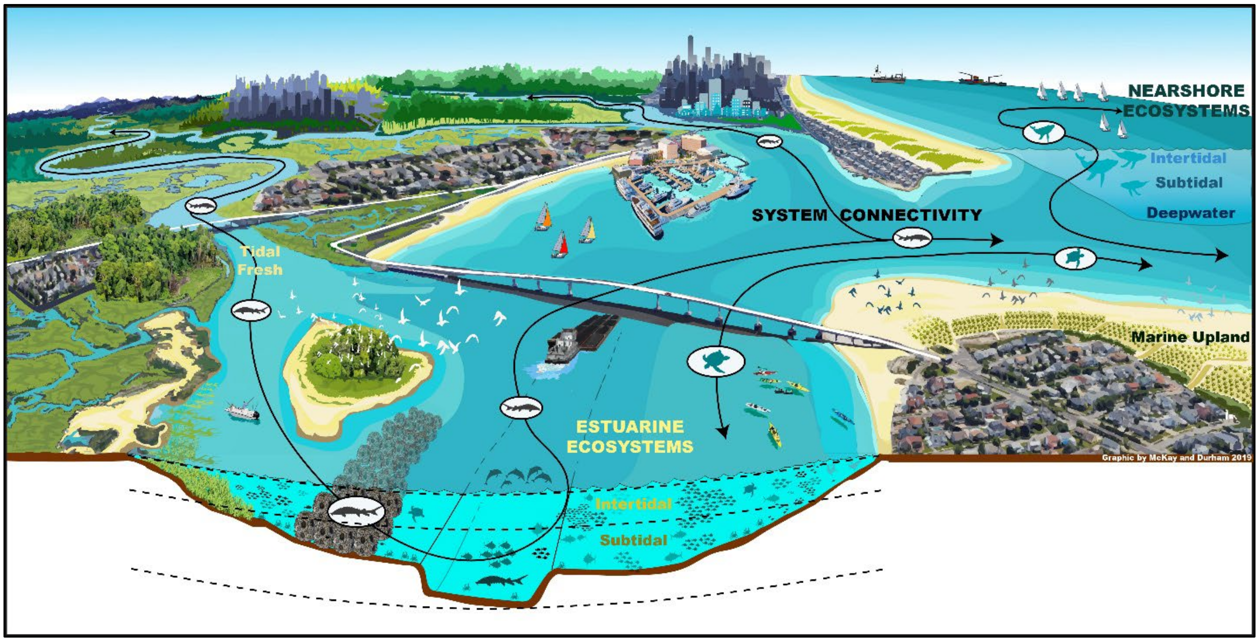
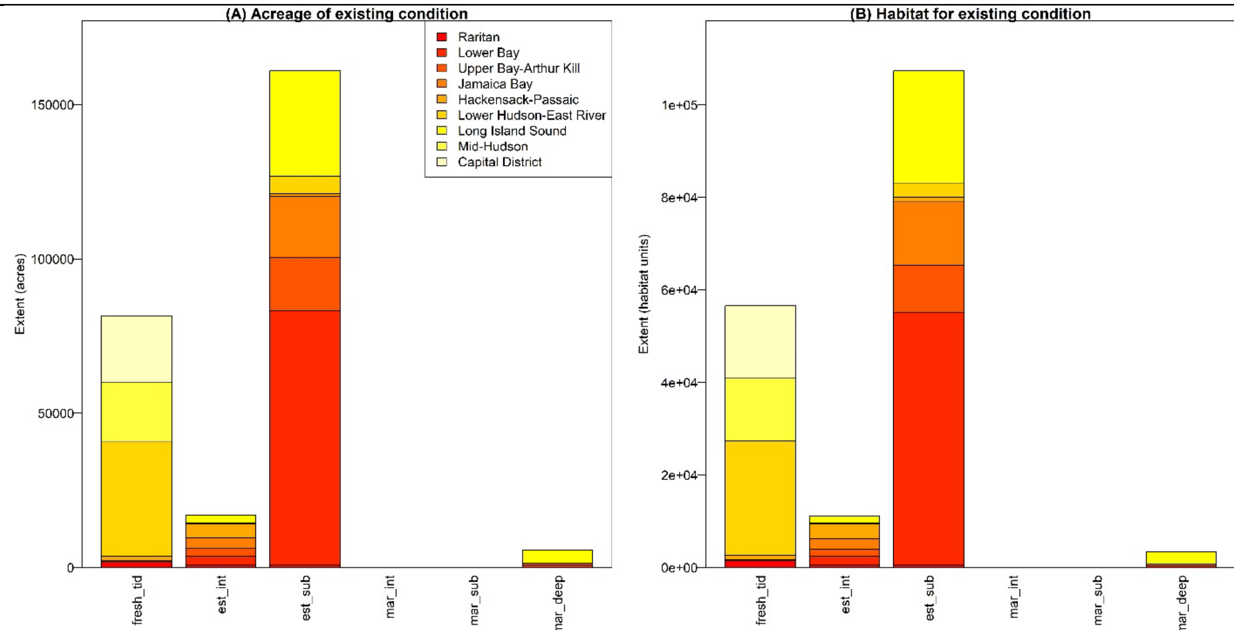


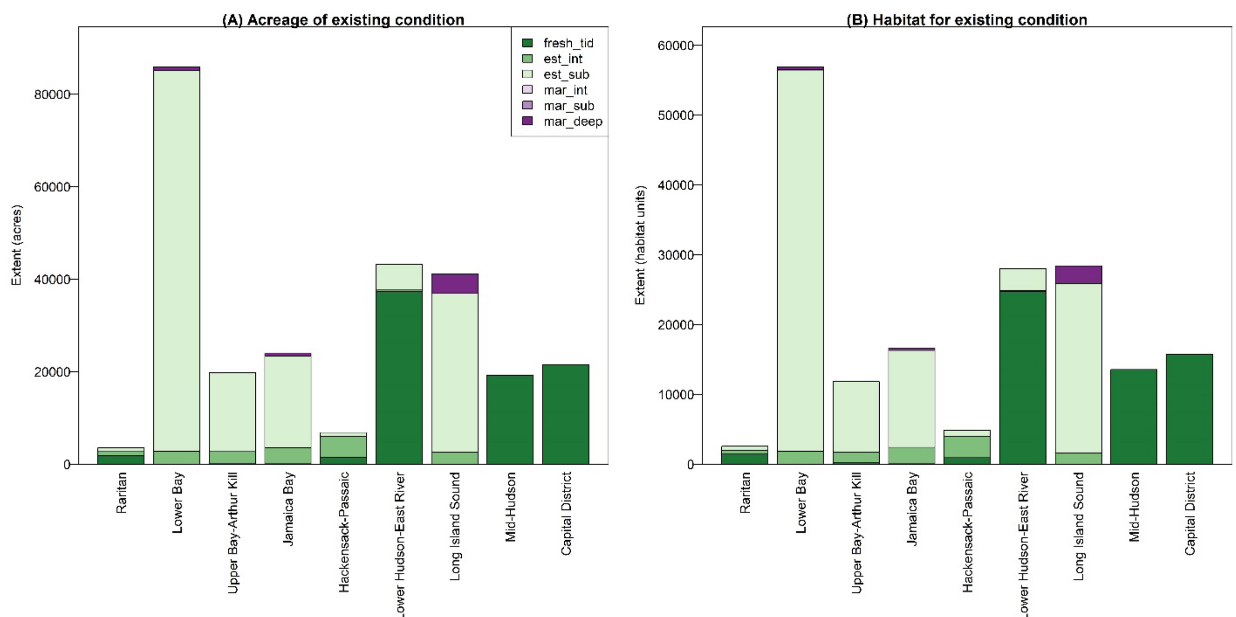
Figure 22: Conceptual model describing the general approach of the New York Bight Ecological Model (NYBEM).

The existing condition for regional ecosystems in the NYNJHAT Study Area was summarized based on NYBEM outputs. Specifically, two outcomes are presented as general summary metrics. First, the extent of a given ecosystem type (in acres) is presented based on NYBEM's tidal, salinity, and habitat zones. This metric provides a general overview of the types of habitats expected within a region (e.g., marine deepwater habitats in the Lower Bay vs. freshwater tidal habitats upstream on the Hudson River) and the order-of-magnitude of their spatial coverage. Second, NYBEM was used to assess the quality of these habitats, and the data are summarized as "habitat units," which represent the product of habitat quantity and quality for each grid cell in the landscape. These units can be thought of as the extent of an ecosystem (in acres) scaled down by the quality of each patch. Notably, the terms habitat suitability and ecosystem condition are used synonymously here to reflect a general notion of the ecological quality of a system scaled from 0 to 1.

Acreage and habitat units were summarized for each ecosystem type across the Study Area as a whole. Based on the salinity criteria used in NYBEM, the Study Area contains small amounts of marine ecosystems with no observed marine intertidal or marine subtidal habitats. This finding emphasizes the important role of freshwater inputs from the Hudson River and other major waterways and generally reflects the focus of the location of the Planning Regions within this major estuary complex. Estuarine subtidal areas provide the greatest coverage in across the region (over 150,000 ac) with notably large patches in the Lower Bay, Upper Bay, Jamaica Bay, and Long Island Sound regions. Freshwater tidal areas are the second largest ecosystem type with large expanses extending up the Hudson River and other freshwater sources. Estuarine intertidal zones represent a smaller fraction of the total area, but a key ecological transition zone and location of potential effect.

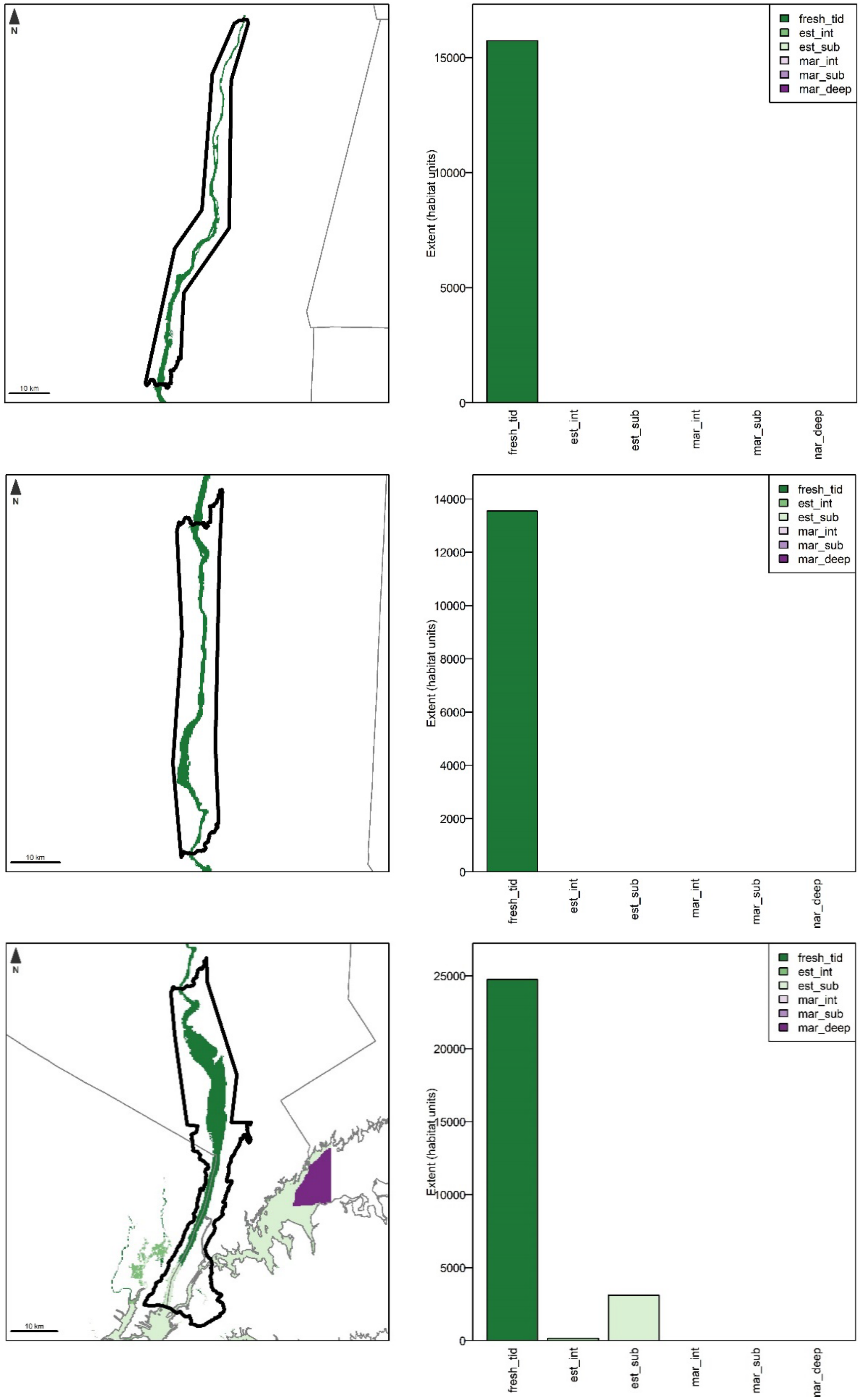


NYBEM estimates were also output by Planning Region to show the distribution of ecosystem types within a region and provide a point of comparison among regions. The largest extents of habitat are in the areas with the largest open water zones (i.e., Lower Bay, Long Island Sound, and the Lower Hudson – East River). Habitat quantity and quality, however, show different trends in the system. The overall magnitude of habitat is reduced from the extent of an ecosystem, and in some cases (e.g., Lower Hudson – East River), the distribution of habitat within the region is quite different in light of habitat quality. Some regions contain relatively homogeneous habitats (e.g., along the Hudson River and Lower Bay), whereas others are quite diverse (E.g., Hackensack-Passaic, Jamaica Bay). The following Sections describe ecosystem condition at more local scale of the Planning Regions.



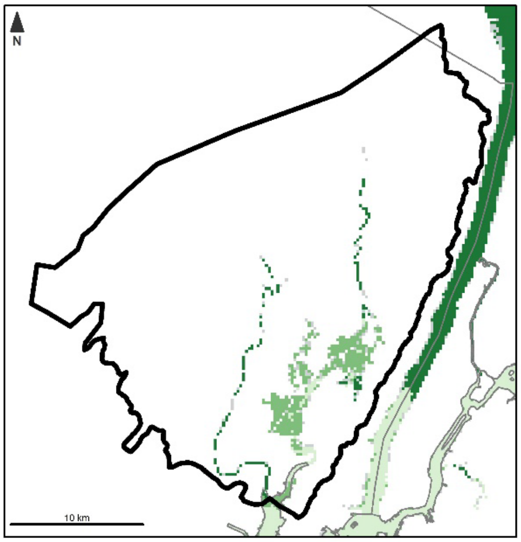
Capital District, Mid-Hudson, and Lower Hudson-East River Regions

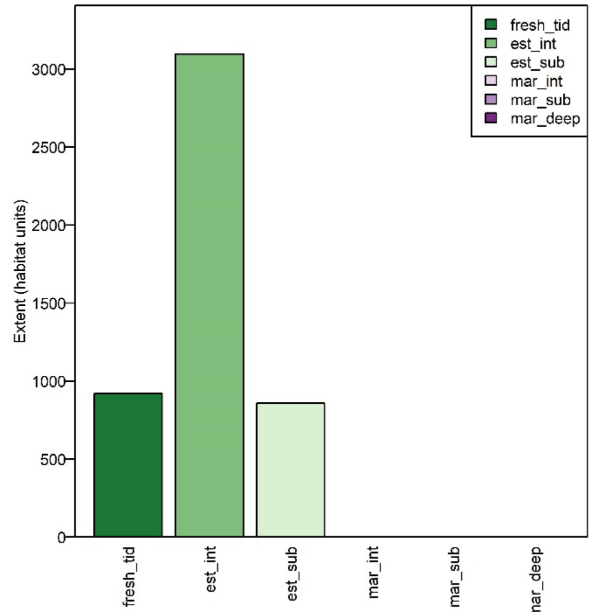
Unsurprisingly, the Hudson River corridor is the primary location for tidal freshwater systems in the Study Area. In particular, the fringing marshes of the Hudson River cover large areas of more than 16,000 habitat units. As the river enters the city, the salinity regime shifts into estuarine conditions, and the deeper subtidal waters of the harbor are the major ecosystem type. The extent of estuarine intertidal habitat is relatively limited due to urban land use pressures around the metropolitan area.



Hackensack-Passaic Region

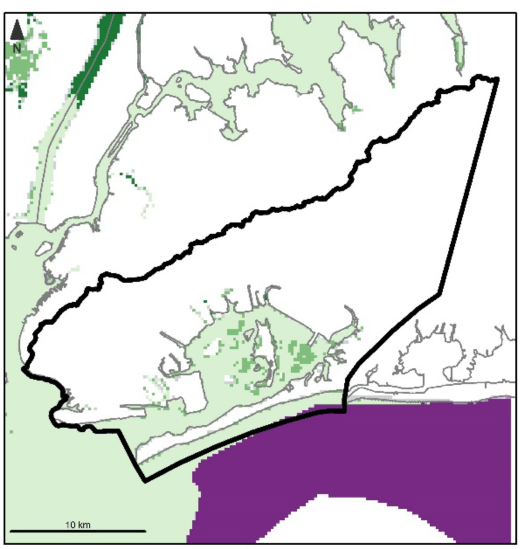
The Hackensack-Passaic region provides the largest extent of estuarine intertidal habitat in the Study Area (over 3,000 habitat units). The upstream portions of the system are tidal freshwaters, while the downstream areas are estuarine subtidal zones.

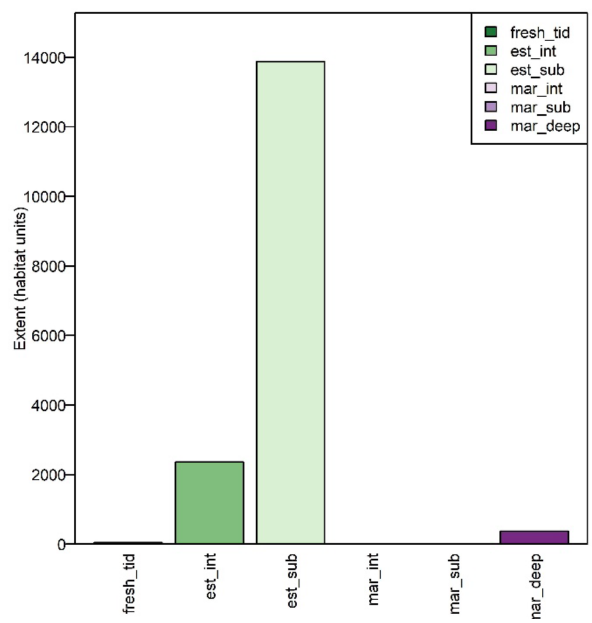




Jamaica Bay Region

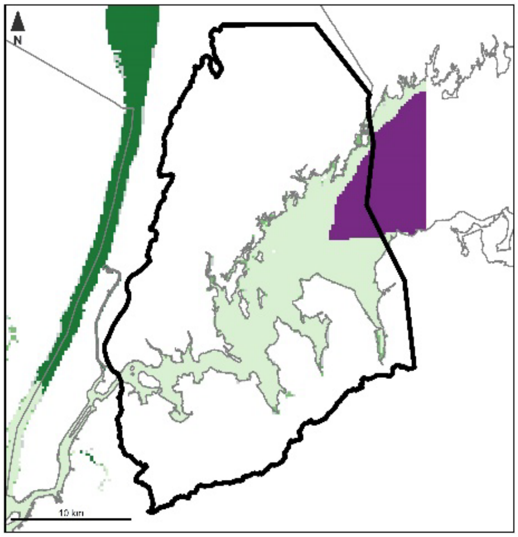
This region provides large expanses of estuarine subtidal areas, primarily in the more sheltered bayside system. The estuarine intertidal areas are fringing marshes and marsh island systems. The marshes areas are relatively narrow, given adjacent urban land use pressures. A small amount of marine deepwater is included in this region, although that is largely an artifact of the region boundaries extending south into the Atlantic Ocean.

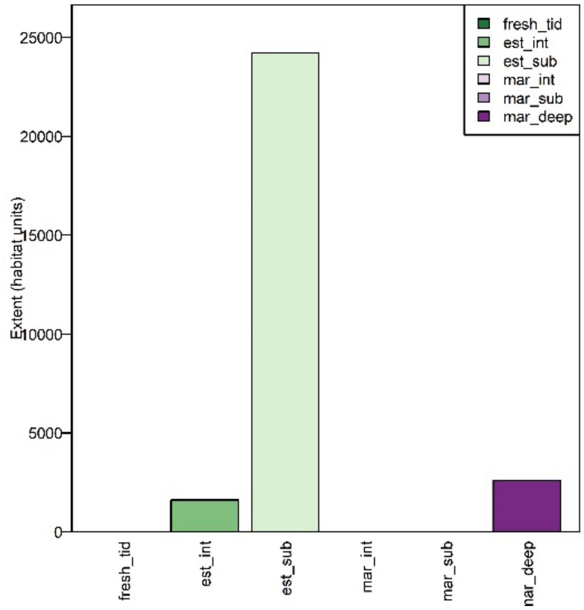


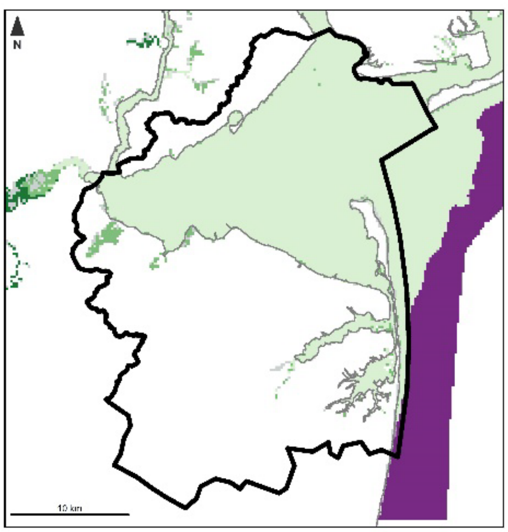


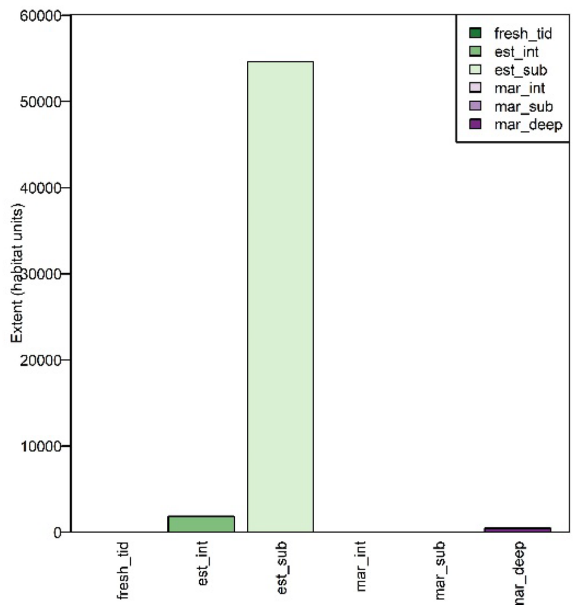
Long Island Sound, Lower Bay, and Upper Bay-Arthur Kill Regions

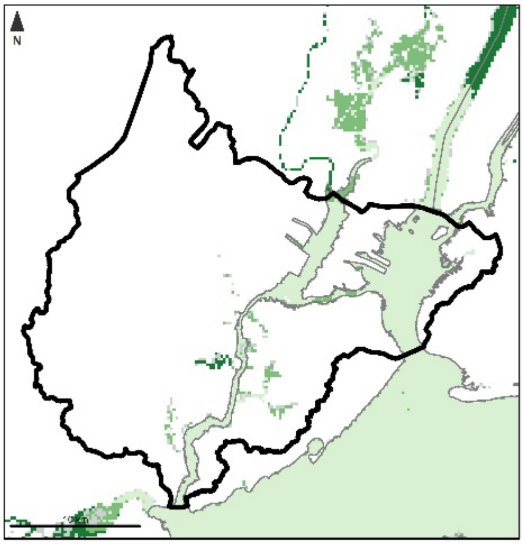
These three regions contain distributions of ecosystem types with large segment of estuarine subtidal systems connecting to marine deepwater and fringed by estuarine intertidal areas. All three regions have large amount of estuarine subtidal habitat (i.e., 20,000, 5,000, and 9,000 habitat units, respectively). These systems are also directly within the harbor environment and experience high use rates from commercial and recreational vessels as well as other forms of development intensity.

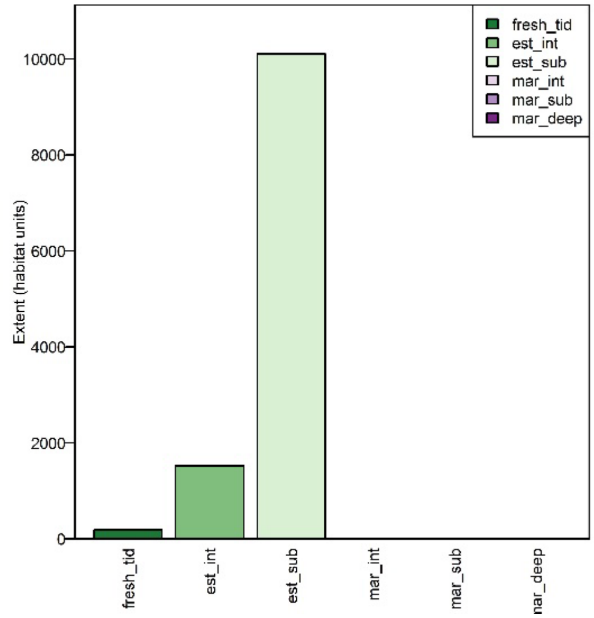






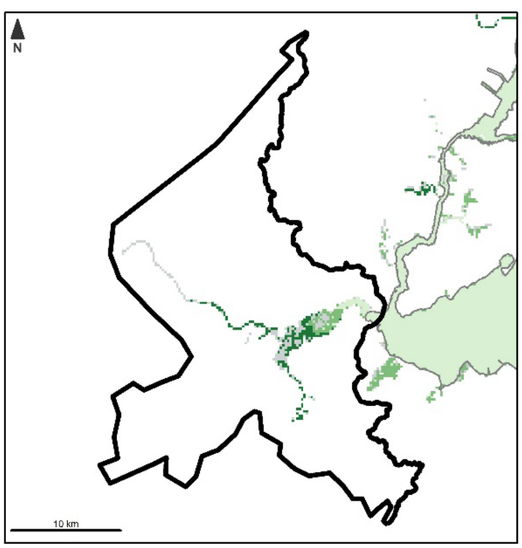


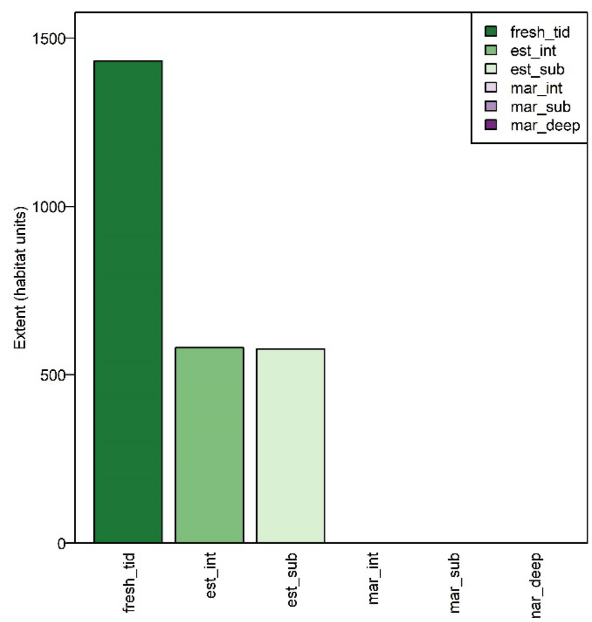




Raritan Region

The region has the most balance composition of estuarine habitats in region showing the transition from relatively freshwaters in upstream areas to brackish waters near the Lower Bay. The overall extent of these ecosystems is, however, significantly small than other portions of the NYNJHAT Study Area (i.e., on the order of hundreds of habitat units rather than thousands or tens of thousands).





2.3.5 Air Quality and Clean Air Act

The following discusses existing conditions based on the “project area”, which encompasses the Federal Action’s location within attainment or non-attainment areas. An attainment area is defined as a “geographic area in which levels of a given criteria of air pollutant (e.g., ozone, carbon monoxide, particular matter (PM)2.5, etc.) meet the health-based National Ambient Air Quality Standards (NAAQS)” (23 CFR 450). A non-attainment area is a geographic area in which air pollutant(s) do not meet the health-based NAAQS. It is possible for a Project Area to be in an attainment area for one or more pollutant, and also be in a non-attainment area for other pollutant(s).

The NYNJHAT project area is located in counties that are part of the New York, Northern New Jersey, Long Island, and Connecticut ozone nonattainment area. This area has been designated with the following attainment status with respect to the NAAQS for ozone: ‘moderate’ nonattainment for the 2015 8-hour ozone standard, ‘serious’ nonattainment for the 2008 8-hour ozone standard. In addition, a number of the counties have been designated a ‘maintenance’ area for the 2006 particulate matter less than 2.5 microns ($PM_{2.5}$) standard, and a ‘maintenance’ area for the 1971 carbon monoxide (CO) standard (40 CFR §81.331). The project area is also part of a larger Ozone Transport Region. Oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) are precursors for ozone, while sulfur dioxide (SO_2) is a precursor pollutant for PM2.5. The NYNJHAT project area is in attainment of the NAAQS for all other criteria pollutants.

Emissions from Federal Actions such as the NYNJHAT project, are regulated under 40 CFR §93 Subpart B, General Conformity, which aims to ensure that emissions from Federal Actions do not impede a state’s progress toward achieving or maintaining compliance with NAAQS under their applicable State Implementation Plan (SIP). Projects with emissions below specified threshold levels are not subject to requirements beyond documentation of the de mininis level of emissions. The relevant threshold levels for the current nonattainment status of the project area are the following:[5] 50 tons per year (tpy) of NO_x or VOCs in a serious O_3 nonattainment area, 100 tpy of $PM_{2.5}$, SO_2, NO_x, VOCs, and ammonia in a $PM_{2.5}$ maintenance area, and 100 tpy of CO in a CO maintenance area (https://www.epa.gov/general-conformity/de-minimis-tables). Emissions from construction of the NYNJHAT project will be below all of these de minimis levels on a yearly basis. Refer to Appendix A6 for additional information.

Greenhouse Gas

The generation of greenhouse gas (GHG) emissions associated with the project’s construction activities will be temporary in nature, spanning only the construction period. The primary GHG emitted from diesel-fueled equipment is carbon dioxide (CO_2). Although nitrous oxides (N_2O) and methane (CH_4) have significantly higher global warming potentials (298 times CO_2 for N_2O and 25 times CO_2 for CH_4)[6], they are emitted at significantly lower rates, resulting in minimal fractional increases in carbon dioxide equivalents (CO_2e) when compared with CO_2 alone. Refer to Appendix A6 for additional information.

2.3.6 Climate and Climate Change

The context of this Section is primarily focused on the existing conditions for how climate and climate change may impact resources within the Study Area including wildlife, vegetation, special status areas, and the human environment (among many other relevant resources). Effects of climate change depend on a multitude of factors including past and present trends and behaviors. The USACE Engineering and Construction Bulletin (ECB) *Guidance For Incorporating Climate Change Impacts To Inland Hydrology in Civil Works Studies, Designs, and Projects* (ECB 2018-04) requires consideration of climate change in all current and future studies to reduce vulnerabilities and enhance the resilience of communities. Engineering Regulation *Incorporating Sea Level Change in Civil Works Programs* (ER 1100-2-8162) provides guidance for incorporating the direct and indirect physical effects of projected future RSLC across the project life cycle in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects.

Climate

[5] https://www.epa.gov/general-conformity/de-minimis-tables

[6] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020*, April 2022.

Much of the Study Area experiences similar climate conditions between the nine Planning Regions, except for those located furthest north, such as the Capital District Region and Mid-Hudson Region which tend to experience shorter summers and longer winters. Climate considerations of the Planning Regions are discussed in more detail below and are grouped based on similar conditions.

Hurricane season in the northeastern United States occurs between June 1 and November 30 each year. On average hurricane season, based on a 30-year analysis from 1991 to 2020, may include approximately 14 named storms and 10 hurricanes, three of which may be classified as major hurricanes (Category 3-5 on the Saffir-Simpson Hurricane Wind Scale). Between 1944 and 2020, the greatest hurricane and tropical storm activity has been observed during the September and October months (NOAA NWS 2022). In the past 10 years, eight hurricanes affected the NYNJHAT Planning Region, including Hurricane Irene (2011), Sandy (2012), Florence (2018), Isaias (2020), Zeta (2020), Elsa (2021), Henry (2021), and Ida (2021), the most recent three of which occurred in the same year (NOAA 2022). Four tropical storms also affected the NYNJHAT Planning Region within the last 10 years, including Tropical Storm Andrea (2013), Ana (2015), Fay (2020), Fred (2021) (NOAA 2022). Hurricane Sandy hit the Planning Region at nearly high tide. Waves eroded beaches, breached boardwalks, and seawalls, and broke against buildings in the oceanfront communities. Storm water inundation reached as much as 10 feet above ground in some portions of the Planning Region. In addition, more than 1.5 million cubic yards of sand was torn from Rockaway Beach and deposited on oceanfront communities or washed out to sea (USACE 2019).

Climate Change

Terrestrial, marine, and freshwater ecosystems are reportedly altered by climate change due to rising air, water, ocean, and ground temperatures that contribute to changes to habitat and mortality of wildlife species as discussed in more detail in the IPCC report:

“Extreme heat and precipitation trends on land have increased vegetation stress and mortality, reduced soil quality and altered ecosystem processes including carbon and freshwater cycling. Warm and dry conditions associated with climate change have led to tree die-offs and increased prevalence of catastrophic wildfire with an increase in the size of severely burned areas in western North America…Among thousands of species spread across terrestrial, freshwater, and marine systems, half to two-thirds have shifted their ranges to higher latitudes, and approximately two-thirds have shifted towards earlier spring life events in response to warming.”

North America has reportedly experienced high or very high climate change related impacts to terrestrial, freshwater, and ocean ecosystem structure and species range shifts, as well as adverse impacts on health and wellbeing (infectious diseases, heat, malnutrition, mental health, and displacement), adverse impacts on cities, settlements, and infrastructure (inland flooding and associated damage, flood/storm induced damages in coastal areas, damaged to infrastructure, and damages to key economic sectors) (IPCC 2022).

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The climate of these Planning Regions is characterized by long, cold winters and short warm summers. The mean annual temperature for this region is approximately 40° F. The normal annual temperature during the winter months is about 25° F, and during the summer months it is about 70° F to 75° F. Annual precipitation, in rainfall, for much of these Planning Regions is approximately 41 inches. This area receives about 10.5 inches of precipitation during the spring and again in the fall, about 9 inches during the winter, and 11.5 inches during the summer. The mean annual snowfall for the entire Hudson River Basin varies from about 100 inches in the northern regions to about 20 inches in the lower reaches near New York City. Storms occurring in this region are transcontinental and extratropical. The transcontinental storms come from the Gulf of Mexico and the west, often in the spring, while tropical storms and hurricanes generally occur in the fall, from the Atlantic Ocean. Thunderstorms and cloudbursts usually occur during the summer months (USACE 2020a).

Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, and Raritan Region

The climate of these Planning Regions is characterized as warm and temperate, with four months of summer (June through September). The average annual temperature is approximately 52.9 degrees F, ranging from an average of 29.5 degrees F to 75.7 degrees F, although winter temperatures below freezing and summer temperatures above 80 are common. January is recorded as the coldest month. Rainfall and snowfall can be significant with approximately 45 inches of precipitation each year. Humidity is relatively stable throughout the year, ranging from an average of approximately 63 to 71%.

Hurricane Sandy caused extensive damage along the Atlantic shoreline, within coastal wetlands and freshwater surface waters within the Planning Region. The Atlantic shoreline, including Coney Island in New York, Sandy Hook, and areas south to Manasquan Inlet in New Jersey, experienced changes to the shore profile and loss of beach fill and erosion, with an estimated average drop in beach elevation of five to 10 feet. Locations which previously supported dunes prior to the storm lost up to 100% of existing dunes (including dune vegetation), which is critical habitat for nesting seabirds, and feeding and roosting migratory shorebirds (USACE 2020b). Significant amounts of sand overwashed into the streets of many coastal residential areas at least 60 to 150 feet inland, including the Borough of Atlantic Highlands, New Jersey, the private community of Sea Gate, New York, and Staten Island Borough (USACE 2020b). Sandy Hook was exposed to the full power of the tidal surge and the worst of the storm's winds. The shore profile was completely changed and sand dunes along the peninsula were pushed up to several hundred feet west. Many dunes were completely flattened, uprooting and dispersing the beach grass normally found on them and likely affecting the bird species that use them for breeding. In addition to the overwash of sand and beach erosion, many coastal areas, such as Coney Island, were inundated and sustained damages to residential buildings and waterfront structures including boardwalks, concrete walls, roads, and other coastal infrastructure. In the private community of Sea Gate, the waterfront bulkhead and the first row of residential buildings were severely damaged by storm waves (USACE, 2012). Coastal wetlands within Raritan Bay and on Staten Island experienced damage caused by the tidal surge and debris. Reportedly, small mammal populations were eliminated in many areas, creating a food shortage for northern harriers, a New York State threatened species, and New Jersey State endangered hawk species (USACE 2020b). Approximately 100,000 tons of debris was deposited in Cheesequake State Park. This debris layer, composed mostly of reeds and other vegetation, combined with tires, duck blinds, and other manmade structures is expected to inhibit vegetation growth, impacting invertebrate communities (e.g., fiddler and marsh crabs) as well as kingfishers, herons, gulls, and other marsh-dependent birds that feed upon them (ALS, 2012). Maritime holly (*Illex opaca*) and red cedar (*Juniperus virginiana*) forests in Sandy Hook survived the storm. However, there was extensive damage to Atlantic white cedar (*Chamaecyparis thyoides*) swamp forests in Cheesequake State Park, including saltwater intrusion, blow-down trees, and the creation of canopy gaps. More than 300 trees were lost, including 100-year old oaks and numerous Atlantic white cedars (USACE 2020b).

Jamaica Bay Region and Long Island Sound Region

Similar to other Study Planning Regions, the climate of these Planning Regions are characterized as warm and temperate. Average temperatures range from approximately 30.3 degrees F to 76 degrees F, although winter temperatures below freezing and summer temperatures above 80 are common. January is recorded as the coldest month. The NYC Metropolitan area experiences a significant amount of rainfall each year, averaging at about 45 inches, and ranging from approximately 2 to 4 inches per month. Humidity is relatively stable throughout the year, ranging from an average of approximately 64 to 71%.

A structural damage assessment of impacts related to Hurricane Sandy was conducted by the NYC Department of Buildings post-storm, finding that 37% of the total count of buildings damaged throughout New York City were located in southern Queens. Structural impacts were caused by waves, inundation, and fires ignited by storm surge into electrical systems that destroyed approximately 175 homes in the Rockaway Peninsula (USACE 2019 and SIRR 2013). Hurricane Sandy floodwaters also funneled through Rockaway Inlet amassing a storm surge that inundated all the neighborhoods surrounding Jamaica Bay. The low-lying neighborhoods in the central and northern portions of Jamaica Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (A line) disrupted service for over six months affecting about 35,000 riders daily.

In the southern Queens portion of the Planning Region 37 schools were closed for up to two months (USACE 2019).

2.3.7 Cultural Resources

As a federal agency, USACE has certain responsibilities for the identification, protection and preservation of cultural resources that may be located within the Area of Potential Effect (APE) associated with the proposed project. Present statutes and regulations governing the identification, protection and preservation of these resources include the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969; Executive Order 11593; and the regulations implementing Section 106 of the National Historic Preservation Act of 1966 (36 Code of Federal Regulations Part 800, Protection of Historic Properties, August 2004). A historic property is defined as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places (NRHP), including artifacts, record, and material remains related to such a property or resource. Cultural resources include historic properties as well as other cultural aspects of the human environment. This work is done in coordination with the State Historic Preservation Offices of New Jersey and New York, federally recognized Tribes, and interested parties. The New York District carried out a phased review of existing surveys and historical documentation as part of the Tier I EIS to identify cultural resources within the Planning Region including previously recorded historic properties and properties with the potential to be eligible for the National Register of Historic Places to inform an initial assessment of potential impacts that the proposed undertaking may have on cultural resources within the APE. The APE represents the physical extent of the undertaking within which direct and/or indirect effects of the construction, operation, and maintenance of the project could be caused to the character or use of a historic property. For this project, the APE includes all areas directly impacted by construction of project features including but not limited to floodwalls, levees, bulkheads, deployable barriers, Storm Surge Barriers, ringwalls, road raisings, elevations and Natural and Nature Based Features as well as construction access and staging areas and, as required, environmental mitigation measures. The APE also includes viewsheds and landscapes adjacent to the project features, additional discussion of the visual APE the viewshed analysis can be found in the Cultural Resource Appendix A8.

In assessing the impacts of the project alternative plan it is also important to acknowledge that cultural resources within the low lying coastal areas of the Planning Region are vulnerable to the impacts of storm surges, flooding, and sea-level rise. These types of exposures can diminish the physical and historic integrity of archaeological sites, historic buildings, and cultural landscapes through physical damage or destruction. Integrity is essential for historic properties to retain their designations as National Historic Landmarks, State / National Register listed or eligible resources, NYC Landmarks, and / or NPS parks or site units, examples of all of which are present throughout the Study Area.

Aboveground Resources

World Heritage Sites. Two United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Sites are in the Planning Region: the Statue of Liberty National Monument (1984) and the Guggenheim Museum in the 20th-Century Architecture of Frank Lloyd Wright (2019) (UNESCO 2022).

Traditional Cultural Properties. A Traditional Cultural Property (TCP) is “one that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in the community’s history, and (b) are important in maintaining the continuing cultural identity of the community” (Parker and King 1998:1). At present a list of properties of traditional religious and cultural importance has not been quantified for the Planning Region. The Stockbridge Munsee consider Papscanee Island, located on the Hudson River just two miles south of Albany and within the Capital District Region, to be a traditional historic property of religious and cultural significance and the New York State Office of Parks, Recreation and Historic Preservation has, under those criteria, determined the site eligible for the National

Register of Historic Places. If additional TCPs are present, they may be associated with Native American Nations, as well as ethnic groups related to more recently arrived populations from Europe, Asia, Africa, South America, and Australia, along with those from elsewhere in North America.

Ethnographic Resources. In NPS parlance, ethnographic resources are "sites, structures, objects, landscapes, and natural resources or features of traditional importance to a contemporary cultural group through associations three generations or more in length" (Rockman et al. 2016:19). At present, these resources are not quantified for the Study Area. If present, they may be associated with Native American Nations, as well as ethnic groups related to more recently arrived populations from Europe, Asia, Africa, South America, and Australia, along with those elsewhere in North America.

Cultural Landscapes. A cultural landscape is "a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person, or exhibiting other cultural or aesthetic values" (NPS 2021). The NPS defines four types of cultural landscapes, which are not mutually exclusive: Historic Designed Landscapes; Historic Sites; Historic Vernacular Landscapes; and Ethnographic Landscapes. At present, cultural landscapes are not well-quantified for the Study Area.

Museum Collections. The NYNJHAT Study Area contains numerous museum collections associated with the rich and varied cultural history of New York and New Jersey, the United States, and other collections from around the world. Museum collections are housed in various types of buildings and storage facilities. The buildings housing these collections are often historic properties or historic sites that range from a small historic house museum such as the Wyckoff House Museum in Brooklyn, an NHL and the first building to be designated a New York City Landmark, to The Metropolitan Museum of Art, the largest art museum in the Western Hemisphere. There are approximately 145 museums in New York City alone.

Archaeological and Submerged Resources

National Register Listed and Eligible Resources: New York Study Area. According to the NYSHPO's Cultural Resource Information System (CRIS), more than 64,400 National Register listed or eligible resources are in the NYNJHAT Study Area. This includes 426 archaeological sites (138 listed and 288 eligible), 63,666 individual aboveground historic resources (51,127 listed and 12,539 eligible properties), and 332 historic districts (202 listed and 130 eligible). There are an additional 1,504 known archaeological sites that have yet to be investigated to determine whether they are eligible for NRHP.

New York State Museum Archaeological Sites. The NYSM has records for 450 archaeological sites and 712 archaeological areas in the Planning Region.

National Register Listed and Eligible Resources: New Jersey Study Area. The State of New Jersey has approximately 1,765 National Register listings (NPS 2022b). This includes archaeological sites, individual historic resources, and historic districts. NJSHPO datasets were not available for review as part of this Tier 1 EIS therefore only listed sites are quantified at this time. The number of NRHP-listed and eligible properties in or partially in the Study Area shall be ascertained in the next phase of the NYNJHAT Study, Tier 2 EIS. A large portion of New Jersey's urban, industrial, and population centers are in the Study Area and a proportional number of its historic properties are likely contained therein.

Submerged Cultural Resources. The submerged cultural resources portion of the Direct APE is defined as the depth and breadth of the geographic areas potentially affected by any bottom-disturbing activities. The marine Direct APE also includes maritime cultural resources landward of the shoreline (i.e., onshore) and resources offshore of the New York-New Jersey Harbor and tributaries.

The New York State Office of Parks, Recreation, and Historic Preservation (NYSOPRHP) has information on more than 1,000 shipwreck sites and reported losses, though there may be as many as 10,000 shipwrecks in state waters (NPS 2022a). There are an estimated 3,000 shipwrecks wrecked and sunk in New Jersey waters

(NPS 2022b). This general summary addresses the potential of identifying submerged cultural resources in the NYNJHAT Study Area and methods to be used in future maritime archaeological investigations after the Project Alternative is implemented.

There are two kinds of historic resources that might be impacted underwater on the U.S. Continental Shelf: submerged Native American sites and shipwrecks. The latter is deposited by sinking, and the former were inundated and buried by rising sea levels during the latest Pleistocene and Holocene times. Shipwreck archaeology is a well-developed discipline, with decades of advancements of method and theory. Submerged prehistoric site archaeology is, on the other hand, a nascent discipline, but it is increasingly clear to historic resources managers that these sites need study in several types of submerged settings, especially offshore New York and New Jersey (Panamerican Consultants [Panamerican] 2020:3).

Potential For Encountering Submerged Native American Sites. Preceramic-period sites in the Northeast are most often found on the high ground of major river terraces, often at confluences, overlooking wide expanses of land. Drainages at these times were larger, longer, and more vigorous, swollen by glacial meltwater that could move glacial outwash boulders, cobbles, and pebbles—accumulations of which have the potential to provide lithic resources. As sea levels rose, the mouths of rivers were drowned; creating bays, estuaries, and salt marshes that migrated over the low slope of the retreating coastal plain. Some of these settings would have been attractive to humans for settlement or exploitation. Lee and back-bay settings such as these may also serve to preserve sites as estuarine sedimentation protects earlier or contemporary deposits from transgressive erosion (Panamerican 2020:17).

While analysis of magnetic and sidescan sonar data with respect to historic archaeological sites entails observing individual objects recorded in the data, the identification of potential prehistoric archaeological sites via a remote sensing survey is more complex. Current remote sensing technology cannot identify existing submerged archaeological sites with any frequency. Instead, the data are used to identify submerged and buried landforms that are likely to have been used for habitation when the area was exposed such as terraces, or features formed by human behavior that are large enough to be remotely sensed, namely shell midden feature (Panamerican 2020:17).

Paleolandscapes can be exposed and apparent on the seafloor during examination of sidescan sonar data, but others are buried under layers of marine sediments; in which case, penetration of the seabed by subbottom profiler is necessary for assessment (Panamerican 2020:18).

Analysis of seismic data utilizes criteria such as linearity, strength of reflection (as indicated by the darkness and thickness of reflectors), and uniformity of reflector patches to determine differences in the stratigraphy. Strong reflectors are indicative of sediment characteristics that reflect more sound energy and will typically show up as lines of high contrast in the subbottom image, including indurated surfaces or peat beds (Plets et al. 2007). Likewise, weaker reflectors are indicative of sediments that attenuate the sound with little reflection, particularly sand and shell beds (Panamerican 2020:18).

Areas of interest for Native American archaeological sites include the margins of stream channels, lakes, ponds, other bodies of water, and the margins/shoals of estuarine environments. Channel facies will show up as a series of concave-shaped reflectors. Other potential reflectors include deltaic features (wedges) and foreset beds that are indicated by the presence of alternating layers of varying reflective properties with indicated slope (Panamerican Consultants 2020:18).

Modeling For Native American Sites in Submerged Setting. In principle, there are three types of data that can help model for where submerged prehistoric sites might be in any specific setting: local geology; local RSLC history; and local culture history (Faught and Gusick 2011).

Knowing the geology of the NYNJHAT project area locations and the local history of RSLC will establish what areas in the vicinity of the project areas were available for occupation and when. Under a “terrestrial analog” modeling methodology, like that used by Faught (2004) or that discussed by Benjamin (2010), likely areas for habitation or exploitation along the Atlantic seaboard tend to be found in settings that are near water (rivers, lakes, and wetlands) and usually in places of moderate to no slope. Coastal occupations, like those expected in the survey area, produce weir features and midden deposits that are likely in paleoestuary settings, in the lee of paleobarrier features, and, of course, on the margins of paleochannels. While there is no direct method of remote sensing submerged prehistoric artifacts or sites, geophysical data, sidescan sonar, and subbottom profiler geophysical devices are critical for identifying preserved paleolandscape features like river pathways and estuarine deposits potential for prehistoric archaeological sites (Panamerican 2020:3).

The potential for any submerged prehistoric resource within the NYNJHAT Study Area is directly related to the geomorphology of the ocean bottom and is the result of past landscapes altered by post Pleistocene sea-level changes and subsequent marine processes. The configuration of the seafloor is reflective of a number of processes, including multiple glacial advances, isostatic rebound (uplift), subsequent marine incursion (and loading), and modern seafloor processes. Data to reconstruct this geological history have come from cores, seismic remote sensing, and sediment studies Panamerican 2020:3).

Archaeological Site and Shipwreck Inventory. Studies of ship losses have been conducted for the New York Harbor area, which demonstrate that numerous vessels have been lost since the early seventeenth century. Vessel types spanning every era in U.S. History have traversed the waters off New York, making it a haven for a variety of shipwreck sites, many still undocumented and unidentified.

Estimates of the number of shipwrecks in the region run from the hundreds into the thousands. The Long Island and New Jersey coastlines form the two sides of a “funnel” directing traffic into New York’s great harbor and have witnessed more shipwrecks than anywhere else along the East Coast of the United States, with the possible exception of Cape Hatteras, along the Carolina Outer Banks [Sheard 1998:8].

A number of sources have been written concerning the history of the approach to New York Harbor and the subsequent loss of numerous vessels due to foul weather, lack of navigational aids, marine accidents, or simply grounding-out near the surf zone (followed by the subsequent degradation of the hull if the vessel could not be removed). Rattray (1973:50) mentions that the southern shore of Long Island is well known for shifting sandbars that parallel the whole length of the island. Any and all of these factors helped to make both the approach to New York Harbor and the harbor itself a haven for shipwreck disasters (Panamerican Consultants 2020:35). For further discussion of the analysis of the shipwreck probability modeling see the Cultural Resource Appendix A8.

Hudson River’s Submerged Heritage. From Troy Dam to George Washington Bridge, a rich heritage of maritime history lies beneath the Hudson River Estuary. For as many as 12,000 years before European colonization the Hudson River had a vital role in Native American life as an important natural resource and for inter-village trading (Hudson River Maritime Museum [MRMM] n.d.]). Since the early 17th century, the river has influenced the development and expansion of the United States as well as served as a link for domestic and international shipping trade. Recent archaeological and historical research suggests that the Hudson River embodies an unprecedented repository of undisturbed shipwrecks which represent Euro-American commerce, military operations, technical developments, and social history (MRMM n.d.]) For further discussion of the Hudson River’s submerged heritage, please see the Cultural Resource Appendix A8.

The bed of the Hudson River is primarily the property of New York State administered by the New York State Office of General Services (NYS OGS). The Abandoned Shipwreck Act of1987 – along with other New York State statutes, rules, regulations and case law – establishes that title and responsibility for these submerged resources rests with New York State.

Study Area Submerged Resources in New York. Of the 1,930 archaeological sites in the Study Area that are cataloged in the NY SHPO CRIS, at least 68 are shipwrecks. Neither CRIS nor the NYSM site database has listings for off-shore Native American sites in the Study Area. NOAA’s ENC database lists 711 shipwrecks in the Study Area, of which 562 are in New York State.

Landmarks

National Historic Landmarks (NHLs). National Historic Landmarks are historic properties that illustrate the heritage of the United States. There are currently more than 2,600 NHLs designated which represents an outstanding aspect of American history and culture (NPS 2022a). There are many types of NHLs which include historic buildings, sites, structures, objects, and districts. Only 3% of properties on the National Register of Historic Places are NHLs. Nationally significant properties convey important stories that have meaning for all Americans, regardless of where they live. A nationally significant property may:

- Be the location of an event that had a significant impact on American history overall.
- Be the property most strongly associated with a nationally significant figure in American history.
- Provide an outstanding illustration of a broad theme or trend in American history overall.
- Be an outstanding example of an architectural style or significant development in engineering.
- Be part of a group of resources that together form a historic district.
- Be a property that can provide nationally significant archeological information

New York State has 275 NHLs, approximately 168 (or 61%) of which are in the Study Area. New York County has 92 NHLs, the highest concentration of NHLs in both the state and the Study Area. Two of these are transportation-related resources which are in both New York and New Jersey: Palisades Interstate Park (Hudson River) and the Holland Tunnel (NPS 2022a). The State of New Jersey has 58 NHLs, of which approximately 22 (34%) are in the Study Area. Other NHL property types in the Study Area include military, maritime, manufacturing, recreational, residential, educational, and religious.

New York and New Jersey Study Area: National Park Service Sites, National Heritage Areas, State Heritage Areas, and New York City Landmarks

National Park Service Sites. NPS properties are administered by the federal government. NPS sites in the Study Area contain a wide variety of cultural resources and historic landscapes. Fourteen NPS Sites are in the NYNJHAT Study Area, eleven of which are in New York City. The NPS organizes twelve parks, including Castle Clinton, the African Burial Ground, and the Statue of Liberty into a grouping of sites called the National Parks of New York Harbor which together represent over 400 years of American history. By far the largest NPS park in the Study Area is the Gateway National Recreation Area (GNRA) which spans 27,000 acres from Sandy Hook in New Jersey to Breezy Point in New York City. In addition to the NYNJHAT the Study Area includes three additional Heritage Areas; The Maurice D. Hinchey Hudson River Valley National Heritage Area, the Erie Canal National Heritage Corridor, and the Crossroads of the American Revolution Heritage Area. For more on NPS Land within the Study Area refer to the Special Status Areas Section.

New York State Heritage Areas. The Heritage Area System (formerly known Urban Cultural Park System) is a state-local partnership established to preserve and develop areas that have special significance to New York State. Heritage Areas encompass some of the state’s most significant natural, historic, and cultural resources. Sections of five NYS Urban Heritage Areas are within the study; these include Harbor Park (New York City), Ossining, Kingston, Albany and Hudson-Mohawk-River Spark (Troy). The western end of the Long Island North Shore Heritage Area is also in the Study Area (NYS OPRHP 2022). USS Slater is a heritage site moored on the Hudson River in Albany, it is the last remaining WWII Destroyer Escort now a floating museum.

New Jersey Women’s Heritage Trail. The Study Area includes sites in the New Jersey Women's Heritage Trail. The Trail uses historic places to communicate the collective story of women, both famous and private, who contributed to the agricultural, industrial, labor, and domestic history of the state (NJ SHPO 2005; 2020b). One example in the Study Area is Women’s Federation Memorial in Palisades Interstate Park, Bergen County. The New Jersey Federation of Women's Clubs played a key role in saving the Palisades. The Trail also recognizes women associated with the history of National Historic Landmarks and national Park sites such as at Sandy Hook, Gateway, NRA and Ellis Island.

New York City Landmarks. The NYNJHAT Study Area in New York includes all five boroughs of New York City, which encompass approximately one million buildings of innumerable types and combination of uses (City of New York 2013:2019). The New York City Landmarks Preservation Commission (LPC) administers the city's Landmarks Preservation Law. It is responsible for protecting New York City's architecturally, historically, and culturally significant buildings and sites by granting them landmark or historic district status and regulating them after designation (NYC LPC 2022). According to the Landmarks Law, the purpose of safeguarding the buildings and places that represent New York City's cultural, social, economic, political, and architectural history is to:

1. Stabilize and improve property values;
2. Foster civic pride;
3. Protect and enhance the city's attractions to tourists;
4. Strengthen the economy of the city; and
5. Promote the use of historic districts, landmarks, interior landmarks, and scenic landmarks for the education, pleasure, and welfare of the people of the city (NYC LPC 2022).

NYC LPC landmarks are designated in four categories: individual landmarks, interior landmarks (i.e., building interiors), scenic landmarks, and historic districts. The National Register is separate from the LPC although many of New York City's individual landmarks and historic districts are also listed on the National Register. There are more than 37,600 landmark properties in New York City, most of which are in 152 historic districts and historic district extensions in all five boroughs (NYC LPC 2022). The NYNJHAT Study Area includes all the NYC boroughs. Most NYC LPC landmarks are concentrated in the boroughs of Manhattan and Brooklyn.

NYC LPC Scenic Landmarks designation requires an outdoor site meet the following criteria: it must be at least 30 years old; have "a special character or special historical or aesthetic interest or value as part of the development, heritage, or cultural characteristics of the City, state, or nation;" and be a landscape feature or aggregate of landscape features. All eleven NYC Scenic Landmarks are in the Study Area. These include seven in Manhattan: Central Park, Grand Army Plaza, Bryant Park, Verdi Square, Morningside Park, Riverside Park, and Fort Tyron Park (Hudson River). The other four scenic landmarks are in Brooklyn: Prospect Park, Eastern Parkway, Coney Island (Riegelmann) Boardwalk (Lower New York Bay & Atlantic Ocean), and a historic Parkway.

Approximately 29 NYC Landmark individual properties and historic districts have been identified as partially in or adjacent to the 100-m Direct APEs for the project alternative plans (see Appendix A8).

2.3.8 Native American Lands

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, Raritan Region, Jamaica Bay Region, and Long Island Sound Region

There are no Native American lands within or near the Study Area. Native American Lands, or Indian Land, is typically either fee land purchased by tribes or land held in trust by the U.S. government. Federally Recognized Tribes whose ancestral lands include all or a portion of the Study Area include the Delaware Nation, the Delaware Tribe of Indians, and the Stockbridge Munsee Community Band of Mohican Indians. The Delaware Nation is based today in Anadarko, Oklahoma, the Stockbridge Munsee Community Band of Mohican Indians is situated in Shawano County, North central Wisconsin, and the Delaware Tribe of Indians in Bartlesville, Oklahoma.

At present a list of properties of traditional religious and cultural importance (Traditional Cultural Properties) has not been quantified for the Study Area. The Stockbridge Munsee consider Papscanee Island, located on the Hudson River just two miles south of Albany and within the Capital District Region, to be a traditional historic property of religious and cultural significance and the New York State Office of Parks, Recreation and Historic Preservation has, under those criteria, determined the site eligible for the National Register of Historic Places.

2.3.9 Hazardous, Toxic, and Radioactive Waste

Hazardous, toxic and radioactive waste (HTRW) is defined by Engineer Regulation 1165-2-132 as:

> *"Except for dredged material and sediments beneath navigable waters proposed for dredging… hazardous, toxic and radioactive waste includes any material listed as a "hazardous substance" under the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. 9601 et eq (CERCLA)."*

CERCLA, commonly known as Superfund, was enacted by the U.S Congress on December 11, 1980 and provides the U.S. Environmental Protection Agency the funds and authority to remediate contaminated sites where there is no identifiable responsible party. CERCLA was enacted to provide the necessary funds to protect human health and the environment, identify responsible parties to pay for remediation of sites, involve communities in the process, and return contaminated sites to productive uses (USEPA 2020a).

The NYNJHAT Study Area predominantly covers the NYC Metropolitan Area, where many federal and state listed known contaminated sites, and other related sites of interest, are prevalent throughout. Engineer Regulation 1165-2-132 states that HTRW collocated within the Alternative footprints must be avoided where feasible, and where they cannot be avoided, those sites must be remediated at 100% nonfederal cost prior to construction. The costs and complexities of remediation will likely impact the local sponsors' ability to expedite plan features located within HTRW sites. The Tier 1 HTRW assessment consisted of a broad level analysis utilizing federal, state, and local records obtained for each Planning Region where Alternative measures are located and identifying which of those sites may be collocated within the Alternative footprints with a potential to impact or be impacted by nearby HTRW sites. Since the Alternative plans are concentrated in the southernmost Planning Regions, and no measures are proposed in the Capital District Region or Mid-Hudson Region that would have HTRW sites collocated within the Alternative footprints, this summary focuses on the existing conditions of Planning Regions where Alternative measures are proposed. Below is a brief summary of HTRW sites within the vicinity of Alternative footprints within relevant Planning Regions. Refer to Appendix A9 for additional details and figures with approximate locations of mapped sites.

Capital District Region and Mid-Hudson Region

Several major power generating facilities, manufacturing plants, petroleum terminals, cement, and aggregate plants, as well as various mining operations, are located along the banks of the Hudson River. Many of the river's tributaries were historically dammed for industrial use. Unregulated discharge of polychlorinated biphenyls (PCBs) from two General Electric capacitor manufacturing plants in the non-tidal river above Troy Lock and Dam between 1947 and 1977 contaminated sediments and has resulted in PCB uptake by Hudson Estuary biota, especially striped bass and other commercially and recreationally significant sportfish (USACE 2020a). The U.S. EPA concluded that contaminated sediments in the upper Hudson River are a major source of PCBs for the entire river environment at least as far as New York Harbor, and the Contaminant Assessment and Reduction Project (CARP) identified the upper freshwater non-tidal portion of the Hudson River Superfund Site, which includes 200 miles of the Hudson River between Hudson Falls and the Battery, to be the dominant external source of PCBs to the New York/New Jersey Harbor Estuary. This portion was contributing about three-quarters of the PCB load below Troy Dam to the Atlantic Ocean, and modeling showed these PCBs were transported throughout the entire estuary, including Newark Bay (USACE 2020a).

Lower Hudson/East River Region

The borough of Manhattan and the surrounding areas are extremely urbanized with large areas of residential, commercial, and industrial properties. The majority of the major HTRW sites are located in Manhattan, western portions of Brooklyn and Queens, and across the Hudson River into New Jersey. Major HTRW sites identified include Radiac Research Corp., All County Environmental Service Corp., Grand Street Mercury, Hoboken Auto Body, Inc., City Chemical Corp., Con Edison NYC Steam Explosion, Hudson River PCBs, and Federated Metals

Corporation. HTRW sites are present throughout the Region, rather than concentrated in only a few locations or industrial parks. Many leaking storage tanks were identified as potentially occurring within the vicinity of Alternative footprints, the majority of which are observed in Manhattan, Brooklyn, the Bronx, Queens, and Hudson County New Jersey. Refer to Appendix A9 for additional details and figures with approximate locations of mapped sites.

Hackensack/Passaic Region

This region is comprised of present day and historically significant industrial areas along the Hackensack River, Passaic River, and Newark Bay as well as within the cities of Newark, Elizabeth, Bayonne, and Jersey City. The area is predominantly comprised of several chemical, herbicide, paint, and pigment manufacturing plants, petroleum refineries, and other major industrial facilities. Historical unregulated discharges from these industrial manufacturing facilities have caused degraded sediment quality and contamination including dioxins, mercury, lead, polychlorinated dibenzofurans, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and DDT, posing threats to human and ecological health (USACE 2020b).

Several National Priority List sites and known contaminated sites are located within the Hackensack/Passaic Region. One National Priority Site, the Diamond Alkali Superfund Site (Diamond Alkali) is comprised of four operable units that extend throughout the region for the main plant (OU1), the lower 8.3 miles of the Lower Passaic River (OU2), the Newark Bay Planning Region (OU3), and the entire 17-mile Lower Passaic River Planning Region (OU4). The main plant of the Diamond Alkali was added to the National Priority List in 1984 and was located at 80 Lister Avenue in Newark, New Jersey along the western shore of the Passaic River. The Diamond Alkali was historically known for the manufacturing of agricultural chemicals and herbicides used in the production of “Agent Orange”. Agent Orange manufacturing polluted the surface and subsurface of the plan grounds in addition to the Passaic River which drains south into Newark Bay. Although production of Agent Orange ceased in the 1970s, adverse effects of manufacturing processes are still present to this day. Due to the known pollution concerns, NJDEP prohibits the consumption of fish or shellfish from the Lower Passaic River and Newark Bay (USEPA 2022). The Newark Bay Planning Region was added as an Operable Unit of the Diamond Alkali in 2004, including Newark Bay, Arthur Kill and Kill Van Kull channels and portions of the Hackensack River. In 2007, a remedial investigation work plan for the Newark Bay Planning Region was prepared and included investigation goals to determine the horizontal and vertical extent of Diamond Alkali contamination by sampling for several contaminants including, but not limited to, polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, pesticides, and metals. Currently, remedial investigation of the Newark Bay Operable Unit is still in progress under the oversight of the U.S. EPA. Additional Diamond Alkali study information and plans are located on the Newark Bay Study website: www.ournewarkbay.org. Other National Priority List and known contaminated sites present within the vicinity are discussed in more detail in Appendix A9 including Frey Industries, Federated Metals Corp, Riverside Industrial Park, Diamon Head Oil Refinery, The Passaic River Sediment Superfund Site, PJP Landfill, Berry’s Creek Drainage Basin, Arsynco Inc., Universal Oil Products, and Scientific Chemical Processing Inc. Recently, the U.S. EPA announced the Lower Hackensack River from Oradell Dam to the mouth of the River at Newark Bay, has been added to the Superfund National Priorities List for sediment contamination related to a long history of industrial activity in Bergen and Hudson County (USEPA 2022). Refer to Appendix A9 for additional information.

Upper Bay/Arthur Kill Region

This Region is highly urbanized and includes significant industrial areas, containing a large number of major HTRW sites present throughout the Region rather than concentrated in only a few locations or industrial parks. Several Superfund NPL sites and Corrective Action sites were identified in the nearby vicinity of Alternative measures including Hudson River PCBs, a Diamond Alkali Superfund Site Operable Unit, Pierson’s Creek, White Chemical Co., Gowanus Canal, Jewett White Lead, and several Hudson County Chromate Sites. The NYNJHAT Study Alternative Plans have been placed to avoid some of the major industrial areas in Port Newark, Elizabeth, NJ, and northern Staten Island, NY which reduces some of the potential for HTRW sites to be collocated with the proposed measures. Refer to Appendix A9 for additional details and figures with approximate locations of mapped sites.

Lower Bay Region

The Lower Bay Region has a relatively low density of major HTRW sites in comparison to other Planning Regions (Hackensack/Passaic and the Upper Bay Regions). Perth Amboy and South Perth Amboy have several mapped HTRW sites along the waterfront and with HTRW related activities along the shoreline. The ocean/bay facing properties have a significant history of military activity with a 19th and 20th century fortress. Based on the presence of these fortifications, UXO may be present along the coastlines. Corrective action and/or Superfund NPL sites identified within this Region include the International Flavors and Fragrances, Inc., Raritan Bay Slag/National Lead site, and Atlantic Salt site. State listed remedial sites identified within this Region include the Harborside at Hudson's Ferry, Keyport Waterfront Park, Sanitary Landfill, and McWilliam Stadium. Refer to Appendix A9 for additional details and figures with approximate locations of mapped sites.

Raritan Region

The Raritan Region ranges from predominantly industrial development with bulk-headed shorelines and piers at the river's mouth to a mix of industrial, commercial, and residential development farther upstream. Several State listed known contaminated sites are present throughout this Planning Region including a landfill, the former Raritan Arsenal, and the Sayreville and Werner generating stations which are located along the Raritan River shoreline (USACE 2020b). A review of HTRW sites within this Planning Region were focused to the footprint and surrounding vicinity of potential Alternative measures, in the South River/Sayreville area of New Jersey. No major HTRW were identified in these areas, however a concentration of minor sites, spills, and leaking underground storage tanks were observed in South River, New Jersey. Refer to Appendix A9 for additional details and figures with approximate locations of mapped sites.

Jamaica Bay Region

Jamaica Bay, and specifically the Brighton Beach area, contains a mix of urban and light industrial uses. Rockaway has a significant number of historic spills and leaking tanks, but most of these are anticipated to be located adjacent to roads and not directly along the beach or shoreline. Nine historical fire control stations and naval shore batteries, one of which is reported as having unexploded ordinance, are located along the barrier coastline. Coastal unexploded ordinance may either be associated with the fire control station(s) or associated with dredging operations or storm events that bring debris from the near shore to the beach. All construction along the beach, especially within 0.25 miles of the former fire control stations should considered unexploded ordinance to be a potential hazard and utilize clearing operations to assure working areas are clear for construction. Refer to Appendix A9 for additional details and figures with approximate locations of mapped sites.

Long Island Sound Region

Much of the Long Island Sound Region is characterized by highly urbanized, but not highly industrialized, uses. The coastline appears to have less major HTRW sites than other regions within the NYNJHAT Planning Region. Three major nearby sites include a landfill (Pelham Bay Landfill), lagoon (College Point Lagoon), and a federal facility (Fort Totten). The majority of other related sites of interest include drycleaners, auto service stations, formerly utilized defense sites (Pelham Camp and Fort Schuyler), and the Sylvania Corning Nuclear Lab. Several Corrective Action and/or national priority list sites were listed in the federal and state record databases in the Port Washington area, however only one of these sites was mapped, identified as the Edmos Corporation which stored and treated hazardous wastes pre-1980s. Refer to Appendix A9 for additional details and figures with approximate locations of mapped sites.

2.3.10 Navigation

The navigable waterways within the NYNJHAT Study Area are largely used routes for vessel traffic. The ports of New York and New Jersey are the largest on the East Coast and the channels used as pathways to them are widely utilized between several different types of vessels. Currently, the types of vessels regularly calling to this area are 31% pleasure craft, 19% container ships, 15% sailing vessels, 7% oil/chemical tankers, and 4% passenger ships (marine traffic, 2022).

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

The navigable waterways in the Capital District Region and the Mid-Hudson Region are in suburban areas encompassing the entirety of the Hudson River from Highland Falls up to Troy, New York. While the Lower Hudson/East River Region encompasses the entirety of the highly urbanized city of Manhattan with the remainder of the Hudson River on the Western side and the East River on the Eastern side. USACE maintains a federal navigation channel in the Hudson River from Troy Lock and Dam to the New York-New Jersey Harbor, and periodically dredges the channel between Albany and New York City to a depth of 32 feet. There is currently an active dredged material placement area on Houghtaling Island on the southern part of Schodack Island State Park (USACE 2020a). River obstructions that created topographic relief, like reefs, shallows, and rocks, were dredged or blasted to create a continuous, navigable channel through Hell Gate (USACE 2020a).

Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, and Raritan Region

The Lower Passaic River has a federally authorized navigation channel from River Mile (RM) 0-15.4, which was constructed at the end of the 19th century, then sporadically maintained through the 1950s above RM2 and through 1983 below RM2. When maintenance dredging stopped, sediment infilling rates in the artificially deep channel were relatively high (approximately 4 inches /year from historical bathymetry data). However, as the deep channel has filled in, the river has begun to reach a quasi-steady state, with overall patterns of infilling slowing considerably and alternating with some scouring during high flow events (Sea Engineering, et.al. 2011).

The Upper Bay/Arthur Kill Region is a major navigational hub in the region, with connections to the Hudson River, East River, Kill van Kull channel, and the Verrazano Narrows Bridge. This region is where most of the shipping ports are located for international shipping. More about shipping within the ports and waterways of the Upper Bay/Arthur Kill Region could be read in Chapter 2. In addition to commercial vessels that frequent shipping terminals along most of the shoreline, many public and private ferry operations cross the bay daily. Ellis Island, Liberty Island, and Governors Island are also busy destinations for consistent boat traffic in Upper Bay (USACE 2020b).

In 2022, USACE completed a Final Feasibility Report and Environmental Assessment recommending deepening the federal navigation channel pathways in much of the Lower Bay and Upper Bay/Arthur Kill Regions. The plan highlights the navigational routes to Elizabeth – Port Authority Marine Terminal and Port Jersey – Port Authority Marine Terminal by 5 feet to a maintained depth of -55 feet Mean Lower Low Water. The plan involves deepening Ambrose Channel, Anchorage Channel, the Kill Van Kull Channel, Newark Bay Channel, South Elizabeth Channel, Elizabeth Channel, and Port Jersey Channel. This includes the additional width required for structural stability and for the navigation of the Ultra Large Container Vessels (ULCV) and Super Large Container Vessels (SULCV) design vessel to transit from sea to Elizabeth – Port Authority Marine Terminal and Port Jersey – Port Authority Marine Terminal (USACE 2022a).

In the Lower Bay Region, the Ambrose Channel, providing 50-foot water access, is the main shipping channel in and out of the Port of New York and New Jersey. The Ambrose Channel is part of the Lower Bay located several miles off the coasts of Sandy Hook, New Jersey and Breezy Point, Queens, New York. The Ambrose Channel connects to the Anchorage Channel at the Verrazano Narrows Bridge and continues to connect to all federally maintained shipping channels leading to main container and cruise ship terminals within the Port to accommodate the fleet of larger and deeper draft ships. The Ambrose Channel terminates at Ambrose Anchorage, just south of the Verrazano Narrows Bridge, where the weekly average of container ships waiting at anchor per day is twelve (Port of New York and New Jersey, 2022). Sandy Hook Channel has a project depth of 35 feet and provides a secondary route from the sea to deep water in Lower Bay; it connects with the Raritan

Bay Channel to the westward, Chapel Hill Channel to the north, and Terminal Channel to the south. Chapel Hill Channel has a project depth of 30 feet. Swash Channel, a natural buoyed passage between Ambrose Channel and Sandy Hook Channel, has a controlling depth of 18 feet. Terminal Channel, entered from Sandy Hook Channel about one mile west-southwest of the northern tip of Sandy Hook, leads to a turning basin, and two deepwater ammunition handling piers of the U.S. Naval Ammunition Depot at Earle/Leonardo. Federal project depth is 35 feet in the channel and turning basin (USACE 2020b). The deepwater piers and barge pier are connected to the shore by a trestle that extends nearly two miles across the mud flats from Earle/Leonardo. This area is restricted to authorized craft or vessels only (NOAA 2017). Raritan Bay is full of shoals with depths of 7 to 18 feet. Great Kills Harbor, a shallow bight on the south side of Staten Island, is used as an anchorage by small craft. The harbor is entered through a dredged channel that leads from deep water in the Lower Bay along the southwesterly side of Crookes Point, thence along the westerly side of the harbor to the head of bay. Coney Island Channel is a buoyed passage along the south side of Coney Island that leads from deep water in Lower Bay to Rockaway Inlet. In January-April 2000, the controlling depth was 12 feet. It is used principally by vessels going to Jamaica Bay and Coney Island (NOAA 2017).

The Raritan Region navigation asset is located in the north-central part of New Jersey and flows generally southeasterly into Raritan Bay between Perth Amboy and South Amboy, about 24 miles by water south and west of the Battery, New York City. This asset provides for the following: a main channel, 25 feet deep, 300 feet wide, from the turn in NY and NJ Channels, near Great Beds Light to the Raritan Arsenal Wharf, thence 15 feet deep, 200 feet wide, to the Washington Canal, thence 10 feet deep in soft material and 11 feet deep in rock, and generally 100 feet wide, with widening at bends, to the Delaware and Raritan canal entrance at New Brunswick, with a total length of about 13.8 miles; a turning basin opposite Raritan Arsenal Wharf, 25 feet deep, 300 feet wide and 1,000 feet long; and a south channel 25 feet deep, 300 feet wide, from its junction with the main channel opposite Keasby to the upper limit of former the NL Industries property, 15 feet deep and 150 feet wide to the Middlesex County Sewerage Authority Dock, thence 10 feet deep and 150 feet wide the junction with the Main Channel and Crab Island. The project is about 96% complete; the work remaining to be done is the dredging of the South Channel to a depth of 10 feet and 150 feet wide for a length of 1,300 fee to the upper junction with the main channel at Crab Island (incomplete work is inactive).

Jamaica Bay Region

The Jamaica Bay Region waterways are often used for ferry boat services. A federal navigation channel is within Jamaica Bay, along the west and south shores, with an entrance channel connecting two (2) interior channels to the Atlantic Ocean at Rockaway Inlet. North Channel is the interior channel from the Marine Parkway Bridge along the west shore of the bay and is authorized to be 18 feet deep at mean low water (MLW) and 300 feet wide to Mill Basin, with a turning basin 1000 feet wide and 1000 feet long at that point. North of Mill Basin the channel continues with an authorized depth of 12 feet MLW and 200 feet wide to Fresh Creek Basin. Beach Channel, authorized to 15 feet deep MLW and 200 feet wide, is the interior channel from the Marine Parkway Bridge along the south shore and continues to Head of Bay. At the entrance to Head of Bay, the channel branches, going north into the Head of Bay and south, forking into Mott Basin and Inwood Creek. The entrance channel, Rockaway Inlet, is authorized to 18 feet deep MLW and 500 feet wide from the Marine Parkway Bridge to Rockaway Point, where it expands to an authorized 20 feet deep MLW and 1000 feet wide to the ocean. The Rockaway Inlet entrance channel is generally dredged on a two (2) to three (3) year maintenance cycle (USACE 2020b)

It was estimated that 1,002 domestic commercial vessels and no non-domestic vessels utilized Jamaica Bay in 2013 (USACE 2019). Commercial vessels in the area commonly transport bulk fuel to several privately operated bulk fuel storage terminals located in basins at the eastern end of Jamaica Bay, and sand and gravel to several aggregate facilities on the eastern end of Jamaica Bay and north of Coney Island (USACE 2019). Recreational navigation includes motor, sail, and paddle boats travelling to and from private (and one municipally owned) marinas associated with permanent storage for boats, as well as temporary storage for restaurants along Jamaica Bay and the Rockaway Peninsula (USACE 2019).

Long Island Sound Region

For about 2.5 miles upstream from its confluence with the East River, the Bronx River is a federally designated navigable waterway and is used frequently by commercial tug and barges. This channel is maintained from the East River to East 172nd Street, approximately 2.6 navigable miles long. It is a shallow draft low-usage channel which had commercial tonnage of approximately 269,000 tons in 2006 and a 10-year average of about 133,500 tons per year. It was last dredged in 1991, at which time 64,158 cubic yards of sediment was removed and placed at the Mud Dump Site or Historic Area Remediation Site in the New York Bight. The maintained navigation channel, which was originally authorized by the River and Harbors Act of 1913, is 10 feet deep and 100 feet wide and runs from the East River to East 172nd Street at the downstream end of the River. A federal navigation channel spans Flushing Bay and Flushing Creek with a designed channel depth of 15 feet mean low water (USACE 2020b).

2.3.11 Noise and Vibration

Noise is generally defined as undesirable sound that may interfere with communication, damage hearing, and/or may diminish the quality of an environment. Noise intensity is measured and monitored in decibels (dBA). Approximate noise levels can be estimated based on surrounding land use and can typically range from an average of 30 dBA in wilderness areas to 90 dBA in more urban areas (USACE 2020b). Common sources of noise in our environment include transportation vehicles, equipment, machinery, construction, appliances, and motors, to name a few. While The Noise Control Act of 1972 established a national policy to promote an environment free of noise that jeopardizes human health and welfare, the primary responsibility for noise control relies on State and local governments (USEPA 2022). Table 13 has a few examples of common sources of noise and their anticipated average sound levels:

Table 13: Common Sources of Noise

Common Sources of Noise	Average Sound Level (Decibels/dBA)	Interpreted Level of Disturbance (from routine or repeat exposure)
Normal conversation and air conditioner	60	Low
City Traffic (from inside a vehicle), Gas-powered lawnmowers and leaf blowers	80-85	Mid-High
Approaching subway train and car horn	100	High
Entertainment venues	105-110	High
Fire crackers	140-150	High

Source: CDC 2022

Noise can carry a considerable distance underwater and on land; however, geographical extents of noise impacts are dependent on several factors including type of equipment utilized, noise exposure duration, amplitude, and wind direction/speed (USACE 2022) in relation to proximity to sensitive receptors such as residential communities and ecologically significant or special status species and wildlife.

Vibration is generally defined as rhythmic repetitive motion that may be experienced from a particular extraneous media (such as the ground or equipment). The duration of constant repetitive motion can cause disturbances in the environment both naturally (such as an earthquake) and mechanically (such as large vehicles, equipment and machinery), as well as occupational hazards to the human body having the potential to cause injury from prolonged exposure (e.g. jack hammer).

Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region

Ambient noise levels within these Regions would be variable depending on location and proximity to developed cities and neighborhoods, particularly in the New York City portion of the Lower Hudson/East River Region. The primary sources of noise in the Capital District and Mid-Hudson Regions would be anticipated to include vehicular traffic in populated city areas and along roads interstate highways, and bridges, commuter and freight train traffic along and near the Hudson River, and boat traffic. Noise is anticipated to increase in intensity as approaching Hastings-on-Hudson, Yonkers, Washington Heights, Harlem, and Manhattan, where primary sources of noise are anticipated to originate from vehicular traffic of pedestrian and commercial vehicles, commuter train traffic of the New York MTA subway lines, entertainment in Times Square and other portions of the City, periodic concerts, festivals, street fairs, music, and air traffic from helicopters and nearby airports. Potential sensitive receptors in the Planning Region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise depend on the type of land use in the vicinity. Potential sources of vibration to sensitive receptors may include automobiles, large motor vehicles, train traffic, boat traffic, and construction.

Hackensack/Passaic Region

Ambient noise levels within the Jamaica Bay Planning Region are anticipated to be mid-to-high range. The primary sources of noise anticipated include automobile traffic, truck traffic on highways and local roads, commercial and industrial processes, air traffic from Newark International Liberty Airport and Teterboro Airport, and New Jersey Transit rail systems. Noise criteria and the descriptors used to evaluate project noise will depend on the type of land use in the vicinity of the proposed project areas. Potential sources of vibration to sensitive receptors may include automobiles, large motor vehicles, air traffic take-off and landing, and construction.

Upper Bay/Arthur Kill Region

As much of the area is highly developed, ambient noise levels within the Upper Bay Planning Region would likely be in the mid-to-high range. The primary sources of noise in the Planning Region include automobile traffic, truck traffic on the highways and piers, boat traffic in Upper Bay, and air traffic from Newark Liberty International Airport. Potential sensitive receptors in the Planning Region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise depend on the type of land use in the vicinity (USACE 2020b). Potential sources of vibration to sensitive receptors may include automobiles, large motor vehicles, air traffic take-off and landing, boat traffic, and construction.

Lower Bay Region

Ambient noise levels within the Lower Bay Planning Region would likely be in the low to mid-range, as much of the Planning Region encompasses residential communities, open water, or open space. The primary sources of noise in the Planning Region include boat traffic in Raritan and Sandy Hook Bays, automobile traffic on local roads, and periodic explosions from demolition training at Naval Weapons Station Earle (USACE 2020b). Potential sensitive receptors in the Lower Bay Planning Region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise depend on the type of land use in the vicinity of the proposed project areas. Potential sources of vibration to sensitive receptors may include automobiles, large motor vehicles, boat traffic, construction, and periodic explosions from demolition training at Naval Weapons Station Earle.

Raritan Region

Ambient noise levels within the Raritan Region would likely be in the low to mid-range, as much of this Planning Region encompasses residential communities with some commercial and/or industrial facilities along the Raritan River. Potential sensitive receptors in the Planning Region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise depend on the type of land use in the vicinity. Potential sources of vibration to sensitive receptors may include automobiles, large motor vehicles, air traffic take-off and landing, boat traffic, and construction.

Jamaica Bay Region

Ambient noise levels within the Jamaica Bay Planning Region would be highly variable due to its combination of developed urban land and the less-developed bay and marsh islands. The primary sources of noise in the Planning Region include air traffic from John F Kennedy International Airport, automobile traffic on the Belt Parkway or other local roads, and boat traffic in Jamaica Bay. Receptors in the Planning Region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise will depend on the type of land use in the vicinity of the proposed project areas (USACE 2020b). Potential sources of vibration to sensitive receptors may include automobiles, large motor vehicles, air traffic take-off and landing, boat traffic, and construction.

Long Island Sound Region

Ambient noise levels within this Planning Region would likely be in the mid-to high-range in the highly developed southwestern portion, and in the low-to mid-range as the Planning Region moves north and west away from the city. The primary sources of noise in the Planning Region include air traffic from LaGuardia Airport, Interstate and local automobile traffic, and boat traffic in Long Island Sound and the East River. Potential sensitive receptors in the Planning Region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise depend on the type of land use in the vicinity (USACE 2020b). Potential sources of vibration to sensitive receptors may include automobiles, large motor vehicles, air traffic take-off and landing, boat traffic, and construction.

2.3.12 Environmental Justice

An analysis was performed to identify Environmental Justice communities within the Study Area and to determine whether the proposed project would have a disproportionately adverse impact on those communities. The analysis was carried out in compliance with the following:

- Title VI of the Civil Rights Act, 42 U.S.C., Sec. 2000 et seq which states that “No person in the United States shall, on the ground of race, color or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.”
- Executive Order (EO) 12898, Federal Action to Address Environmental Justice in Minority and Low-Income Populations which states “…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations….”
- 15 March 2022 Memorandum for Commanding General, USACE Implementation of Environmental Justice and the Justice40 Initiative which instructs USACE to “take a more proactive approach towards achieving environmental justice” by in Civil Works studies and planning.

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin or income regarding the development, implementation and enforcement of environmental laws, regulations, and policies, with no group bearing a disproportionate burden of environmental harm, and risks. USACE has been working with the State of New York and New Jersey and the City of New York to identify disadvantaged communities and to tailor this analysis to the specific needs and concerns of the communities within the Study Area. Throughout the Study process USACE prioritized public outreach and held nine scoping meetings and eight public meetings following the release of the interim report that were dispersed throughout the Study Area in locations that were easily accessible by public transit for people living within Environmental Justice communities.

For the purposes of this analysis environmental justice communities were defined as communities that meet established thresholds for low-income (having populations with greater or equal to 23.59% below the federal poverty level) and minority (greater than or equal to 51.1% identify as minority) and live in proximity to at least 1 pollutant in the 90th percentile for the country (U.S. Census Bureau 2020a-f). Approximately 59% of the census tracts in the Study Area qualify as disadvantaged. When combined with proximity to environmental pollutants, roughly 62% of the census tracts in the Study Area met the criteria for an environmental justice community (U.S. Census Bureau 2020d). The text below explores the unique demographic characteristics of each Planning Region within the Planning Region. Appendix A12 provides additional detail about the Tier 1 environmental justice analysis conducted for this study.

Capital District Region

This region is located at the northern extent of the Study Area in New York state and is bisected north to south by the upper reaches of the Hudson River. This Region is home to 259,195 people, which is the smallest Region population in the NYNJHAT Study Area. The mean age is 39.8 years old, with 19% that are 18 or younger and 16.6% that are 65 or older. 72.6% of residents identify as White, 14.7% as Black, with the remainder identifying as other minority races. 31% of the 70 census tracts in the region meet the criteria for designation as a disadvantaged community. Eleven census tracts have 20-40% of residents with less than a high school education. All the tracts have less than 30% of people who are linguistically isolated. Compared to other regions, the Capital District Region has a higher percentage of its population that lives with a disability (13.9% of all people in the region and 11 census tracts that have 19-38% of the population living with a disability).

Mid-Hudson Region

This region is also located in New York State, south of the Capital District Region. There are 263,355 residents of the Study Area in this Region, which is comparatively small for Regions in the NYNJHAT Study Area. The mean age is 39.25 years old, with 19.4% that are 18 or younger and 16% that are 65 or older. 69.5% of residents identify as White, 14.2% as Black, with the remainder identifying as other minority races. 23% of the 60 census tracts in the region meet the criteria for designation as a disadvantaged community. Very few census tracts have 20-40% of residents with less than a high school education. None of the tracts have more than 30% of people who are linguistically isolated. 12.4% of the population lives with a disability.

Lower Hudson/East River Region

This region has 4,159,324 residents, which is substantially higher than the two regions to the north. A greater portion of the Study Area overlaps with this Region and the population density is high. The age distribution similar to the northern regions (mean is 39.25, 18.3% 18 or under, 14.3% 65 or older). 50.7% of residents identify as White, 17.6% as Black, 14.3 as other race, and 10.5% as Asian. 57% of 464 census tracts in the region meet the criteria for a disadvantaged community. The number of tracts with a notable proportion of the population with low educational attainment is higher in this region than those to the north. 10.2% of people live with a disability, which is similar to other regions of the Planning Region. There are more census tracts that have an elevated number of people that are linguistically isolated (56 have 30-60% of its population that is linguistically isolated). 34 census tracts have an elevated proportion of the population living with a disability (19-38% and 38-57%).

Hackensack/Passaic Region

This region is located in New Jersey, across the lower Hudson River estuary from New York including Manhattan. The population is 1,996,763. The mean age is 40.51 (22.3% are 18 or younger; 15.1% are 65 or older). 56.8% of residents identify as White, 14.4% as Black, 11.3% as Asian, 10.7% identify as other. 59% of the 398 census tracts in the region meet the criteria for designation as a disadvantaged community. 9.3% of the population lives with a disability. Few census tracts have an elevated portion of people living with a disability, though one census tract has 95% of its population living with a disability. There are 35 census tracts that have 30-60% of the population that is linguistically isolated. 13.3% of the population have less than a high school diploma, with 92 tracts having 20-40% of the population with low educational attainment and 10 tracts with 40-60% in that same category.

Upper Bay/Arthur Kill Region

This region is located in New Jersey, across the lower Hudson River estuary from New York. This Region has 2,007,373 residents in the Planning Region. It has the second highest percentage of its population that is 18 or younger (22.7%). 14.2% are 65 or older. 52% of residents identify as White, 23.2% as Black, 10.1% as Asian, and 9% identify as other race. 57% of the 415 census tracts in the region meet the criteria for designation as a disadvantaged community. 131 census tracts have elevated numbers of the population with low educational attainment (20% - 40% and 40% - 60%) and 34 census tracts have 30%-60% of their population who are linguistically isolated. 9.8% of residents live with a disability, with no tracts that are specifically elevated.

Lower Bay Region

This region is the southernmost in the Study Area and is located in coastal New Jersey. 576,208 people reside in the Planning Region of the region. The mean age is the highest in the Planning Region (41.74) but not notably so. 81.8% of the population identifies as White, 7.6% as Asian, and 4.6% as Black. 6% of the 108 census tracts in the region meet the criteria for designation as a disadvantaged community, which is very low compared to many of the Planning Regions. 7.8% have less than a high school diploma, which is comparatively low for the Planning Region, however there are specific tracts where 20-40% of the population have completed high school. Tracts do not have an elevated number of people that are linguistically isolated (none with over 30% of people). 10.1% live with a disability and one census tract has 19-38% living with a disability.

Raritan Region

This region is located in New Jersey and is the most western of the regions. The population is 872,853. 22.5% are 18 or younger and 14.2% are 65 or older (mean age is 40.56). 55.4% of residents identify as White, 19.6% as Asian, 13.1% as Black, 7.1% as other. 47% of the 157 census tracts in the region meet the criteria for designation as a disadvantaged community. 9.9% of the population has less than a high school diploma. There are some tracts that have a higher proportion of the population than the region; 18 tracts have 20-40% of the population, three that are 40-60% and one greater than 60%. 8.7% of the population lives with a disability, which is the lowest in the Planning Region. This region has eight tracts with 30-60% of the residents being linguistically isolated.

Jamaica Bay Region

This region includes some of southeast New York City and the western portion of Long Island. It has a large amount of coastline, exposed to the Atlantic Ocean. 79% of the 810 census tracts in the region meet the criteria for designation as a disadvantaged community, which is the highest in the Study Area. About 2,889,000 people live in the Jamaica Bay Planning Region. It is the only Planning Region for which the proportion of people who identify as Black (33.9%) and White (35%) are almost even. 16.2% identify as Asian and 9.8% identify as Other. 16.7% of the population does not have a high school diploma, which is higher than all by one region. Low attainment is concentrated in some census tracts and the number of total tracts with low educational attainment is high compared to the Study Area. The same is true for the number of tracts that have a high proportion of linguistic isolation. The proportion of people living with a disability is 9.3%. While there are few overall tracts that have a high percent of the population that lives with a disability, one has 57-76% of its population living with a disability and another with 76-95% of its population.

Long Island Sound Region

This region is to the east of the Lower Hudson/ East River Region and includes the northeastern portion of New York City. The coastline is touched by the sound. 70% of the 685 census tracts in the region meet the criteria for designation as a disadvantaged community, which is very high compared to many of the other regions and is the second highest after Jamaica Bay Region. 2,996,602 people reside in the Planning Region of the regions. The mean age is 40.19, with the percent 18 or younger and 65 or older similar to other regions. The racial distribution has the largest spread in the Study Area: 37.7% of residents identify as White, 19.7% as Other, 19.5% as Black, and 16.8% as Asian. 11.7% of the population lives with a disability, and a few tracts have a high concentration of people that live with a disability. This Region has a comparatively high number of tracts (303) where the population has elevated low educational attainment (20% of population or greater); 19.7% of the population in the Planning Region do not have a high school diploma. This region has 11 tracts with greater than 60% of the residents being linguistically isolated.

2.4 BUILT ENVIRONMENT (INFRASTRUCTURE)

The built environment is defined broadly as man-made resources and infrastructure that define the urban fabric, support communities, and enable economic activity. This definition includes transportation infrastructure (i.e., roads, bridges, and tunnels, transit, freight rail, ports and waterways, aviation), storm and wastewater infrastructure, energy infrastructure, communications infrastructure, public spaces, schools, and aesthetics. While the built environment spans the entire Study Area, there is emphasis placed on the urban metro NYC area due to its dependent relationship to many of the identified resources. Many resources are currently exposed to coastal risk or are expected to become exposed in the future as RSLC continues to increase the frequency and severity of coastal flooding within the Study Area, as described in this Section and Chapter 5.

2.4.1 Roads, Bridges, and Tunnels

Roads, bridges, and vehicular tunnels connect communities and provide access to opportunity by allowing for the commute to and from work. They are an important piece of infrastructure within the Study Area and are the backbone of modern supply chains. Particularly in the heavily urbanized regions of the Study Area, high density road networks define the urban fabric within the coastal zone. While infrequent road flooding can temporarily disrupt travel and delay deliveries, more frequent flooding of roadways can cause chronic access issues for adjacent communities and businesses. Coastal flooding can also cause significant physical damage to roads and supporting infrastructure, with salt water-related damage capable of significantly decreasing the useful life of supporting infrastructure (e.g., damage to structural components, supporting electrical infrastructure, mechanical equipment). While there are both direct and indirect benefits of managing flood risk for roads, bridges, and tunnels, these benefits are not considered in the economic analysis at present.

Roads and Highways

There are a significant number of highways that are located within the Study Area that are vulnerable to coastal flood risk. Within the Lower Bay Region of the Study Area, the Garden State Parkway is vulnerable to coastal flooding, particularly in the proximity of Old Bridge and Aberdeen Township, NJ.

Bridges

While many of the major bridge crossings are elevated well above current mean sea level to provide an allowance for vessels of varying sizes to pass underneath, bridge piers, abutments, and support facilities in the coastal zone remain potentially vulnerable to coastal flood related damages. Saltwater flood exposure can cause damage to sensitive electrical equipment on bridges and fast-moving currents and wave action can also induce scour, damaging bridge foundations (MTA 2015).

Tunnels

There are several major vehicular tunnels located within the Study Area, all of which are located within the coastal zone. Connecting the West Side Highway to FDR Drive, as its name implies, the Battery Park Underpass traverses Battery Park; both tunnel portals are very low-lying and within the current FEMA 1% floodplain. The Battery Park Underpass was also severely flooded during Hurricane Sandy. NYC DOT is engaged in an FHWA-funded project to manage future flood risk to the Battery Park Underpass, and this work is scheduled to begin construction in 2023 and conclude in 2025. Separately, there are capital projects planned in the nearby vicinity for the Battery and Battery Park City which may also provide CSRM benefits to the Battery Park Underpass.

Passing directly beneath the Battery Park Underpass, the Hugh L. Carey (Brooklyn-Battery) Tunnel, owned and operated by MTA Bridges and Tunnels (MTA B&T), carries I-478 beneath the East River into Brooklyn. The portal at the Battery and the ventilation shaft adjacent to Governors Island are within the current FEMA 1% floodplain, whereas the Brooklyn portal is within the current FEMA 0.2% floodplain. The Queens-Midtown Tunnel also crosses the East River; its portal in Long Island City (Queens) is also within the FEMA 1% floodplain. Both tunnels experienced significant flooding during Hurricane Sandy (MTA 2017). In response, MTA Bridges and Tunnels installed permanent deployable barriers at tunnel portals for both tunnels, as well as additional floodproofing measures at the Governors Island Ventilation Building, and drainage pump replacement (MTA 2017; MTA 2019).

Two vehicular tunnels, the Holland Tunnel and the Lincoln Tunnel, cross the Hudson River, providing connection between Manhattan and New Jersey. Both tunnels are operated by PANYNJ, though the Holland Tunnel is more vulnerable to coastal flooding, as both ventilation shafts and portals on both the Manhattan and New Jersey sides of the tunnel lie within the FEMA 1% floodplain, whereas only one of the Lincoln Tunnel ventilation shafts lies on the periphery of the FEMA 1% floodplain. As part of a post-Hurricane Sandy recovery project, CSRM improvements are underway on the Holland Tunnel and are designed to meet current FEMA design flood elevation standards (PANYNJ 2018; PANYNJ 2020).

Transit

Compared to the rest of the U.S., residents of the greater New York City metropolitan area are heavily reliant on transit service. Serving as a vital conduit of economic development and opportunity, 58% of workers in the greater NYC area commuted by transit in 2019, as opposed to just 5% of workers nationally (NYC Planning 2019). These transit trips are supported by a robust network of transit infrastructure that spans the Planning Region, much of which lies adjacent to or below coastal waterways. As such, a significant portion of the existing transit infrastructure within the Planning Region was damaged during Hurricane Sandy, causing an estimated $8.7B [2022 USD] in damages to the Metropolitan Transit Authority, Port Authority Trans-Hudson (PATH), NJ Transit, and Amtrak assets within the Planning Region (Aerts et al. 2013). Significant investments in flood protection and climate resilience have been made after Hurricane Sandy, providing substantial CSRM benefits to nearly all the coastally vulnerable transit assets within the Planning Region.

Rapid Transit

The New York City Transit (NYCT) Department of Subways, an MTA subsidiary, is primarily responsible for the operation and maintenance of New York City's subway system, which serves four of the five boroughs. An additional MTA subsidiary, the Staten Island Railway (SIR) is responsible for rail rapid transit service in the borough of Staten Island. With many underground stations, ventilation shafts, tunnel portals, rail yards, and maintenance facilities located within the coastal zone, the NYCT subways and SIR sustained heavy damage during Hurricane Sandy, with all but one subway river tunnel flooded during the storm and flooding at several critical rail yards (MTA 2019). In response to Hurricane Sandy, the MTA has actively invested in climate resilience measures principally aimed at managing coastal flood risk.

In particular, the MTA has invested in over 3,500 deployable flood control devices, the vast majority of which NYCT Department of Subways plans to deploy at low lying openings in advance of a coastal storm (MTA IG 2022). These flood control devices are intended to provide a watertight closure around existing openings that must otherwise be kept unobstructed during normal operation of the system (e.g., ventilation shafts, station entrances, tunnel portals). As of February 2022, the MTA has approximately 97% of these devices already installed and/or ready for deployment (MTA IG 2022). When deployed the flood control devices are designed to manage flood risk from costal flood events less severe than the NOAA SLOSH Category 2 event (approximately +18 feet NAVD88).

The MTA has also invested in additional pump capacity and related resilience improvements to tunnel infrastructure to minimize the severity and duration of flooding within subway tunnels in the event of flood control device failures (MTA 2019). The Port Authority Trans-Hudson (PATH) system has also implemented similar flood protection upgrades inclusive of deployable barriers at three stations in Jersey City that previously flooded during Hurricane Sandy (USACE 2019). It is assumed NYCT Department of Subways and PATH will be able to substantially manage flood risk to underground stations and tunnels through the successful deployment of these barriers in the event of a significant coastal storm.

NYCT, SIR, and PATH have also invested in floodproofing (including deployable barriers), drainage improvements, backflow preventers, and additional pump capacity at rail yards, maintenance facilities, and bus garages within the coastal zone (USACE 2019; MTA IG 2022). The design flood elevation of floodproofing measures varies by site, though is generally three feet higher than NOAA SLOSH Category 2 Hurricane flood elevation for MTA projects and 3 feet higher than current FEMA base flood elevations for PATH project locations to account for future RSLC (PANYNJ 2018; USACE 2019). Additional flood mitigation along the MTA /NYCT Department of Subways Rockaway Line is designed to manage flood risk along low lying at-grade portions of track to an elevation of +14ft NAVD88. It is assumed these projects will be in place and remain effective.

Commuter and Regional Rail

Commuter and regional rail infrastructure within the Planning Region is vulnerable to coastal flooding. For instance, during Hurricane Sandy, more than 50% of the Metro North Railroad Hudson Line right of way was completely submerged, with saltwater intrusion significantly damaging power, signals, and communications equipment (MTA 2015); New Jersey Transit commuter and light rail lines, as well as LIRR lines experienced similar, though less extensive damage (USACE 2019; MTA 2019). In response, New Jersey Transit and the MTA have floodproofed or raised sensitive signal and communications equipment in coastal areas, with the MTA elevating equipment four feet higher than The FEMA Base Flood Elevations and New Jersey Transit elevating assets 2.5 feet higher than the FEMA Base Flood Elevations. Metro North Railroad is also installing floodwalls and deployable barriers at Highbridge Yard (Bronx) and Harmon Shop (Croton) to provide protection to a design flood elevation of 4 feet above Base Flood Elevations. The LIRR has adopted the same design flood elevation and plans resiliency improvements for the West Side Yard (i.e., Hudson Yards), Long Island City Yard, and the North River and East River tunnel vent shafts and portals (MTA 2019; USACE 2019; MTA 2021). The North River and East River tunnels are also critical components of Amtrak’s Northeast Corridor, a vital regional rail line that connects Washington DC to Boston.

2.4.2 Ports and Waterways

Waterways and canals of the New York City metropolitan area continue to play a vital role in the economic and social development of the Planning Region. The Port of New York and New Jersey serves a local population of over 27 million people with 3,000 acres of owned property, shared amongst five main terminals. In addition to these, there are a number of privately owned facilities including dry and liquid bulk terminals, general cargo and barging facilities, cruise terminals, ferry landings, and recreational users, as well as vessel support facilities (such as tie-up berths, marine fueling facilities, and tug support) (Port Master Plan, 2019).

The Port of New York and New Jersey are ranked number three on the list of top U.S. seaports in terms of cargo throughput and number one on the East Coast, moving over 7 million twenty-foot equivalent units annually (trade.gov, n.d.). International trade has been a large economic stimulant for the Planning Region as there are several terminals for trade of containers, bulk & break-bulk cargo, refrigerated cargo, automobiles, petroleum, and other liquid cargoes. As of now, the ports and waterfront area of New York City and its surrounding five boroughs are mere inches above the current sea-level. After the detriment of Hurricane Sandy in 2012, there was an estimated $50 billion lost in revenue and damages of the shipping ports of NY and NJ (NewsRescue.com, 2012). The ports remained closed for a week after the storm impacted the region.

International container cargo trade has been trending upwards and is expected to continue increasing in tonnage as time goes on (USACE NYNJHDCI 2022). The global vessel fleet is also growing larger in size with ships being built to hold more twenty-foot equivalent units. Besides coastal storm risk, some of these larger vessels have already experienced inefficiencies in New York Harbor because of the channel depth and width limitations in the ports of NY and NJ.

Additionally, New York City has been known as a hub for global tourism with a record high of 66.6 million visitors in 2019, prior to the COVID-19 pandemic (Office of the New York State Comptroller, 2021). Tourism amongst New York waterways is encapsulated by the three cruise ship terminals, several ferry terminals, and a number of marinas for personal boats in the Planning Region. While some ferry companies focus on growth by tourist attractions such as dinner cruises and sightseeing tours, other companies are primarily known for their numbers in ridership amongst commuters traveling to and from work. New York City Ferry, New York Waterway and Seastreak Ferry, are the three main commuter ferries within the Planning Region. New York City Ferry is operated by Hornblower cruises out of the Brooklyn Navy Yard and has several stops throughout the boroughs along their six different routes. New York Waterway is primarily known to be back and forth on the Hudson River between midtown Manhattan and their several New Jersey stops. Seastreak Ferry is a high-speed commuting ferry between Highlands, New Jersey and Midtown Manhattan on the East River side.

The Staten Island Ferry is best known to be used for both commuting and tourism and is an important piece of transit for those who live in the borough of Staten Island. The St. George terminal, Whitehall terminal, and maintenance facility were all considerably damaged from Hurricane Sandy. The terminals were closed from October 29th, 2012 and were able to reopen on November 2nd, 2012 after crews worked around the clock to repair damage.

2.4.3 Freight Rail

Four Class I freight railroads and 36 Regional and Short-line railroads (Class II and Class III) operate in 62 New York counties and 62 New York cities. These railroads employ over 4,000 individuals mostly in the large yards, such as Albany, Buffalo, Syracuse, and New York City. Freight rails and cargo are particularly vulnerable to coastal flooding within the Planning Region. The freight trains transport everything from food and household products to construction equipment and municipal waste. Approximately 405 million tons of freight moves through the New York Metropolitan Transportation Council (NYMTC) region each year, which encompasses New York City, Long Island, and the lower Hudson Valley. Freight tonnage is expected to rise in the region by 45% through 2040 (NYMTC, 2007). John F. Kennedy Airport is the leading U.S. freight gateway by value of shipments and handles approximately 65% of the New York and New Jersey Region's air cargo.

Freight Railways in New Jersey also play a key role for the container ports within the Planning Region, moving about 15% of all the containers going through the Port of New York and New Jersey by rail (NJDOT, 2019). As of 2019, there were just over 1,000 freight track miles throughout the State of New Jersey and 1,013 individuals employed (GoRail, 2019). Three Class I railroads, two Conrail operations, and more than a dozen shortline railroads make up the track miles within the state of New Jersey (NJDOT, 2019). Considering about half of the goods received in the metropolitan area, enter through the West Coast and are shipped across the United States via railway, maintenance and growth of freight railways is vital (NJDOT, 2019). Freight rail moves an array of products with intermodal, waste, and scrap materials compromising the majority of shipments leaving from New Jersey (GoRail, 2019). The NJDOT continues to support railways by the rail safety program, the Rail Freight Assistance Program (RFAP), and both the State Rail Plan developed with NJ Transit, and the Freight Rail Strategic Plan (NJDOT, 2021).

New York City's current freight infrastructure was mostly developed in the early 20th century and is outdated and increasingly obsolete, making it even more vulnerable to major damage from coastal flooding. The public recognizes inadequate rail infrastructure as a threat to the connectivity of the New York mobility system. According to the Association of American Railroads (AAR), freight railroads in New York originated eight million carload tons and terminated 16 million tons of freight in 2019 (AAR, 2019). Freight railroads continued to provide vital transportation to each of the 62 cities and 62 counties by upgrading an aged infrastructure and investing in the ongoing maintenance required by the heavy rail cars operating up to 40 mph. In 2021, CSX, the main freight operator in New York, spent an average of $72,000 per mile on maintaining its infrastructure (CSX Annual Report, 2021).

Active Freight Rail Yards in New York City

- 65th St Yard – Upper New York Bay in Sunset Park, Brooklyn, equipped with two transfer bridges which allow rail cars to be loaded and unloaded onto car floats
- Arlington Yard – North Shore of Staten Island, Howland Hook Container Terminal is used to transfer containerized municipal waste from barges to trains, servicing roughly half of New York City's barged trash volume
- Harlem River Intermodal Yard – the Bronx, main food distribution hub for online grocery retailer FreshDirect
- Hunts Point Terminal Market – the Bronx, largest food distribution center in New York
- Industry City – Upper New York Bay in Sunset Park, Brooklyn, used for car float operations
- Fresh Pond Junction – Queens, main freight yard servicing Long Island, hub of New York and Atlantic Railway
- Oak Point Yard – Bronx, largest freight yard in New York City, owned by CSX
- Wheel Spur Yard – Long Island City, Queens, New York and Atlantic Railway transload facility used for food products and construction material

Active Freight Rail Yards in New Jersey

- Newark Yard (Oak Island)-- Jointly owned by the Norfolk Southern Railway and CSX. Support yard for the Port of New York and New Jersey ExpressRail system within Port Newark
- Camden Yard—Conrail Shared Assets Operations (CSAO) rail yard. Serves as a main classification yard for the Southern New Jersey area.
- South Kearny Yard—CSX rail terminal
- North Bergen Yard—Intermodal terminal operated by CSX
- Manville Yard (Port Reading Junction)—Major rail junction that serves all freight travelling between the Port of New York and New Jersey
- Ridgefield Heights Yard—Auto Distribution Terminal
- Little Ferry Yard—Formerly operated as an intermodal terminal. Available for rail/truck transfer operations and product storage. Owned by CSX
- Elizabeth Yard—ExpressRail terminal within Port Elizabeth

In September 2021, Hurricane Ida greatly exposed the vulnerability of rail operations within the Planning Region to flooding. Service was stalled for days, and restoration was slow and patchy. Several freight train derailments have also been blamed on track flooding, some of which have resulted in the spillage of diesel fuel into nearby bodies of water. The Hudson tunnel took on significant damage during Hurricane Sandy in 2012, greatly affecting Amtrak operations. After Hurricane Sandy, railroads made CSRM (planned barriers at East River, and Hudson tunnels) and resilience measures high priority, as many of the active freight rail yards lie in high-risk flood zones. However, post-disaster recovery remains a serious challenge to freight infrastructure.

New Jersey freight railways have existing programs in place through the NJDOT to encourage the growth and maintenance of their existing tracks. "The New Jersey Rail Freight Assistance Program supports the preservation, rehabilitation, and preservation of New Jersey's Freight Railroad Network..." (NJDOT, 2019). The goal of this program is to support the increased accommodation of rail freight operating in New Jersey to continue limiting the amount of truck traffic within the area for trade. Similarly, the Port Authority of New York and New Jersey has continued to make significant investments to advance the rail capacity at both of the Port Elizabeth and Port Newark ExpressRail terminals, to keep up with the growing annual amount of containers in trade.

2.4.4 Stormwater and Wastewater Infrastructure

Aqueducts deliver one billion gallons of freshwater daily from reservoirs in the Catskill Mountains, where it is distributed through water lines and used amongst the Metropolitan area. In New York City alone, there are fourteen WWTPs, servicing around 7.7 million of the population by treating 1.3 billion gallons of wastewater daily to be released into the surrounding bodies of water (nyc.gov). With a population in New York City of 8,467,513 people in 2021, the daily average of water consumption for the city was 979 million Gallons per day (NYCDEP).

One of the main byproducts to come out of the cleaning process in WWTP is a thick "sludge" of what's leftover of the human waste, toilet paper, and food particles that go into the sewer system. The first "sludge vessels" were built during The Great Depression, this sludge would be dumped into the surrounding waters of New York until it became a health emergency as the area became more densely populated and it wasn't until 1992 that this practice was banned all together. As a result of the Ocean Dumping Ban Act of 1988, this sludge is now sent by ship to one of the eight WWTP that can fully "dewater" sewage, loaded onto tractor trailer trucks, and shipped away to be properly disposed of in landfills. These ships are commissioned by the NYCDEP and can transport about four-hundred thousand gallons, or more of sludge at a time.

Stormwater encompasses all precipitation that runs into the drains from streets and sidewalks, including melted snow during the winter months and excess water remaining after a flooding event. Only 30-40% of stormwater in New York City is carried separately from sewage in Municipal Separate Storm Sewer Systems (MS4), while the remaining 60% of storm water is combined with CSO. CSO is characterized by tiers and by the percentage of the total CSO volume of discharge they release. Tier 1 CSO discharge 50% of the total CSO volume in NYC, Tier 2 facilities discharge 20% of total CSO volume, and Tier 3 facilities discharge only 10% of the total CSO volume (NYCDEP). In the combined sewer system, there is a single pipe that carries the mixture of stormwater and sewage through the wastewater treatment facilities before it is treated and discharged in large bodies of water. Any influx of stormwater from heavy precipitation or flooding events that moves through wastewater treatment facilities prevents proper treatment of stormwater flowing back into the surrounding bodies of water.

CSO is known to cause variation in water quality after large events and measures have since been implemented to mitigate this. Aquatic pollution is likely with any abundance of stormwater, as it has been proven to carry an excess of nutrients, such as phosphorus and nitrogen, bacteria from animal and human wastes, oil and grease, sediments from construction, pesticides, herbicides, fertilizers, and trash debris into the waterways within the Planning Region. The NYCDEP has implemented the Bluebelt Program, originally in Staten Island that helps mitigate runoff precipitation by preserving natural drainage corridors. Bluebelts have been a cost-effective and ecologically rich solution to rising sea-level and increased flooding events in New York (NYCDEP). Additionally, to both help with absorption and protecting water quality, the NYCDEP has implemented the Green Infrastructure Program to collect stormwater from streets, sidewalks, and other hard surfaces before it can enter the sewer system or cause local flooding. By reducing the amount of stormwater that flows into the sewer system, green infrastructure helps prevent sewer overflows and improves the health of local waterways.

There are many stormwater and wastewater facilities located in the Planning Region. The following is a list of facilities within each Planning Region.

Capital District Region

Rensselaer County SD #1 WWTP, Albany County (CO) Sewage District (SD) – North WWTP, Albany CO SD – South WWTP, East Greenbush WWTP, Cedar Hill Water Pollution Control Plant (WPCP), Hudson Sewage Treatment Plant (STP), Greenport SD 1 STP, Catskill WWTP, Saugerties Dock Street STP

Hackensack/Passaic Region

Ridgewood Village WPC Facility, Mountain View STP, Cedar Grove STP, Bergen City Utilities Authority (UA), Secaucus Municipal Utilities Authority (MUA), Verona Township (TWP) WTP

Jamaica Bay Region

NYCDEP – Coney Island WPCP, NYCDEP – 26th Ward WPCP, NYCDEP – Rockaway WPCP, NYCDEP – Jamaica WPCP, Cedarhurst WPCP

Long Island Sound Region

Blind Brook SD WWTP, Mamaroneck Sanitary SD, New Rochelle STP, NYCDEP – Hunt's Point WPCP, NYCDEP – Tallman Island WPCP, NYCDEP – Bowery Bay WPCP, Belgrave WPCP, Great Neck WPCP, Port Washington WPCD, Glen Cove WWTF

Lower Bay Region

NYCDEP – Oakwood Beach WPCP, Monmouth County Bayshore Outfall Authority, Middletown Sewerage Authority (SA), Long Branch Sewerage Authority, Richmond Creek Bluebelt, New Creek Bluebelt, South Beach Bluebelt, Oakwood Beach Bluebelt, Jack's Pond Bluebelt, Wood Duck Pond Bluebelt, Sweet Brook Bluebelt, Blue Heron Bluebelt, Arbutus Creek Bluebelt, Wolfe's Pond Bluebelt, Lemon Creek Bluebelt, Mill Creek Bluebelt, Butler Manor Bluebelt, Conference House Park Bluebelt

Lower Hudson/East River Region

Peekskill Sanitary SD WWTP, Stony Point STP, Ossining Sanitary SD WWTP, Rockland CO SD #1 STP, Orangetown SD #2 STP, Yonkers Joint WWTP, NYCDEP – North River WPCP, Bergen County Utilities Authority, NYCDEP- Ward's Island WPCP, Woodcliff STP, North Hudson Sewerage Authority, Adams Street WTP, Newtown Creek WPCP, Red Hook WPCP

Mid-Hudson Region

Kingston WWTP, Lloyd Highland Sewer District STP, Poughkeepsie WWTP, Arlington WWTP, Tri-Municipal WWTP, Newburgh WWTP, Beacon WPCP, Highland Falls WWTP

Raritan Region

Middlesex County UA

Upper Bay/Arthur Kill Region

Passaic Valley Sewerage Comm, Owls Head WPCP, Port Richmond WPCF, Linden Roselle SA, Rahway Valley Sewerage Authority, Clay Pit Ponds Bluebelt, Rossville Bluebelt, South Shore Golf Course Bluebelt, Village Greens Bluebelt, Arden Heights Bluebelt

2.4.5 Energy Infrastructure

Critical energy infrastructure in the NYNJHATS Planning Region include petroleum pumping stations, a nuclear power plant, natural gas storage facilities, electrical substations as well as oil and gas pipelines, electrical power lines, gas stations and compressor stations. Within the Planning Region there are 112 petroleum pumping stations, two oil refineries, one natural gas storage facility, eight natural gas compressor stations, 146 electrical power generation plants, and 274 substations. Many of these critical resources will be affected by RSLC and continued coastal flooding. The energy infrastructure within the FEMA 1% floodplain is particularly vulnerable to coastal storm damage and flooding due to rising sea levels and climate change.

There are 112 petroleum pumping stations (EPA FRS Database, 2003) 24 of which are in the FEMA 1% floodplain. The two oil refineries are both in New Jersey (ConocoPhillips, 2010) but neither are within the FEMA 1% floodplain.

There are four natural gas interconnects (Platts 2011) in the Planning Region as well as 355 natural gas pipelines, 3,276 refined petroleum pipelines and one "other" pipeline (Platts 2011). The total milage of pipelines in the Planning Region is 1,648.3, and 1,278.6 of those miles lie in the FEMA 1% floodplain.

The Planning Region has 2,066 gas stations of which 132 are in the FEMA 1% floodplain. There are no natural gas import terminals, however there is one natural gas storage facility in New Jersey (Platts 2011) that is within the FEMA 1% floodplain. Further infrastructure includes 38 natural gas receipt and delivery points (Platts 2011), and eight natural gas compressor stations; six natural gas receipt/delivery points and three natural gas compressor stations in the FEMA 1% floodplain (NAVTEQ 2011).

There is a three-unit nuclear power plant in Buchanan, NY, however it ceased operation April 30, 2021 and it was the only nuclear plant in the Planning Region. The Planning Region has 524 electrical generating units (Aerial Imagery, Ventyx 2010) including four operating in Green Island, NY. A total of 172 of these units are in the FEMA 1% floodplain. Out of the 274 substations in the area, 261 are currently in service and 13 are proposed/in construction (Ventyx, FERC, 2010). 57 of these substations are in the FEMA 1% floodplain.

Throughout the Planning Region there are 1,217.5 total miles of electric transmission lines, of which 1081.5 miles are at particular risk for storm damage. There are 307 in service lines, and one proposed line and 146 electric power generation plants with 38 located in the FEMA 1% floodplain (Ventyx. FERC, 2010).

After Hurricane Sandy, approximately 8.5 million people were left without power (USACE, 2019). Not only were residents left without power, but vital infrastructure also such as WWTP were unable to operate due to the loss of power causing hazardous waste to be discharged into surrounding water bodies. The Long Island Power Authority (LIPA) Long Island’s largest public energy system experienced over $200 million in damages after Hurricane Sandy (2012) and Hurricane Irene (2011). With help from both FEMA Public Assistance funding, LIPA was able to make more resilient elements of the power grid most effected by coastal storm damage. The State of New York has built or plans to build more than 300 community reconstruction projects that includes addressing vulnerabilities in NY energy infrastructure to coastal storm and flood damage. GOSR also has a “Fuel NY” initiative which required downstate gas stations located within a half mile of hurricane evacuation routes to have a transfer switch as of 2014 and to have a generator running within 24 hours of losing power during a fuel supply or energy emergency. Furthermore, gas station chains were required to install transfer switches in an additional 30% of stations by 2015. These measures were installed under state law to allow people mobility during and after a major storm event.

Other known infrastructure management projects in NY include a $2.3 billion grant program through the Department of Energy for electric grid operators, states and tribes to implement electrical grid resilience measures including improvements to make the electrical grid more resilient to extreme weather events. NYC has also initiated a $1.5 billion coastal resilience project that would include an integrated flood protection system covering 2.4 miles of the east side of Manhattan. Along this 2.4-mile stretch is an electrical substation that powers much of Lower Manhattan that will be protected by the resilience project.

In New Jersey, after Hurricane Sandy, the Bureau of Climate Change and Clean Energy (BCCCE) focused on energy resilience efforts, primarily on petroleum sector terminals and retail fuel stations. BCCCE developed the “petroleum emergency toolkit” (PET) which is a tool is a confidential tool used to support planning and response personnel during emergencies that will affect the petroleum supply chain. The PET lists in a database the location and details of each facility along with emergency contact information for all petroleum refineries, marine transfer facilities, storage facilities, major pipelines, petroleum distributors, heating fuel suppliers and retail gasoline stations within the state and relevant region. The state also announced $25 million in energy allocations to municipalities, counties, and critical infrastructure facilities. The funding is to be used to support alternative energy systems such as microgrids and emergency generators to allow facilities to operate if the power grid fails during an emergency. In addition to these measures, The Board of Public Utilities and the New Jersey Economic Development Authority partnered to commit $200 million in funding for the Energy Resilience Bank (ERB) to finance the design, acquisition, construction, and installation of energy resources to improve and increase the energy resiliency at certain New Jersey critical facilities. This effort is focused primarily on preventing hospitals and WWTPs from losing power in the event of a disaster. With all of these measures combined, New Jersey may be better prepared for another major storm event.

While there are a few projects that will protect critical energy infrastructure, many substations, powerlines and other critical infrastructure, primarily upstate and in upper Manhattan, that power the major cities of New York and New Jersey will remain vulnerable to coastal storms. Damage to this infrastructure is likely to leave millions of people without power as it has as a result of past coastal storms.

2.4.6 Communications Infrastructure

There is a great amount of nationally important communications in the Planning Region, much of which remains vulnerable to coastal storm damage. There are 82 cell towers in Planning Region, with two are in the FEMA 1% floodplain (HIFLD 2022). After Hurricane Sandy, the Federal Communications Commission (FCC) Chief, Public Safety & Homeland Security Bureau disabled approximately 25% of cellular towers in the storm-affected region – and more than 50% in the hardest-hit counties due to critical damage (FCC 2022). Along with the negative impacts to interpersonal and business communication, when cell phone towers are not operational, the 911 automatic routing is affected and can route to the wrong services which prolongs the time it takes for emergency vehicles to be dispatched. In 2013, the FCC chartered a Communications Security, Reliability, and Interoperability Council (CSRIC IV) that makes recommendations to the FCC to promote the security, reliability, and resiliency of the Nation's communications systems. The Council was established at the direction of the Chairman of the FCC in accordance with the provisions of the Federal Advisory Committee Act, 5 U.S.C. App. 2 The Council’s term was from March 19, 2013 - March 18, 2015. According to the Council’s Charter, the focus of the Council’s advisory efforts was to ensure the reliability and security of communications systems and infrastructure, especially focusing on mobile systems, 911 routing and accuracy and emergency alerting.

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) provides research and development to ensure the resiliency of critical infrastructure in the United States. The DHS funded a study through this directorate that found 0.43% of the national internet was out post-Hurricane Sandy, which is double the average daily internet outages. It took four days for these outages to resolve (dhs.gov 2022). Downtown Manhattan, which is a global hub for e-commerce, flooded as a result of Hurricane Sandy, causing several internet sites and portals to be taken out of service for several days which impacted both local and worldwide businesses. If downtown Manhattan floods again due to future hurricanes and coastal storms, then cellular towers and internet hubs may be down for several days again, affecting emergency response and e-commerce ventures.

There are 22 digital TV transmitters (FCC 2022) in the Planning Region, however none are in the FEMA 1% floodplain and are unlikely to be affected negatively. After Hurricane Sandy, most residents still had access to cable and television.

2.4.7 Public Spaces

Within the generally urbanized Planning Region there is an emphasis on creating and maintaining access to public space for leisure and recreation. These spaces include, but are not limited to parks, playgrounds, community gardens, community pools, greenways, community gardens, athletic fields, and biking and walking paths. These spaces are utilized for a myriad of activities.

There are over 2,000 public spaces identified within the Planning Region from data maintained by New York City Parks Department, NYSDEC, and NJDEP. The full list of public spaces broken up by Planning Region is in Appendix A and includes supplemental information about public spaces of historic and cultural significance.

Parks

National Parks, Recreation Areas, and Monuments

The NPS manages a wide range of resources in the Planning Region, the largest of which is the Gateway National Recreation Area (Gateway) and its Jamaica Bay, Staten Island, and Sandy Hook Units, as described in Appendix A8).

In addition to Gateway, the Planning Region also includes the following NPS-managed resources, as listed here are described in Appendix A8 (NPS n.d.).

It is assumed that access to these resources would be limited or blocked as a result of coastal storm damage, as was the case in the aftermath of Hurricane Sandy. The storm caused damage to many of these sites, including significant damage to the Statue of Liberty and Ellis Island. Approximately 75% of Liberty Island and 100% of Ellis Island was inundated by storm surge. The Statue of Liberty was closed to its millions of annual visitors until July 4, 2013 (Allen 2013). Other sites were closed due to limited transportation access to staff and visitors.

New York City Parks

The New York City Parks Department (NYC Parks) is the steward of over 30,000 acres of land, approximately 14% of New York City – including more than 5,000 individual properties. NYSDEC also maintains many parks and recreational facilities within the limits of the city, and all other New York counties.

The development of park spaces is closely tied with public access to waterfronts and waterways. As a result, a large majority of parks within the Planning Region are adjacent to NJ/NY waterways. These spaces provide important ecological habitat and exciting recreational opportunities for the public but are highly vulnerable to coastal storm events and well as anticipated RSLC. After Hurricane Sandy in 2012, New York's parks and other environment facilities sustained downed trees and more at a cost of about $800 million, displaying Public Spaces vulnerability to storm events (Sledge 2012).

In the aftermath of Hurricane Sandy, NYC Parks and NYSDEC have all put an emphasis on restoring and maintaining parklands, as well as incorporating resiliency into park design. Park resiliency is defined as the ability of parks and open spaces to withstand and recover from disruptive events such as coastal storms and catastrophic flooding. Resiliency also refers to these parks' ability to withstand more gradual threats, such as RSLC, associated with global climate change. Resiliency is a key guiding principle for NYC Parks; in addition to advancing resiliency through incorporation of resilient design considerations into individual capital projects, the agency also oversees a number of ongoing initiatives to support citywide resiliency measures. Key initiatives include the creation of overall sustainability goals for planning and design of all New York City Parks, collaboration on neighborhood coastal protection projects like the East Side Coastal Resiliency project to the establishment of a unique multi-party management structure for Jamaica Bay, one of the region's most ecologically valuable, and vulnerable, areas (NYC Parks 2022).

In 2017, NYC Parks released *Design and Planning for Flood Resiliency: Guidelines for NYC* an interdisciplinary manual, that provides background and guidance for developing and renovating coastal resilient waterfront parks. The manual draws from NYC Parks decades of experience with waterfront park planning and design and takes into consideration the valuable lessons learned after Hurricane Sandy (NYC Parks 2017). The report builds upon strategies laid out in 2010.

High Performance Landscape Guidelines (2010), which is NYC Parks' manual for the design and construction of sustainable parks and open space in partnership with the Design Trust for Public Space. The best practices in this manual inform the way New York City's parks are designed, built, and maintained, ensuring that the public spaces clean NYC air and absorb storm water, reduce the urban heat island effect, provide habitat, and address the challenges of climate change (NYC Parks 2022).

NYC Parks and NPS are working together to advance the Jamaica Bay Resiliency Planning. Key components of the planning initiative include a Wetlands Interpretive Center (currently in the conceptual planning stage), a Science & Resiliency Institute being planned in coordination with the City University of New York (CUNY), and a General Management Plan for the park which will guide long-term decision-making over the next 20 years.

The goal of the effort is to keep Jamaica Bay's estuary ecologically intact under the threat of damage from coastal storms (NYC Parks 2022).

New Jersey State Parks

The New Jersey State Park Service administers over 452,000 acres of land comprising parks, forests, historic sites and other recreation areas actively working to manage and promote thriving natural and historic resources. New Jersey state parks and beaches sustained significant damage during Hurricane Sandy, many facilities were closed for weeks, some even months.

Most recently in April 2022, NJDEP released the "The Outside, Together!" plan which aims to give New Jersey an opportunity to ensure that communities have equitable access to the benefits of New Jersey's natural resources. This initiative is emphasized as being imperative as the States continues to assess how climate change will impact recreational activities and the future of natural resources. The plan will look to expand investments in local parks, open space and natural resource restorations (NJDEP 2022).

New York State Parks

After Hurricane Sandy there was significant flooding at Roberto Clemente, Gantry Plaza and East River state parks in New York City, as well as tree and flood damage at parks in the lower Hudson Valley. The greatest amount of damage sustained to a NYSDEC Parks on Long Island, with Jones Beach, Robert Moses and Orient Beach. Early cost estimates of flooding and wind damage at these and other state parks in the affected regions amounted to well over $100 million in the initial clean-up efforts (OSI 2012)

In 2016, NYSDEC released an Open Space Master Plan which addresses eight main goals, one of them being, "address climate change through forest, wetland and riparian area stewardship, ecosystem protection, urban and community forestry, and community planning". The Open Space conservation plan also provides details on priority conservation projects nominated by Regional Advisory Committees, recommends projects for funding, and makes policy recommendations on new initiatives, such as using wetlands and forests to mitigate and adapt to climate change (NYSDEC 2016).

Bike Paths/Greenways

New York City

Each of the five boroughs is home to network of Greenways that are maintained by numerous City and State agencies, below is a sample across the city (NYC Parks 2022): Bronx, Greenway

2.1 Brooklyn, Waterfront Greenway
2.2 Manhattan, Hudson River Greenway
2.3 Queens, Eastern Queens Greenway
2.4 Queens, Jamaica Bay Greenway
2.5 Staten Island, Springville Greenway

New York State

New York State maintains the 750-mile-long Empire State Trail which connects many New York public spaces, and landmarks. The trail runs from New York City through the Hudson River Valley, west to Buffalo along the Erie Canal, and north to the Champlain Valley and Adirondacks (NYSDEC 2022).

New Jersey State

New Jersey is home to many bike trails, most dominantly rail-trails that run through the state connecting state managed park and recreation areas. Some waterfront cities in the Planning Region also maintain biking trails along their shorefronts. An example is the Hudson River Waterfront Walkway. Hudson County offers views of the New York City skyline through its maintained 18.5-mile Hudson River Waterfront Walkway. The path connects Hudson County's scenic waterfront neighborhoods with a pedestrian and bike-friendly walkway from Bayonne, through Jersey City, Hoboken, West New York, and North Bergen, finishing all the way up by the George Washington Bridge, just beyond Fort Lee (Hudson County 2021).

Public Pools

Public pools are a public recreational resource heavily utilized in the urban Planning Region. The City of New York maintains 12 indoor public pools and more than 60 outdoor pools. The City of New York utilizes these resources to host important community cohesion programs such as the "Learn to Swim" program. New Jersey and other parts of New York also house many public pools. These spaces are utilized for recreational and programming (NYC Parks 2022).

Community Gardens

New York City

New York City houses over 550 NYC Parks-affiliated community gardens on city property along with additional community gardens managed by other organizations such as schools, churches, and public housing authorities (NYC Parks 2022). Community Gardens are often located in underprivileged communities which are traditionally subject to coastal storm events. Community Gardens not only provide the vital resource of food to NYC communities, but also serve the purpose of mitigating flooding in these areas. Gardens have been improved over time with the additions of rain gardens, bioswales, and rainwater collection apparatuses. These small changes can be credited with diverting approximately 165 million gallons of storm water from the city streets and sewer systems (Hu 2022). Community gardens are a valuable resource utilized as part of the solution for CSRM as permeable surfaces (Hu 2022).

New Jersey and New York

There are many community-maintained and educationally sponsored gardens in the states of New Jersey and New York, many of which provide the public with free, fresh produce in return for their engagement with the gardens.

Athletic Fields

There is a great number of athletic fields such as ballparks and soccer fields within the Planning Region. Some of these facilities are maintained by public entities, including park managing agencies and local municipalities, while many others are maintained by private entities. These spaces are utilized by youth organizations, schools, summer programs, and adult recreational leagues. They are valued event and cohesion spaces for communities and offer space for physical activity in the more urbanized portions of the Planning Region.

Aviation

Like many urbanized coastal regions, the major airports in the greater New York City metropolitan area are situated directly within the coastal zone, making them vulnerable to coastal flood risk. The consequences of disruption to commercial and passenger air travel can be enormous. For example, PANYNJ estimates a single day shut down at John F. Kennedy airport would result in $96M [2022 USD][7] in disruption costs (NASEM 2021). In addition to the three major airports in the region (John F. Kennedy International Airport; JFK, Newark Liberty International Airport; EWR, and LaGuardia Airport; LGA) the greater New York City metropolitan area is served by several smaller regional airports, heliports, and seaplane bases that are located within or adjacent to the coastal zone.

Major Airports

All three of the major airports in the region (JFK, EWR, LGA), which are among the busiest in the U.S., are situated adjacent to coastal waterways and were constructed by reclamation of coastal marshland. As such, each airport is exposed to flood risk of varying severity under present conditions; all three airports flooded during Hurricane Sandy in 2012 (USACE 2019; FEMA MAC 2021). Though situated within Jamaica Bay, JFK International Airport is largely above the present-day FEMA designated 1% floodplain and is expected to become more vulnerable to storm surge with RSLC. EWR, adjacent to Newark Bay, is more exposed to flood risk at present, with the majority of the airport located within the FEMA designated 0.2% floodplain. LGA, bordering the East River and Flushing Bay, is the most vulnerable of the three airports. Situated within the present-day FEMA 1% floodplain, the airport experienced significant flooding during Hurricane Sandy when the berm surrounding the airport was overtopped during the storm. In response to the flooding, PANYNJ has invested in additional shore-based CSRM measures, pump capacity, drainage improvements, and backup generator upgrades, protecting critical assets up to the FEMA Base Flood Elevation plus 5 feet (2 feet of freeboard and 3 additional feet for future RSLC; USACE 2019). It is assumed the remaining major airports (i.e., JFK, EWR) do not have any additional CSRM projects in place.

Regional Airports and Heliports

In addition to the three major airports, there are two regional airports and two active seaplane bases situated within or adjacent to the coastal zone in the Planning Region. Teterboro Airport (TEB), owned by PANYNJ, situated in the New Jersey Meadowlands and primarily serving private aircraft, is located within the current FEMA 1% and 0.2% floodplains and is potentially exposed to coastal flooding. Linden Airport (LDJ), a municipal owned facility, while not currently within a FEMA designated floodway is adjacent to industrialized and undeveloped tidal marshland within the current FEMA 1% and 0.2% floodplain and is likely to be exposed to coastal flood risk with future RSLC. It is assumed neither of these locations will have any significant CSRM measures in place.

While the runways of the two seaplane bases will remain operable given future expectations of RSLC, adjacent support facilities are directly within the present-day FEMA 1% floodplain. The Little Ferry Seaplane Base, located on the Hackensack River is listed as an active but small base (Federal Aviation Administration 2022). While not much larger, the New York Skyports Seaplane Base is the only seaplane base in NYC and supports private and seasonal commercial flights (DockNYC 2022). This seaplane base is adjacent to the NYC East Side Coastal Resiliency project and will not benefit from the CSRM provided by this project. It is assumed neither of these locations will have any significant CSRM measures in place.

The Planning Region is also home to a number of heliports located directly adjacent to riverbanks or shoreline or within the coastal zone. In addition to accommodating private aircraft for sightseeing and personal or business travel, there are several coastally vulnerable heliports in the region that support emergency services, such as the NYPD’s Aviation Unit, situated in Floyd Bennet Field, and the Palisades General Hospital Heliport in North Bergen, NJ. It is assumed none of the heliports within the Planning Region will have any significant CSRM measures in place.

[7] This number reflects the original estimate of $75.9M in 2018 USD adjusted for inflation to 2022 Q4 price levels using USACE Civil Works Construction Cost Index System (CWCCIS) escalation percentage, as outlined in EM 1110-2-1304.

2.4.8 Schools

School infrastructure in the Planning Region is particularly vulnerable to coastal flooding. Hurricane Sandy displayed the extent to which schools and childcare centers can be impacted by intense storm conditions, leaving thousands of students and teachers without a school to return to since the storm ravaged buildings to the point where they were not considered inhabitable. The storm shut down all 1,750 NYC public schools, which serve 1.1 million students for a full week, and many remained closed or were relocated in the following week. A few schools would not return to their normal location until the following year. A week following Hurricane Sandy, a majority of the city's schools reopened in their normal locations, although many lacked heat. In addition to the challenges of storm clean-up, the 76 schools that were currently being used as shelters had to find a way to allow students back into the classroom while still housing displaced residents.

A variety of factors had to be considered before students could be allowed to return to school after the disaster. Many schools within the Planning Region were left without power and could not reopen until electricity was back on. Gasoline shortages across the region made it difficult to supply emergency services and school buses, in addition to faculty and administration not being able to make it school due to fuel shortages. Structural damage, such as flooding and roof damage, was extensive to schools in some of the hardest-hit areas within the Planning Region. Additionally, school transportation was greatly impacted. Many school buses suffered damage, fuel shortages made it difficult to get them back up and running and fallen trees throughout the region made the navigation of regular bus routes nearly impossible in certain locations.

There was a wide spatial variance in the schools that were affected. The extended school closures largely followed the path of Hurricane Sandy, with effects most strongly concentrated in the Rockaways, Coney Island, and downtown Manhattan, where the storm hit hardest. Although the displaced schools represented a relatively small percentage of the total number of schools, the challenges of relocation imposed a heavy burden on the students and faculty forced to move, the schools accepting those displaced, and on the NYC Department of Education as it coordinated the relocations. The New York City public school system does not have a large buffer of empty schools or seats, so finding a place to send over 20,000 students was an extremely difficult task (Liberty Street Economics, 2012). In addition, transportation was limited, making it difficult for parents to send children to their new school location.

There was also spatial variance in how attendance rates recovered after Hurricane Sandy. For example, the attendance rate of relocated schools in New York City was below 33%, while their average rate in the pre-Hurricane Sandy period was around 91%. Attendance rates were lowest in the Rockaways and Coney Island, which were the areas with significant damage and disruption (Liberty Street Economics, 2012). Nonetheless, there was a large variation in attendance in schools across New York City, and low attendance rates plagued schools in all the city's five boroughs. Perhaps the most important reason behind the low attendance rates in the relocated schools is the long commutes these students faced. For example, some students were relocated to schools halfway across the city or in different boroughs. With the public transportation system in recovery and the school bus coordination in disarray, these treks were undoable for many students.

2.4.9 Aesthetics

Shorelines

The shorelines in the Study Area are characterized by low elevation areas, developed with residential and commercial infrastructure, and is subject to tidal flooding during storms. Coastal storms have played important roles in shaping the present-day shoreline through erosion and movement of sand. Historical and ongoing development of housing and waterfront properties along the coastline has placed many property owners in areas of high vulnerability due to lack of shoreline stabilization, erosion and supportive and protective landforms (2019). These shorelines contain a mix of industrial facilities, commercial, and residential development (USACE 2019). Agricultural lands are also found (upstream) along the shoreline of the Planning Region as well as unremediated landfills.

Recreational Areas

Many of the shorelines in the Study Area are heavily utilized for recreation. There are many maintained beaches with public access, designated wildlife viewing and bird watching areas, amusement park/waterparks, fishing holes, bike trails and scenic areas that have been used by commonly used by the public. (USACE 2019).

Natural Areas

Natural areas within the Planning Region consist of tidal and freshwater wetlands/preserved wetlands, mudflats, riparian forests, estuarine habitat and beaches. These regions support many sensitive ecosystems for bird, fish and other aquatic species. Many areas within the Planning Region include Important breeding grounds for large populations of migratory birds and are used for as ecological Planning Regions (USACE 2019).

2.5 HUMAN ENVIRONMENT (DEMOGRAPHICS & SOCIOECONOMICS)

A demographic analysis utilizing United States Census data was completed in order to understand who lives, works, and otherwise visits the Planning Region, and how they interact with built resources. Important information regarding population, age, housing units, households, income, and poverty broken up by counties within the Planning Regions are summarized in Table 14. Some counties are located within multiple Planning Regions; their data is reflected only once underneath one of the Planning Regions they fall into.

Table 14: Study area demographics.

Planning Region	County	Total Population	Percentage Population under 18	Percentage Population over 65	Housing Units	Households	Median Household Income	Per capita Income	Persons in Poverty
Upper Bay/Arthur Kill Region	Richmond	493,494	21.7%	17.0%	184,162	167,160	$85,381	$38,096	10.6%
	Kings	2,641,052	6.7%	15.1%	1,086,068	972,314	$63,973	$36,295	17.8%
	New York	1,576,876	4.4%	18.3%	916,602	758,720	$89,812	78,771	16.3%
	Hudson	702,463	6.5	12.6%	317,046	261,289	$75,062	$42,822	13.1%
	Union	572,114	6.1%	14.9%	211,074	191,862	$82,644	$42,606	9.2%
	Essex	854,917	6.3%	14.2%	336,299	1,086,068	63,959	$39,695	14.3%
	Middlesex	860,807	21.6%	15.9%	317,113	287,971	$91,731	$40,933	7.4%
Lower Bay Region	Monmouth	645,354	20.8%	18.7%	269,917	238,235	103,523	$53,886	5.9%
Jamaica Bay Region	Nassau	1,390,907	21.5%	18.4%	478,163	449,967	$120,036	$53,363	5.7%
	Queens	2,331,143	20.0%	17.4%	902,824	783,362	$72,028	$33,626	10.3%

Planning Region	County	Total Population	Percentage Population under 18	Percentage Population over 65	Housing Units	Households	Median Household Income	Per capita Income	Persons in Poverty
Hackensack/Passaic Region	Bergen	953,819	21.0%	17.8%	369,209	342,059	$104,623	$52,800	6.4%
	Passaic	518,117	23.7%	15.3%	185,497	168,681	73,562	$33,863	16.9%
	Rockland	339,227	29.2%	15.7%	108,510	101,167	$94,840	$39,923	14.4%
Raritan Region	Somerset	345,647	21.3%	16.7%	133,263	119,721	$116,510	$58,021	4.8%
Long Island Sound Region	Westchester	997,895	21.4%	17.8%	392,186	353,485	$99,489	$57,953	7.6%
	Bronx	1,424,948	24.5%	14.0%	552,470	510,135	$41,895	$22,749	24.4%
Mid-Hudson Region	Orange	404,525	25.6%	14.5%	148,237	130,428	$80,816	$35,616	10.6%
	Putnam	97,936	19.2%	18.6%,	38,359	34,915	$107,246	$47,533	5.7%
	Ulster	182,951	17.2%	20.8%	86,168	70,088	$65,306	$35,816	12.7%
	Dutchess	297,112	18.4%	18.5%	122,641	110,095	$81,842	$42,309	8.3%,
Capital District Region	Greene	48,499	15.9%	23.0%	28,993	17,681	$56,681	$30,970	11.2%
	Columbia	61,778	16.3%	25.4%	33,301	25,323	$68,750	$40,475	10.2%,
	Albany	313,743	18.2%	17.9%	146,813	128,122	$68,327	$38,592	11.3%,
	Rensselaer	160,232	19.2%	18.1%	74,356	65,455	$72,510	$37,011	10.4%
Lower Hudson/East River Region	All Covered								

3 FUTURE WITHOUT-PROJECT CONDITION

Forecasting the future is an essential part of water resources planning. The most important recurring forecasts in the USACE planning process are the future without-project and future with-project conditions. The future without-project condition is a forecast of future conditions without a proposed project in place, while the future with-project condition is a forecast of future conditions with a proposed project in place. The future without-project condition is used as a baseline in comparison of future with-project conditions. This Chapter describes the future without-project condition, and Chapter 6 describes the future with-project condition.

Best available scientific and engineering information and tools are used to predict conditions in the Study Area. Ecological surveys and models described in Appendix A, as well as engineering models and forecasting tools described in Appendix B were used to develop the future without-project condition.

3.1 FUTURE WITHOUT-PROJECT CONDITION ASSUMPTIONS

Important assumptions were used in forming the future without-project condition including assumed coastal resilience projects in the Study Area, Climate Change, and the rate of RSLC used for the analysis presented in this report.

3.1.1 Assumed Coastal Resilience Projects

There are numerous coastal resilience projects currently in differing phases of planning, design, and construction that could affect CSRM in the Study Area. While some efforts are relatively certain to be built as they are near or in construction, others are largely conceptual with uncertainty in scope or funding. The coastal resilience projects will have differing scales of localized and site-specific effects and may or may not substantially change the broader planning for this study. Additionally, the timeframe in which these various studies and projects may be performed or implemented is varied and oftentimes uncertain. The future without-project conditions can be developed to take into account planned and in-progress resiliency projects so vulnerability and risk are managed in areas that will be protected by these soon to be constructed projects. As observed with the incorporation of projects into the vulnerability index for the future without-project conditions, few projects manage risk to a catastrophic event.

Of the 160 projects identified in the SRIRC database, there are approximately 47 assumed projects that could affect economic justification of alternative plans and were factored into the economics modeling of benefits (Figure 23 and Interim Report Plan Formulation Appendix). Dimensions for the projects below (extent and build heights) were factored into the economics modeling of existing conditions, which were then run for the period of analysis from 2044 to 2093.

Table 15: Coastal resilience projects included in the Future-Without Project condition

Amtrak Hudson Yards Concrete Casing	NYC Raised Shorelines
Coney Island Coastal Storm Risk Reduction Project	NYC Rockaway Line Resiliency
Edison Pump Station Mitigation	NYC Transit Flood Resiliency for Critical Bus Depots
Flood Mitigation in Rail Yards – 148th Street	NYC Transit Internal Station Hardening
Hoboken Long Slip Flood Protection	NYC Transit Right-of-Way Equipment Hardening
Hoboken Wet Weather Pump Station H5	NYC Transit Tunnel Portals and Internal Tunnels
Joseph G. Minish Park Coastal Erosion Project	NYU Langone Medical Center
Leonardo Costal Storm Risk Reduction Project	PANYNJ Concrete Sea Wall and Flood Barrier at PATH Harrison Car Maintenance Facility
LIRR Long Island City Yard Resiliency	PANYNJ Exchange Place, Newport Station & Grove Street Station Head House Protection
Metro-North Power and Signal Resiliency	PANYNJ Extension of PATH Rail Yards

Middletown Township Sewer Authority Mitigation	PANYNJ LaGuardia Airport Mitigation
MTA LIRR West Side Yard and East River Tunnel Portal Flood Mitigation	Passaic River Tidal Protection Area, Newark
MTA NYCT Flood Mitigation in Rail Yards – Coney Island Rail Yard	Passaic Valley Sewerage Commission Repairs and Mitigation
MTA NYCT Protection of Transit Street Level Openings	Penn-Moynihan Station Complex-Train-Shed Hardening Project
New York Flood Mitigation in Rail Yards – 207th Street	Port Monmouth Coastal Strom Risk Management Project
New York Harbor Healthcare System	Rebuild by Design – Hudson River
NJ North Hudson Sewerage Authority Mitigation	Rebuild by Design - Meadowlands Flood Protection Project
NJ Transit Train Controls, Signals, Power & Communication Resiliency	Sayerville Pump Station Mitigation
NJDEP Old Bridge MUA Laurence Harbor Floodwall	South Shore of Staten Island Coastal Strom Risk Management Project
NYC Comprehensive Ferry Transit Resilience Project	Staten Island Residential Buyout Program
NYC East Side Coastal Resiliency Project	Union Beach Storm Risk Management Project
NYC Lower Manhattan Coastal Resiliency Project	USACE Oakwood Beach Wastewater Plant Mitigation

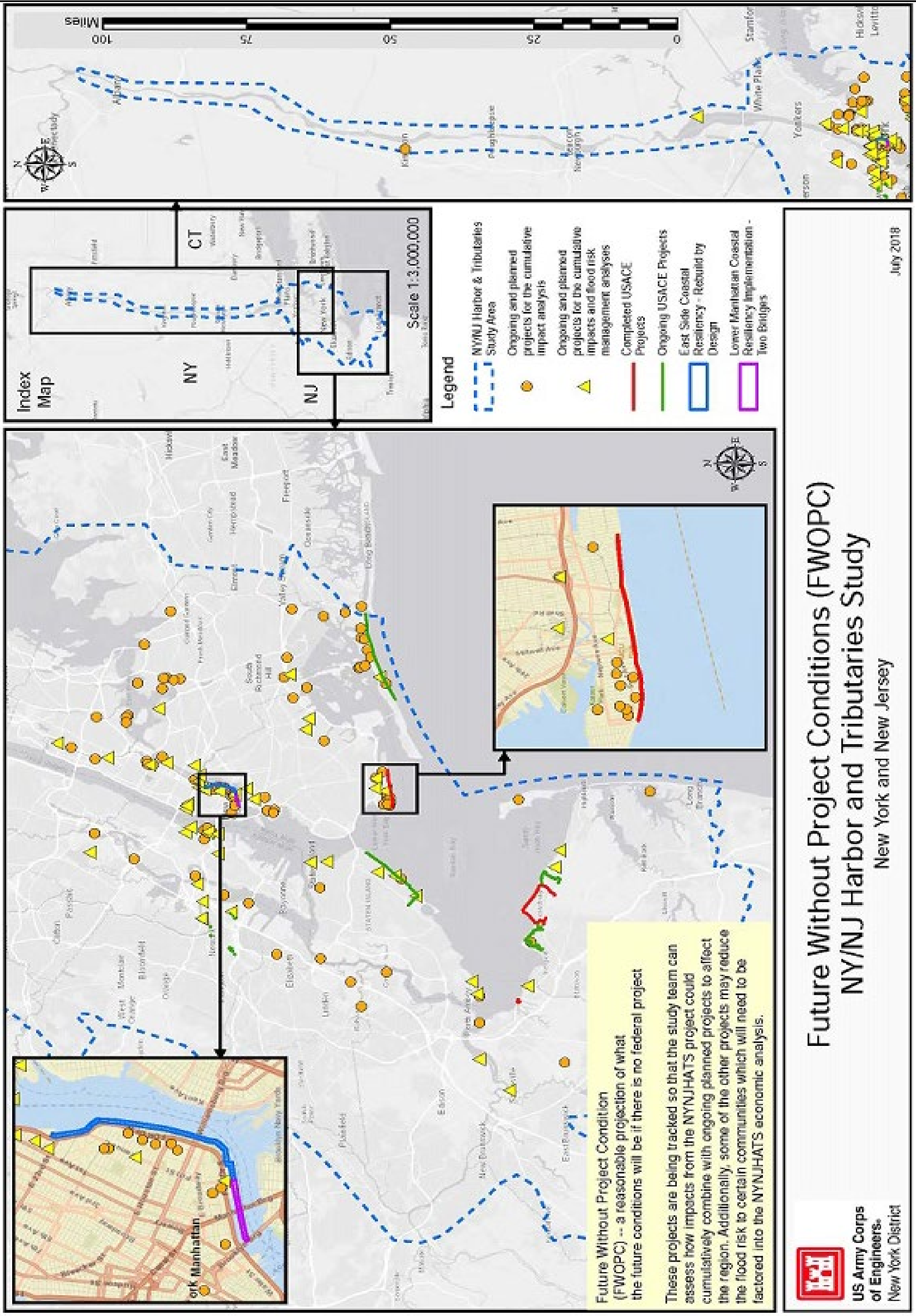


Figure 23. Projects Assumed for the Future Without Project Condition.

Other Coordinated Future Without-Project Condition Projects

Projects funded and into construction by January 2023, which include dozens of single-efforts actions, will be considered in the overall analysis of (possible) benefits for future without-project conditions. Benefits from the following (implemented) projects have been considered in the analysis of cumulative effects of the future without-project conditions (the following projects appear on the list above, as well, and are not considered duplicate projects):

Resilient NJ

Resilient Northeastern NJ (Resilient NENJ) seeks to build climate resilience while improving quality of life for the 700,000 people who live in Jersey City, Newark, Hoboken, and Bayonne, as well as those who work and play in the region. The program launched in the Spring of 2021 to develop a regional Resilience and Adaptation Action Plan (Action Plan) for addressing current and future flooding. The Action Plan outlines clear measures such as policy changes, programs, and capital projects that can ease the financial and resource burdens of unmitigated climate-related risk, protect people and places from flooding, and fostering connectivity and the capacity to adapt. The actions aim to advance efforts already ongoing in the region and to work alongside the New Jersey Statewide Climate Change Resilience Strategy and other statewide initiatives.

Rebuild by Design, Hudson River, NJ

This project is a comprehensive urban stormwater management strategy to address impacts from coastal storm surge flooding as well as systemic inland rainfall flooding. The municipalities of Hoboken, Jersey City and Weehawken were inundated by flood waters during Hurricane Sandy. The U.S. Department of Housing and Urban Development (HUD) awarded $230 million in funds in the form of Community Development Block Grant – Disaster Recovery (CBDG-DR) funding. The program includes four components:

- *Resist*: Hard infrastructure + soft landscaping to act as coastal barriers during high tide/storm surge events
- *Delay*: Reduce the volume of stormwater entering the combined sewer system during rainfall events
- *Store*: Create additional storage capacity in the system to detain stormwater during rainfall events
- *Discharge*: Actively pumping stormwater from the combined sewer system during rainfall events

While the Resist component is being implemented by NJDEP, the City of Hoboken has already started efforts for Delay, Store, and Discharge through additional pump stations, rain gardens, and resiliency parks.

Rebuild by Design, Meadowlands, NJ

The Rebuild by Design Meadowlands Project (RBDM) is a flood risk management project located in Little Ferry, Moonachie, South Hackensack, Teterboro and Carlstadt. After the destruction of Hurricane Sandy in 2012, the U.S. Department of Housing and Urban Development started a program to provide integrated flood-risk management and resilient solutions in flood-prone areas. HUD allocated $150 million towards the design and construction of the Rebuild by Design Meadowlands Project, a solution that will manage flooding risks and enhance resiliency in this area. The designed project improvements help manage flooding from heavy rain events and include new pump stations, channel improvements, a new force main, native planting, green infrastructure-type improvements on public rights-of-way and at existing municipal buildings, and a proposed waterfront park on the Hackensack River.

Red Hook, Brooklyn, NY

The City of New York is expected to complete the design phase of the Red Hook Coastal Resiliency Project (RHCR) by the end of 2022. RHCR is an integrated coastal protection system for more frequent, lower intensity coastal storm surges and tidal flooding. Community engagement is a key component for project development since the earliest stages of project feasibility. The project has also aimed to maintain access to the waterfront, and create improved public spaces in response to six years of community engagement. The Red Hook Coastal

Resiliency Project will be a critical step toward ensuring a more resilient Red Hook community in the face of future extreme weather and a changing climate.

East Harlem, Manhattan, NY

In 2018, the City of New York led a planning Study in East Harlem for the area spanning 94th – 155th Street in Manhattan, resulting in a Vision Plan for a Resilient East Harlem. The Vision Plan was released in late 2019 and identifies how East Harlem can be a stronger and safer community in the face of a changing climate, including risks from increased flooding (i.e. future RSLC, storm surge, increased precipitation) and higher temperatures. In developing the plan, the City of New York brought together residents, students, and community groups to identify open space improvements and community programs that will help East Harlem adapt to the risks presented by climate change. The plan highlights a vision for the community to manage the risk from stormwater flooding, to create resilient public spaces, and to adapt the waterfront and integrate it with the city's drainage infrastructure. Recommendations from the Vision Plan are being incorporated into ongoing City of New York projects, including the Manhattan Greenway Harlem River project to build a new park from E125th St – E132nd St, 107th St Pier Reconstruction and "Bobby Wagner Walk" on the East River Esplanade, and NYCHA's A Resilient Clinton stormwater resiliency project, all in Manhattan.

Financial District (FiDi)/Seaport, Manhattan, NY

After detailed engineering studies completed December 2021 as a part of the Financial District and Seaport Climate Resilience Master Plan and earlier efforts, the City of New York concluded that flood defense solutions on existing land are not feasible due to conflicts with nearby sub-surface and above ground infrastructure. Further, the City of New York found that on-land solutions would reduce or eliminate access to important waterfront transportation and recreational facilities. Therefore, the City of New York determined that extending the shoreline of Lower Manhattan into the East River is necessary to build flood defense infrastructure that is reliable, is technically viable, and that meets the needs of waterfront users. USACE New York District's Regulatory Branch, as a key regulator overseeing in-water construction, convened the Aquatic Regulatory Advisory Committee (ARAC) in conjunction with city, state, and other Federal regulatory agencies to review these efforts over the last several years. USACE and the City of New York will continue to coordinate and collaborate to further advance and refine the design.

3.1.2 Climate Change and Relative Sea Level Change Assumptions

Global climate change and RSLC has been a persistent trend for decades and is anticipated to continue beyond the end of this century, which will cause significant impacts throughout the Study Area. The IPCC predicts that RSLC coastal risks will increase by at least one order of magnitude over the 21st century (IPCC 2022). Scientists have very high confidence (greater than 90% chance) that global mean sea level will rise at least 8 inches (0.2 meter) and no more than 6.6 feet (2.0 meters) by 2100 (USACE 2013a).

RSLC is defined as a change in the mean ocean level due to the effects of climate change. "Local" or RSLC is the locally observed RSLC relative to a fixed point. RSLC considers the effects of (1) the eustatic, or global, average of the annual increase in water surface elevation due to climate change trends, and (2) the "regional" rate of vertical land movement that can result from localized geological processes, including the shifting of tectonic plates, the rebounding or subsidence of the Earth's crust in locations previously covered by glaciers, the compaction of sedimentary strata and the withdrawal of subsurface fluids. USACE ER 1100-2-8162 (December 31, 2013)[8] requires that future projections be incorporated into the planning, engineering design, construction,

[8] An overview of how USACE considers RSLC can be found at: https://planning.erdc.dren.mil/toolbox/library/LessonsLearned/Quick%20Reference%20-%20Climate%20Considerations%20Oct2018.pdf

and operation of all civil works projects. The Study team should evaluate the proposed alternative plans in consideration of the "low," "intermediate," and "high" potential rates of future RSLC for both "with" and "without project" conditions. This range of potential rates of RSLC is based on findings by the National Research Council (NRC, 1987) and the Intergovernmental Panel for Climate Change (IPCC, 2007). The historic rate of future RSLC is determined directly from gauge data gathered in the vicinity of the Study Area. As presented in ER 1100-2-8162, the historic rate of RSLC represents the "low" scenario. The "intermediate" rate of local mean RSLC is estimated using the modified National Research Council (NRC) Curve I and equations 2 and 3 and is corrected for the local rate of vertical land movement. The "high" rate of local mean RSLC is estimated using the modified NRC Curve III and equations 2 and 3 and is corrected for the local rate of vertical land movement. This "high" rate exceeds the upper bounds of IPCC estimates from both 2001 and 2007 to accommodate the potential rapid loss of ice from Antarctica and Greenland, but it is within the range of values published in peer-reviewed articles since that time.

Additionally, ER 1100-2-8162 allows for the use of a single scenario to identify a TSP or preferred alternative, and evaluate the performance of that alternative under the other two scenarios. When using this approach, the most important consideration in the selection of a scenario is the sensitivity of the project area and the array of alternative plans to RSLC, and the adaptability of the available plans or the plan which is likely to be selected. For this study, the intermediate RSLC scenario was used for the conceptual designs and costs presented in this report.

While USACE formulates to USACE-derived RSLC projections, the Study team is coordinating with the non-federal sponsors and partners on their own RSLC projects. USACE, New York City Panel on Climate Change, and New Jersey's RSLC projections in the Study Area are shown in Figure 24 and all show the same trends across the 50-year economic period and 100-year planning horizon. The planning horizon, which is a 100-year period to account for the effects of relative sea level change, has been identified as 2016 - 2115 (starting from the initiation of this study).

Due to the spatial extent of the Study Area, there are multiple RSLC curves for the area, and the sensitivity of plan formulation to RSLC varies greatly. USACE projections for the Study Area range from an increase of +0.7 feet for the low scenario up to five feet for the high scenario through 2100. For purposes of considering the potential impacts of RSLC during initial plan formulation, the Study team used the USACE intermediate rate of RSLC (an increase of +1.8 feet through 2100) as a rough approximate for the median, to decrease the amount of adjustment needed later for future rounds of formulation, when the low and high rates will be evaluated as well. The 50-year economic period and 100-year planning horizon (2044-2143) is shown in Figure 24. Based on a desktop inventory of structures compiled for the Hydrologic Engineering Center – Flood Damages Analysis (HEC-FDA) model, the expected average annual damages in the future without-project conditions are $5.1 billion in 2030 and expected to increase to approximately $13.7 billion by 2100, based on the intermediate rate of RSLC.

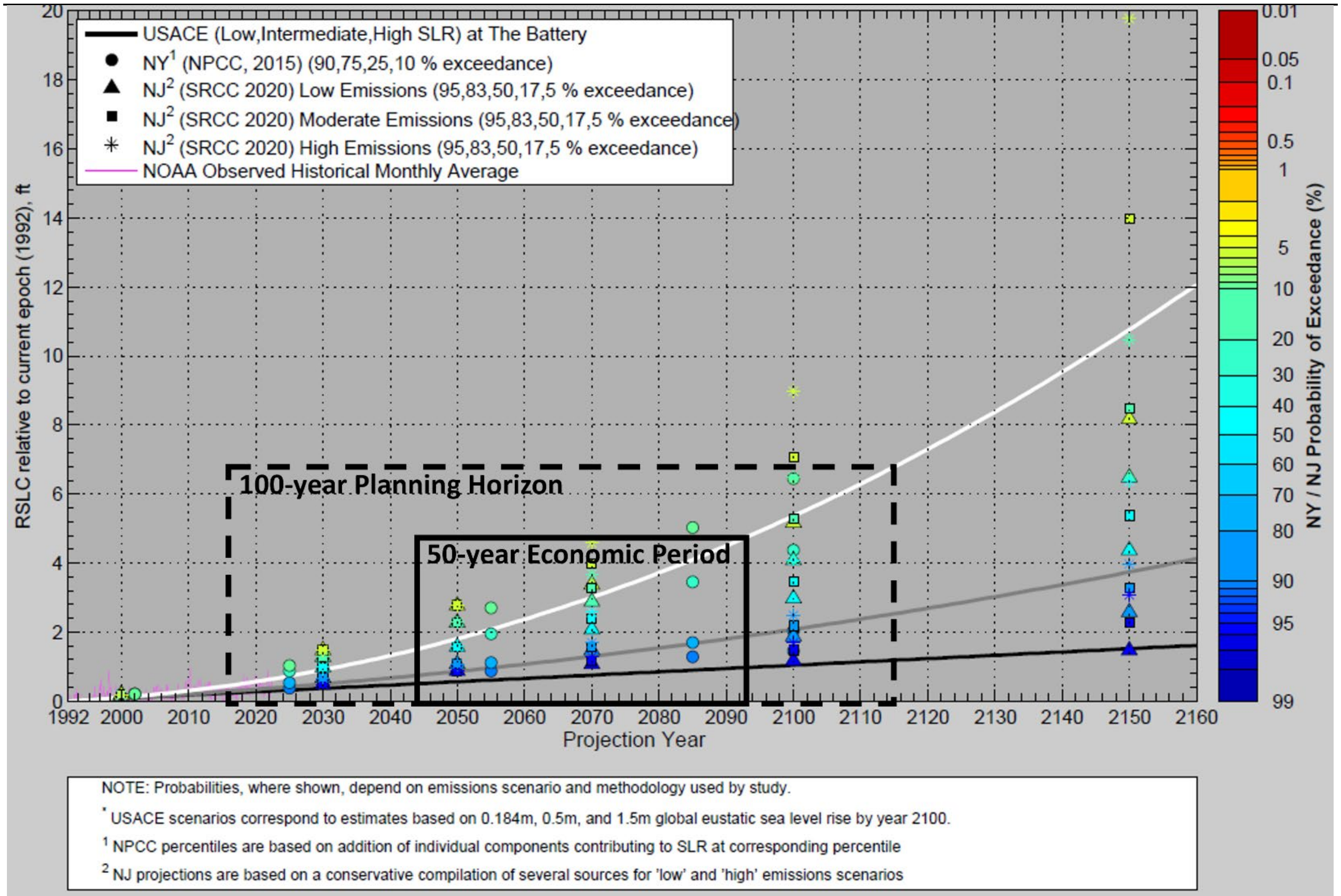


Figure 24: Comparison of Relative Sea Level Change Projections

The following discusses general trends of projected climate change and RSLC related effects to the future without-project condition throughout the Study Area by Planning Region. These trends and analysis may vary to different degrees depending on existing conditions, source data, and existing recent reports relative to each region:

Capital District Region, Mid-Hudson Region, and Lower Hudson/East River Region

Climate change impacts including rising sea levels may exacerbate the loss and degradation of sensitive ecosystems, increase shoreline erosion, and adversely affect proposed development. Studies show that this region could experience a rise of 6 to 36 inches by the year 2077. This could lead to extensive reaches of hardened shorelines, reduced shallow water environments, diminished connectivity, and degraded sediment distribution processes. Degraded sediment distribution processes will lack the resiliency to adequately adapt to such changes leaving this region vulnerable to devasting impacts. Areas of wetlands will not be able to migrate due to space constraints, sediment accretion rates in these wetlands will not be able to sustain with rising water elevations and shallow waters will deepen, resulting in further habitat loss (USACE 2020a).

Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, Lower Bay Region, and Raritan Region

Degradation of ecosystems in these Planning Regions is expected to continue with losses of area and quality of riparian, wetland, and aquatic habitats. Wetlands and marshes along the bay will decrease in acreage due to erosion, subsidence, and relative seal level change. Despite the cleanup of legacy sediment in the Lower Passaic River proper, the environmental health of the Newark, Hackensack River and Passaic River Planning Region are still expected to decline or remain continuation of the existing condition in the absence of ecosystem restoration due to climate change and RSLC. Those declining conditions include continued losses of low-lying coastal habitats from erosion and sedimentation. These environmental changes are associated with long-term nature of RSLC effects and the variables intrinsic to predicting global carbon emissions, global climate conditions and the resulting effects of seal level. There are ranges in RSLC projections that take into account various scenarios (New York City Panel on Climate Change, 2009).

Jamaica Bay Region and Long Island Sound Region

A Nature Conservancy report on climate change-related impacts in New York State predicts a minimum temperature increase of 5 degrees Fahrenheit by 2100, RSLC related damages to coastal habitats and existing infrastructure, a decline in drinking water quality and quantity, declining freshwater and saltwater fish populations, and further degradation of air quality ultimately resulting in exacerbated unhealthy conditions (The Nature Conservancy 2006). This same report further states:

Climate projections developed by New York State indicate a future increase in temperatures, precipitation, sea levels, and severity of flooding (NYSDEC, 2018b). The State's average annual temperature is expected to increase approximately four to six degrees F by mid-century and as much as 11 degrees F by 2100. The total annual precipitation is expected to increase as much as 11% by mid-century and 18% by 2100. These changing climatic factors will likely alter flooding patterns in the Hudson River. It is projected that today's 1% storm will become 20 to 50% more likely by 2020 and as much as 610% more likely by 2100 (New York State, 2018 and USACE 2020a). According to the 2022 IPCC Report, climate change-related impacts have become more frequent, more intense, and are affecting millions of people across North America. Climate change risks are anticipated to continue to rapidly increase by the mid-century causing irreversible changes to ecosystems, damage to infrastructure, economic stress, adverse effects to mental and physical health, and threats to recreation and life safety (IPCC 2022).

3.1.3 Summary

The Study Area, as it stands, is vulnerable to coastal damage from storm surge, wave attack, erosion, and intense rainfall events that can also cause riverine or inland flooding. These forces constitute a threat to human life and increase the risk of flood damages to public and private property and infrastructure. Global climate change and historic RSLC has exacerbated flooding over the past century, and potential RSLC in the future will only increase the magnitude, frequency, and extent of the problem. Since 1900, sea level in the lower Hudson has risen 13 inches. RSLC along the Hudson River is projected to continue. The Hudson River is projected to rise a minimum of nine additional inches by 2050, with mid-range projections of approximately 10 to 20 inches by 2050 (New York State, 2018 and USACE 2020a). As sea levels continue to rise, coastal storms will cause flooding over a larger area and at increased heights than they otherwise would have in the past. The States of New Jersey and New York, in their respective state hazard mitigation plans, have documented the numerous, historic instances of flooding, Presidential disaster declarations, and damage estimates. Coastal storms have and will continue to cause flooding and severe impacts to the NYNJHAT Study Area. It is projected that the frequency and intensity of these coastal storms will increase (NPCC2, 2013).

With storm frequency and strength increasing, human life continues to be more at risk because of the lack of shoreline protection. In the future without-project conditions, coastal storms could cause an increased disruption of emergency operations, damage to homes or properties, and loss of life. While flooding coming from increased precipitation events could cause additional dangers in that CSO has been linked to higher pollution rates in waterways within the Study Area. Within the past ten years since Hurricane Sandy, infrastructure investments have been made on a Local, State, and Federal level within the Study Area to increase resiliency of the shoreline and adjacent structures. While there have been more resiliency projects successfully designed and built, destruction of historical structures and irreplaceable ecosystems continues to be an ongoing issue in the Study Area. Loss of habitat by conversion of forests, grassland and coastal habitats to commercial, residential, and industrial development has contributed to species loss. Future development and habitat loss is expected to occur and effect the listed species over the temporal scale of the NYNJHAT Study (i.e., over the next 50 years). Given the rate of change associated with climate impacts (i.e., on a decadal to century scale), it is likely that climate related impacts will influence the status of any listed species over the temporal scale of the NYNJHAT Study (i.e., over the next 50 years) or that the abundance, distribution, or behavior of those species in the Study Area will significantly change as a result of climate change impacts. More information about ecosystem changes from global climate change and the impact it has on the future without-project can be found in Chapter 6.

4 PLANNING PROCESS

This chapter describes the planning process used in identifying and evaluating alternative plans and selecting a Tentatively Selected Plan (TSP). It includes a summary of problems and opportunities; inventory and forecast; and plan formulation, evaluation, comparison, and selection. It describes each step of the planning process, including data sources, considerations, and assumptions that informed identification of the TSP.

4.1 USACE PLANNING PROCESS

The USACE Civil Works planning process follows a standard approach to identifying and evaluating potential water resource solutions in order to ensure potential federal projects comply with applicable laws and guidance. The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (Principles and Guidelines, or P&G) provide guiding principles for the USACE planning process. The 2013 PR&G supersedes the 1983 P&G, though both are used to guide the planning process. ER 1105-2-100 Planning Guidance Notebook and the Planning Manual Part II: Risk-Informed Planning lay out an iterative planning process used for all USACE Civil Works studies in developing and evaluating alternative plans (IWR 2017).

The iterative six-step USACE planning process is outlined in the P&G and ER 1105-2-100, and was modified by the Planning Manual Part II into a risk-informed planning process (Figure 25). The six steps are denoted on the figure and include identifying water resource problems and opportunities (Step 1), inventory and forecast of existing and future conditions (Step 2), plan formulation (Step 3), plan evaluation (Step 4) and comparison (Step 5), and finally plan selection (Step 6), with evidence gathering, risk management, and stakeholder involvement as taking place throughout the process. This chapter describes the completion of each of these steps.

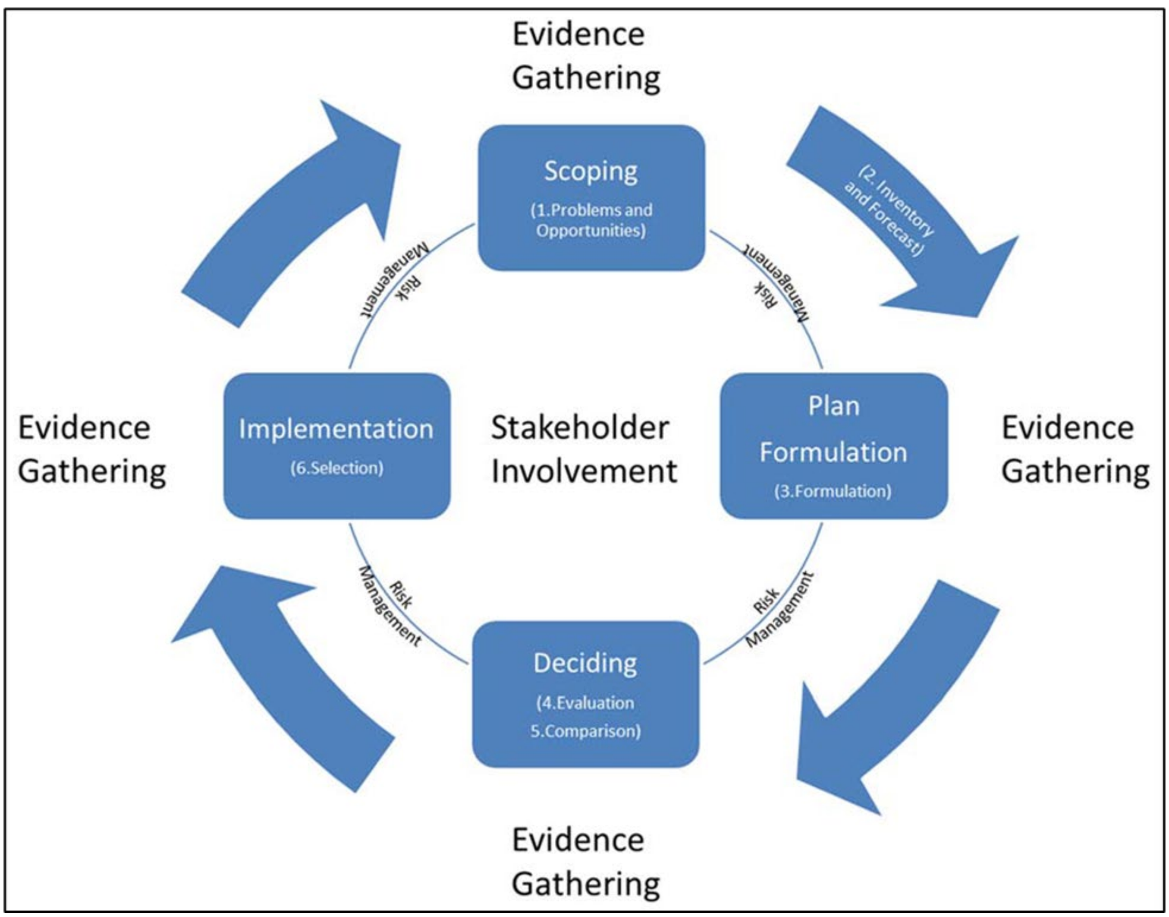


Figure 25: USACE risk-informed planning process (from IWR 2017).

4.1.1 The Planning Process, NEPA, and Tiering

NEPA requires federal agencies to consider the potential environmental impacts of proposed actions and any reasonable alternative plans before undertaking a major federal action, as defined by 40 Code of Federal Regulations (CFR) 1508.18. The procedures outlined in the PR&G, P&G, ER 1105-2-100, and the Planning Manual Part II complement and are consistent with USACE NEPA guidance, including ER 200-2-2 Procedures for Implementing NEPA.

4.2 PROBLEMS AND OPPORTUNITIES

Problems: A problem statement is the detailed description of a problem that helps guide the planning process. It informs the identification of the study's goals and objectives, and ultimately plan formulation, comparison, and selection. The problems can be summarized as follows:

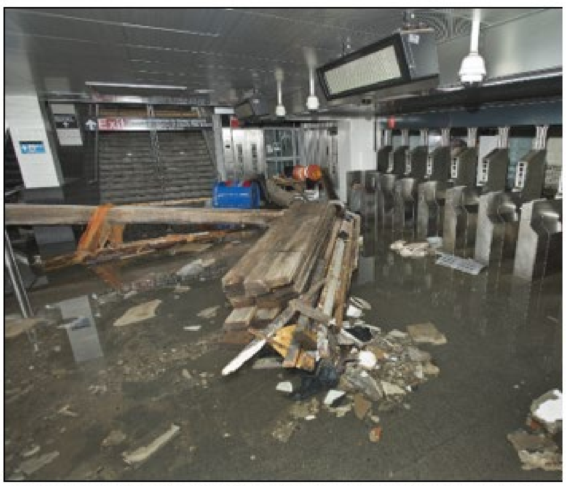
- Coastal storm flooding, impacting nationally important areas/facilities, critical infrastructure, societal resources, communities, and the environment
- Threats to life safety

Coastal storm flooding significantly impacts nationally important areas, critical infrastructure, societal resources, communities, and ecosystems in the study area.

Photos of damage to the Study Area resulting from Hurricane Sandy (2012) are in Figure 26 and Figure 27.

Damage to house in Brooklyn, NY
(Proud Novice, 30 Oct 2012)

Damage in Breezy Point, NY
(Courtade; 14 Nov 2012)



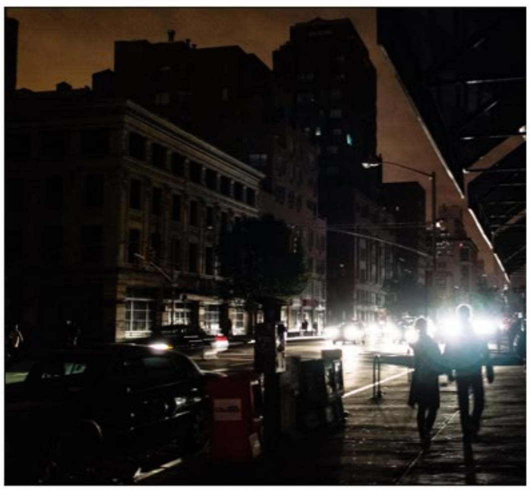
MTA New York City Transit South Ferry subway station after it was flooded by seawater during
(Cashin, 30 Oct 2012)

Destroyed popular pedestrian bridge at Liberty State Park, NJ
(Arias, 23 Sep 2013)

Figure 26: Damage From Hurricane Sandy, Examples 1

Damage to main roadways used for connecting the Ports moving commerce in Newark, NJ
(DuBrowa, 12 Dec 2012)

Howard Beach, Queens, NY
(Andrade, 31 Oct 2012)



Blackout and the streets of lower Manhattan.
(Nguyen, 31 Oct 2012)

New Jersey National Guard Soldiers assist displaced residents at the town of Hoboken
(Davis, 1 Nov 2012)

Figure 27: Damage from Hurricane Sandy, Examples 2

Opportunities: Opportunities are instances in which the implementation of a plan has the potential to create a desirable future condition and provides ways to address the specific problems within the study area. The primary opportunities identified for the study area are:

- Manage coastal storm flood risk
- Better communicate coastal storm risk to communities
- Restore natural systems in ways that provide CSRM benefits
- Contribute to community resilience
- Contribute to resilience of infrastructure and the economy

4.3 PLANNING GOALS AND OBJECTIVES

Planning Goals: Planning goals describe the overarching intent of the project and helped in creating and evaluating alternative plans. The planning goals are to:

- Manage the risk of coastal storm flood damage in the study area
- Contribute to National Economic Development by managing coastal flood risk, consistent with protecting the Nation’s environment, pursuant to applicable laws, guidance, and requirements

Objectives: Planning objectives describe the desired results of the planning process. Objectives are based on problems and opportunities. The planning opportunities are to:

- Reduce the risk of coastal storm damage to communities, public infrastructure, important societal resources, and the environment
  Metric: *dollars economic damages reduced as calculated by the HEC-FDA model*
- Improve the community's ability to recover from damages caused by storm surges by reducing the duration of interruption in services provided by man-made and natural systems
  Metric: *qualitative analysis of how a project would aid the community in recovery from storms by reducing damages*
- Enhance human health and safety by improving the performance of critical infrastructure and natural features during and after storm surge events
  Metric: *qualitative analysis of how a project would aid the community in recovery from storms by reducing damages*
- Restore natural coastal features that have ability to reduce coastal storm risk for communities and ecosystems
  Metric: *qualitative analysis of how a project would aid the community in recovery from storms by reducing damages*

4.4 PLANNING CONSTRAINTS AND CONSIDERATIONS

Unlike planning objectives that represent desired positive changes, planning constraints and considerations represent restrictions that should not be violated or avoided, if possible. The formulation and evaluation of alternative plans are constrained by technical, environmental, economic, regional, social, and institutional considerations.

Constraints: Constraints are restrictions that limit the extent of the planning process. Constraints are designed to avoid undesirable changes between the with- and without-project conditions. They can be divided into universal constraints and study-specific constraints. Universal planning constraints are the legal and policy constraints to be included in every planning study. Study-specific planning constraints are statements of things unique to a specific planning study that alternative plans should avoid. Study-specific constraints include:

- Minimize impacts to ongoing recovery, ecosystem restoration, and risk management efforts by others
- Minimize impacts to resources within the Gateway National Recreation Area.

- Minimize impacts to access for federal navigation channels
- Minimize induced flooding in areas not currently vulnerable to flooding and minimize induced additional flooding in flood-prone areas
- Minimize impacts to community access and egress during emergencies
- Minimize impacts to operations at international airports
- Minimize negative effects to plants, animals, or critical habitat of species that are listed under the federal Endangered Species Act or a New York State Endangered Species Act

Considerations: Considerations are important values and things that are folded into the planning process but do not limit it. Study constraints include:

- Local sensitivity to certain measures (e.g., acquisition, unintended adverse impacts to communities and/or the environment)
- Enhancing sustainability by incorporating resilient features
- Complement other post-Hurricane Sandy resilience projects and planning efforts (avoid duplication of effort)
- The effect of relative sea level change in the study area

4.5 COASTAL STORM RISK MANAGEMENT MEASURES

Measures are features or actions that contribute to the planning objectives. Project-specific measures were developed to address problems and to capitalize on opportunities. They were derived from a variety of sources, including prior studies including the NACCS, the NEPA scoping process, and coordination with the non-federal sponsors (USACE 2013b). Appendix B includes detailed information about these measures.

4.5.1 Structural Measures

Structural measures reduce flood risk by modifying the characteristics of the flood. They are physical modifications designed to reduce the frequency of damaging levels of flood inundation. Structural measures are often employed to reduce peak flows (flood storage); direct floodwaters away from flood prone property (flood barriers); or facilitate the flow of water through or around an area (channel modifications or diversions). They may be used alone or in combination with other measures.

STRUCTURAL MEASURE TYPES

Shore-Based Measures
Land-based measure that can impede coastal storm flooding

Risk Reduction Feature
Land-based or in-water feature that can reduce residual coastal storm flooding prior to closure of a storm surge barrier, and to address risk behind a storm surge barrier due to interior drainage or other hydrodynamics.

Induced Flooding-Mitigation Feature
Land-based or in-water feature that can offset the impacts of increased water levels due to the presence of a storm surge barrier

Storm Surge Barriers
In-water structural measure consisting of navigable and auxiliary gates that can be opened and closed to impede coastal storm floods

Categorization by Function

Structural measures provide various functions that serve to support a coordinated approach to coastal storm risk management. For example, some structural measures manage flooding from higher-frequency coastal storms but not large hurricanes. Other structural measures can serve to manage potential induced flooding caused by complementary measures.

Structural measures were categorized by four major functions – Storm Suge Barrier, Risk Reduction Features, and Induced Flooding-Mitigation Features, and Shore-Based Measures. These terms are used throughout this report to denote the function of a particular structural measure.

Storm Surge Barriers. Storm Suge Barriers are in-water structural measure consisting of navigable and auxiliary gates that can be opened and closed to impede coastal storm floods. They provide a large-scale, regional approach to coastal storm risk management by impeding flood waters from traveling to shorelines.

Risk Reduction Feature. Risk Reduction Features are land-based or in-water feature that can reduce residual coastal storm flooding prior to closure of a storm surge barrier, and to address risk behind a storm surge barrier due to interior drainage or other hydrodynamics. They are used in concert with Storm Suge Barriers and are not a stand-alone measure.

Induced Flooding-Mitigation Feature. Induced Flooding-Mitigation Features are land-based or in-water feature that can offset the impacts of increased water levels due to the presence of a storm surge barrier. They are used in concert with Storm Suge Barriers and are not a stand-alone measure.

Shore-Based Measures. Shore-based measures are land-based measure that can impede coastal storm flooding. They typically tie into high ground or other measures.

Measures Considered

The following structural measures were considered. A singular measure may provide different functions, and so it can be defined by more than one functional category. For example, a floodwall can provide coastal storm risk management to an area on its own (shore-based measure). It can also be used to manage induced flooding (Induced Flooding-Mitigation Features). This section describes structural measures without distinguishing by function.

Berms. Berms are earthen structures that are wide at the base and tapered toward the top, made of compacted soil with grassy vegetation on top. They are smaller versions of levees.

Beach Renourishment. Beach renourishment consists of placing sand material onto an existing beach. Note this measure can also be considered a Natural and Nature-Based Feature, as described later in this section.

Breakwater. Breakwaters are structure constructed at a coastal area to manage the effects of tides, currents, waves, and storm surges. They are typically made of stone and are built in-water near the shoreline.

Bridge Trash Rack. Bridge trash racks are gate- or mesh-like structures that act to sieve trash from waterways and drainage features.

Bulkhead. A bulkhead consists of a steel sheet pile wall and reinforced concrete pile cap. While a bulkheads' main function is usually to retain and prevent sliding of land, bulkheads can reduce the risk of upland flooding if vertically extended beyond existing grade and constructed watertight.

Figure 28: Floodwall under construction in New Orleans, LA.

Deployable Barriers. Deployable barriers are temporary coastal storm risk management measures that could be deployed manually or passively. For example, a flip-up barrier is a passive deployable flood barrier. The passive deployment mechanism allows deployment of flip-up barrier without any involvement from operation personnel and is operated by physics (i.e., water pressure) and activated when the design conditions are met (i.e., at the onset of submergence of the base). Deployable barriers are categorized as structural measures in this report, though they are sometimes categorized as nonstructural measures.

Elevated Promenade. An elevated promenade preserves an accessible waterfront space and viewshed. It is typically constructed along a shoreline.

Floodwalls. Floodwalls are typically reinforced concrete structures that are built to prevent floodwaters and storm surge from reaching at-risk areas. They are typically built parallel to a waterway.

Floodwall with Park Integration. A variation of a floodwall, this measure consists of a floodwall with park integration that provides or maintains a public amenity and open space along the waterfront.

Groin. Groins are shore perpendicular structures, used to maintain updrift beaches or to restrict longshore sediment transport. They are typically made of stone and are built in-water near the shoreline.

Jetty. Jetties are shore perpendicular structure and are placed adjacent to tidal inlets and harbors to control inlet migration and minimize sediment deposition within the inlet.

Levees. Levees are earthen structures that are wide at the base and tapered toward the top, made of compacted soil with grassy vegetation on top. Levees are typically built parallel to the water way.

Reinforced Dune. A reinforced dune is a sheetpile wall that is covered fully or partially by with material such as rubble and/or sand.

Seawall. Seawalls are composite structures and is comprised of a rubble mound structure and reinforced concrete floodwall. They are typically built parallel to a waterway.

Tide gate. Tide gates are in-water structures that stay open under normal conditions to let tidal flow pass but are closed when water levels are expected to exceed a certain level. A tide gate is typically a reinforced concrete superstructure supported on steel pipe piles.

Storm Surge Barrier. A storm surge barrier is an in-water structure that prevents floodwaters from traveling into an area when its gates are closed. A storm surge barrier can consist of navigable and/or non-navigable gates.

Figure 29: Bulkhead at S. 5th Street Brooklyn,

Navigable Gate. Navigable gates are in-water structures that, when open, allow for marine traffic. When closed, they prevent floodwaters from traveling into an area.

Figure 30: Tide gate along a navigable waterway in Louisiana.

Revetment. Revetments are structures that reduce erosion caused by wave action, storm surge, and currents.

Pedestrian and Vehicular Gate. Pedestrian and vehicular gates are structures that, when open, allow for the passage of people and vehicles. When closed, they prevent floodwaters from traveling into an area.

Road Raising. Road raising consists of raising an existing road's surface elevation to use the road itself as a berm-like feature, thus reducing the risk of flooding on one side of the road. In order to raise the road surface, any connecting driveway or side street may need to be raised and ramped to meet the raised road. In addition, buried retaining walls may be used to support the increased height of the roadway.

Ringwalls. Ringwalls are floodwalls or levees constructed to encircle individual structures or small groups of structures. Ringwalls typically surround the entire building or property with a limited number of access points. They are subject to the same design standards as floodwalls.

Stormwater System Improvement. Improvements to stormwater systems include physical changes to system components that could expand or otherwise improve flow.

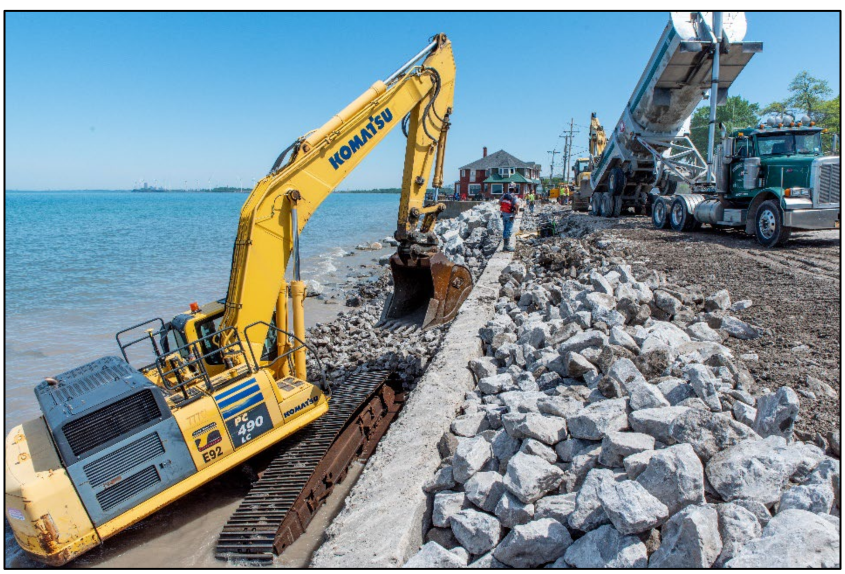


Figure 31: Seawall under construction in Athol Springs, NY.

4.5.2 Nonstructural Measures

Nonstructural measures are permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding. Nonstructural measures differ from structural measures in that they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding.

Nonstructural measures can be grouped into two categories: physical and non-physical measures. Physical nonstructural measures include actions that require modifications to a property or structure. They include structure elevation, dry and wet floodproofing, basement removal, relocation, and acquisition. Nonphysical nonstructural measures do not modify individual structures, but rather focus on behaviors and plans that reduce flood risk.

They include evacuation plans, flood warning systems, flood insurance, floodplain mapping, emergency preparedness plans, risk communication, and land use regulations and zoning.

Figure 32: Home elevation on Long Island, NY.

Acquisition (Buyout). Acquisition involves purchase and elimination of flood damageable structures, allowing for inhabitants to relocate to locations away from flood hazards. Lands can then be preserved for open space, recreation, or other uses. USACE policy requires that acquisition recommendations become mandatory and include the potential use of condemnation if necessary.

Basement Removal. Basement removal includes filling of or otherwise removing a basement of a structure.

Dry Floodproofing. Dry floodproofing allows floodwater to enter the structure, vulnerable items such as utilities appliances and furnaces are relocated or waterproofed to higher locations. By allowing floodwater to enter the structure hydrostatic forces on the inside and outside of the structure can be equalized reducing the risk of structural damage.

Elevation (Raising). Elevation involves raising the lowest finished floor of a building to a height that is above the flood level. This nonstructural technique lifts an existing structure to limit floodwaters from reaching living areas.

Emergency Preparedness Plans. Emergency preparedness plans are guides that include information about how to prepare for emergencies such as a coastal storm.

Evacuation Plan. Evacuation plans are guides that outline when and how residents will evacuate prior to an emergency such as a coastal storm. They typically supplement or are part of an emergency preparedness plan.

Flood Insurance. Flood insurance provides financial benefits for property owners who hold policies. Insurance can be used to offset economic losses due to coastal storm damage.

Floodplain Mapping. Floodplain mapping consists of using maps to communicate flood risk. Flood maps are typically generated using hydraulic and hydrodynamic models.

Flood Warning System. A flood warning system is a communication pathway that can afford residents advance warning of flooding and allow them time to make appropriate preparations. While a flood warning system does not prevent flooding and does not reduce damage to property that is left in the path of floodwaters, it can provide an aid in reducing property loss and increasing the safety of individuals.

Figure 33: Dry floodproofing in the Midwest.

Land Use Regulations and Zoning. Through proper land use regulation, floodplains can be managed to ensure that their use is compatible with the severity of the flood hazard. Several means of regulation are available, including zoning ordinances, subdivision regulations, and building and housing codes. Their purpose is to reduce losses by controlling the future use of floodplain lands and would not be effective in mitigating the existing hazard.

Relocation. Relocation involves moving people or structures out of the floodplain. USACE policy requires that relocation recommendations become mandatory and include the potential use of condemnation if necessary.

Risk Communication. Risk communication is the exchange of information between experts and people who face a hazard such as a coastal storm.

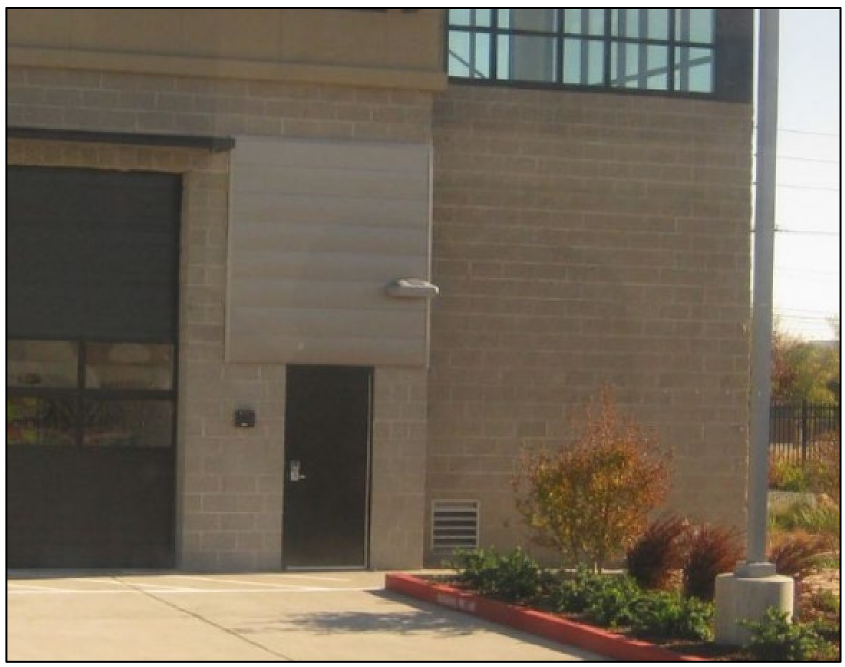


Figure 34: Wet floodproofing in Sacramento, CA.

Wet Floodproofing. Wet floodproofing allows floodwater to enter the structure, vulnerable items such as utilities appliances and furnaces are relocated or waterproofed to higher locations. By allowing floodwater to enter the structure hydrostatic forces on the inside and outside of the structure can be equalized reducing the risk of structural damage.

4.5.3 Natural and Nature-Based Features

Natural and nature-based features (NNBFs) are habitats or features that may reduce flood risk while providing ecosystem benefits. NNBFs considered include dunes and beaches, vegetated features, oyster and coral reefs, barrier islands, and maritime forests/shrub communities. Note some of these measures are also considered structural measures.

Barrier Island. Barrier islands are coastal landforms that are typically flat areas of sand that form by wave and tidal action parallel to the mainland coast. They usually occur in chains, consisting of a few islands to more than a dozen islands.

Beach. A beach is a landform alongside a body of water such as an ocean, which consists of loose particles of material such as sand. A beach can also be considered a structural measure, as described previously.

Dune. A dune is a landform composed of wind- or water-driven sand. It typically takes the form of a mound, ridge, or hill.

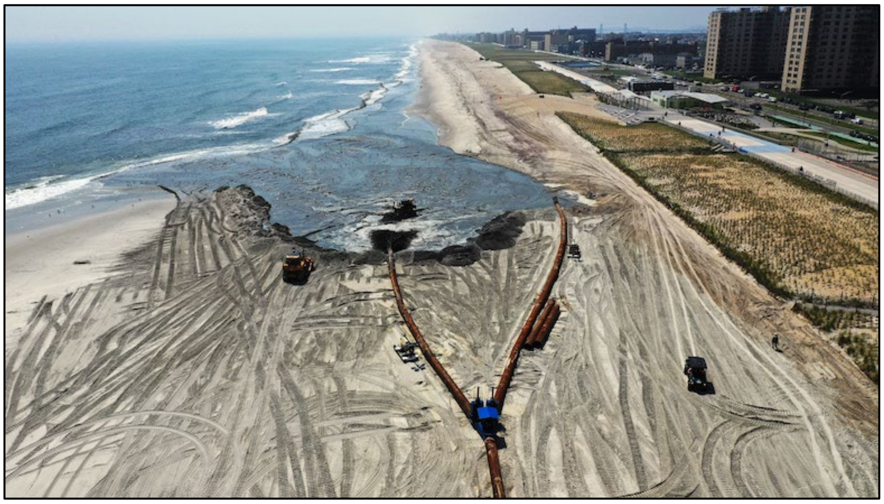


Figure 35: Beach construction in Rockaway, NY.

Green Stormwater Management. Green stormwater management is an approach to managing stormwater by using green infrastructure, such as vegetated rooftops, roadside plantings, and absorbent gardens.

Maritime Forest/Shrub Community. A maritime forest is an ocean coastal wooded habitat within range of salt spray. They are native to the Atlantic Coast.

Modify/Remove Channel Structures. This measure includes modifying or removing channels structures such as dams that have changed flow in a waterbody.

Oyster and Coral Reef. Oyster and coral reefs are dense aggregations of marine that form large colonial communities in waterbodies.

Regional Sediment Management. Regional sediment management is a systems approach using best management practices for more efficient and effective use of sediments in coastal, estuarine, and inland environments.

Submerged Aquatic Vegetation. Submerged aquatic vegetation is found in aquatic habitats and includes aquatic grasses (seagrasses) and attached macro-algae.

Vegetated Feature. Vegetated features are areas that are planted with vegetative, typically native species of grasses, shrubs, and trees.

Wetland. Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season.

4.6 PLAN FORMULATION

Plan formulation is the process of building alternative plans from management measures that will meet planning objectives. Addressing the complex and often conflicting water resource needs requires the formulation of a diverse range of solutions that need to be fully considered in the decision-making process. Such solutions may produce varying degrees of effects relative to environmental, economic, and social goals. No hierarchal relationship exists among these three effects, and as a result, tradeoffs, risks, and unknowns among alternative plans was assessed as detailed in this chapter.

4.6.1 Plan Formulation Strategy

For the initial round of alternative plan screening documented in the Interim Report, the focus was on the feasibility of implementing system-wide, or basin-wide, or site-specific CSRM solutions. In other words, the primary question was the optimal scale of a solution. A system-wide solution has the potential to reduce the number of localized studies and projects, resulting in considerable economies of scale. However, it may not leverage the benefits of existing and planned CSRM projects, resulting in what may be unnecessary expenditures. For this reason, the Future Without Project Condition is critical to the calculation of potential benefits. At this first stage of screening, benefits and costs were calculated on a parametric basis, and the goal was to identify system-wide, basin-wide, and site-specific scales of solutions in order of maximum return. At this point there were assumptions of the type of measures to be included for cost estimating purposes. However, the actual type of barrier, gates, and shore-based measure's (floodwall vs. levee, nonstructural, or natural and nature-based features) were not yet been confirmed, nor their exact locations. Documentation from this first round of screening included assumptions made, major uncertainties, and the analyses recommended to address the uncertainties.

In the second round of formulation (current phase), the optimal scale of solution (whether system-wide, basin-wide, and site-specific) is further developed through the recommended analyses from the first round to arrive at the best combination of measures (barriers, floodwalls, levees, pumps, nonstructural, and natural and nature-based features) and the anticipated footprint of the overall alternative, known as the TSP. For structural and nonstructural measures, a 1% design concept was assumed to maintain comparability. Natural and nature-based features were assumed between the 4% and 10% design concept because the study area is heavily developed and there are relatively few areas to build NNBFs to the scale that could be comparable to structural and nonstructural. These design concept levels are for screening purposes, and the TSP will be evaluated at different sizes to maximize net benefits after the draft report. Documentation from the second round of screening in the draft Feasibility Report/Tier 1 EIS includes explanations behind the selection of specific measures and alternative plans and aspects of the TSP that will be refined after the draft report.

In the final round of formulation, comments from review of the draft report are addressed and different dimensions of the measures from the TSP will be considered for the purpose of maximizing net benefits. The footprint of the alternative is not expected to change substantially, but the height could be lower or higher, and the study could consider more cost-effective ways to achieve the target level of risk reduction. This final round, through which the TSP becomes the Recommended Plan, will be documented in the Final Report/Tier 1 EIS.

Multiple Lines of Defense Strategy

When storm surge barriers are proposed, it is assumed that the gates will be open during ambient conditions, nuisance events, and high frequency flooding to minimize impacts to navigation and the environment. Accordingly, complementary measures to address high frequency events, known as Risk Reduction Features, including small scale structural measures, nonstructural measures, and natural and nature-based features (wetlands, living shorelines, etc.) are assumed for surge barrier measures. The small-scale structural measures include levees, floodwalls, tide gates, and elevated bulkheads with a crest elevation of +10 feet NAVD88 for shorelines and associated floodplain at elevation +7 feet NAVD88 and below.

In addition to the primary criterion of floodplain elevation below +7 feet NAVD88, the criteria for identifying locations for Risk Reduction Features were based on the analysis for high frequency measures from the East Rockaway to Rockaway Inlet General Reevaluation Report (Rockaway GRR), including:

- Existing bathymetry and lateral space—if there is enough space and appropriate underwater bathymetry offshore to fit an NNBF.
- Site suitability—consideration was also given to whether the site conditions will support the appropriate NNBF type being able to persist. An example is that docks and piers are not suitable because they typically have heavy traffic.
- Ability to provide wave attenuation and erosion control.

For the draft feasibility report analysis, the Risk Reduction Features mitigate high frequency and nuisance flooding under the assumption that the storm surge barrier closure criterion is elevation +7 feet NAVD88. In the subsequent feasibility level analysis, closure trigger elevations of +8 feet NAVD88 and +9 feet NAVD88 will be investigated as well to optimize net benefits under increasing rates of RSLC, when it is possible that a +7 feet NAVD88 closure will become too frequent to be practical. Note that higher elevations for barrier closure could dramatically increase the linear and spatial extent of associated Risk Reduction Features at the corresponding floodplain elevations.

Risk Reduction Features can also consist of tide gates, and their closure when the main storm surge barrier is closed can provide a layered defense for storm surge. Two examples of this are in the Jamaica Bay, where there are multiple channels or creeks that could have tide gates in addition to the main barrier at the entrance, and the Hackensack River. A storm surge barrier could be placed at the mouth of the Hackensack River, or a smaller barrier (to elevation +10 feet NAVD88) could act as a Risk Reduction Feature to accompany a primary storm surge barrier at the Arthur Kill.

4.6.2 Screening and Combining of Measures

For initial planning purposes, the study area was divided into 64 reaches based on water body and county limits. For each reach, a suite of structural, nonstructural, and natural and nature-based features from the NACCS report were considered. This section describes how measures were screened, and how remaining measures were combined to form alternative plans.

Screening of Measures

Measures were screened in two rounds. In the first round, each measure was assessed to see if other projects, authorities, or agencies were implementing any measures – that is, if there's limited or no opportunity to include them in the alternative plans. If so, the measure was screened from consideration. The following measures were screened in this round:

- Breakwater
- Bridge Trash Rack
- Evacuation Plans
- Flood Insurance
- Floodplain Mapping
- Flood Warning System
- Emergency Preparedness Plans
- Groin
- Jetty
- Land Use Regulations and Zoning
- Stormwater System Improvements

In the second round of screening, the remaining measures were screened by dominant shoreline type of each reach. Structural measures, nonstructural measures, and natural and nature-based features (NNBF) apply to the entire study area. Beach measures were limited to Raritan Bay and Sandy Hook Bay, Lower Bay, Jamaica Bay, and Atlantic coastline. In other reaches of the study area, space constraints dictated whether the shore-based measures would be a levee (less expensive, more space requirement) or a floodwall (more expensive, smaller footprint). From this step, alternative plans were developed based on systems approach, starting with alternative plans that would maximize spatial coverage of the study area and progressing to more localized, perimeter-based scale solutions. Appendix B provides the detail of this screening.

Screening of Measures: Interim Report

The analysis presented in the Interim Report contains several measures that were found to be not cost effective at the 1% design scale. The benefit-to-cost ratio for these features were calculated to be 0.5 or lower. It would not be cost effective to proceed at this larger scale of shore-based measure, however, there are still vulnerable properties and communities in need of coastal storm risk management. These areas are slated for further analysis for smaller scale shore-based measures, to find a scale that are cost effective, or for nonstructural treatments. These measures include:

- Stony Point Perimeter shore-based measure
- Stony Point Shore shore-based measure
- Ossining shore-based measure
- Tarrytown shore-based measure
- Yonkers North shore-based measure
- Yonkers South shore-based measure
- Bronx River/Westchester Creek Storm Suge Barriers
- Pelham Bay Storm Suge Barrier
- Astoria shore-based measure
- Long Island City shore-based measure

4.6.3 Combining Measures into Plans

Measures that warranted continued consideration were assembled into alternative plans. An alternative plan (also known as, “plan” or “alternative”) is a set of one or more management measures functioning together to address one or more planning objectives. The remaining management measures were used individually or combined with others to form alternative plans. The preliminary locations and types of measures were based on an understanding of coastal flood risk, as quantified by Adaptive Hydraulics (AdH) and the Advanced Circulation (ADCIRC) engineering model results detailed in Appendix B.

4.7 ALTERNATIVE PLANS*

The following alternative plans were developed from the remaining management measures to meet planning objectives and avoid the planning constraint while reasonably maximizing NED benefits. All but Alternative 1, the No Action Alternative, are made up of combinations of remaining management measures. Appendix B includes engineering details of the alternative plans.

The alternative plans span the spectrum of predominantly off-shore, in-water structures such as storm surge barriers that provide CSRM for most of the study area, to solely shore-based measures consisting of measures such as floodwalls and levees at localized areas of high coastal storm risk. In between are the regional hybrid combinations of smaller barriers and land-based measures. The continuum of in-water to land-based measures is illustrated in Figure 36.

The details of nonstructural and NNBFs are conceptual and so are not presented in detail in this section. For the nonstructural portions of the alternative plans, number of structures and types of nonstructural treatments are not yet final, and so are not included in the TSP. Similarly, the locations of potential NNBFs have not yet been chosen. The plans will be refined as more information is made available and documented in the final version of this report.

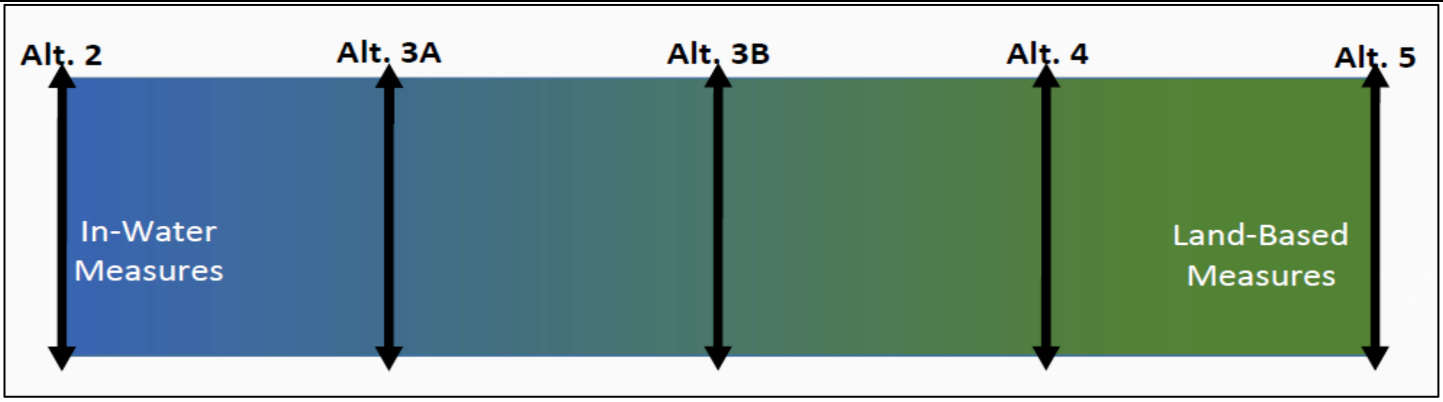


Figure 36: Gradient of in-water measures and land-based measures of Alternatives 2 through 5.

4.7.1 Alternative 1: No Action Alternative (FWOP Condition)

Alternative 1 is defined by the present and future conditions in the study area that are reasonably anticipated to exist should there be no action as an outcome of the study. It is also known as the FWOP condition.

4.7.2 Alternative 2: Harbor-Wide Storm Surge Barrier with Shore-Based Measures

Alternative 2 employs a strategy to impede storm surge before it travels into the inner areas of New York Harbor. The plan includes one primary component, several primary Induced Flooding-Mitigation Features, and the most Risk Reduction Features of any alternative plan. The first primary component was formulated given the geography of the study region which indicates that a combination levee, berm and Storm Surge Barrier connecting to Sandy Hook, New Jersey, across the transect to Breezy Point of Rockaway peninsula and similar surge barrier enclosure along the East River just west of the Throgs Neck could broadly address coastal storm surge and wave attack from either the New York Bight or Long Island Sound to the vast majority of the study area (Figure 37). Numerous navigational surge gates, auxiliary gates and static barrier connectors (e.g., seawalls) of approximately 34,700 feet total length comprise the in-water measures in the SH-BP surge gate structure in alternative feature. At the Throgs Neck between the Bronx and Queens, the surge gate structure is estimated to involve approximately 4,700 feet of navigational and auxiliary surge gates and static barrier connectors. At the land connection points of these two Storm Suge Barriers, approximately 128,467 feet of associated shore-based measures including floodwalls, levees, operable flood gates and buried seawalls/dunes would connect the surge gate measures to high ground.

ADCIRC modeling results show that this alternative, particularly the Storm Suge Barriers spanning the Throgs Neck, has the potential to cause induced flooding in western Long Island Sound. To reduce the impacts of induced flooding, approximately 12 complementary primary Induced Flooding-Mitigation Features components were incorporated into this alternative in Eastchester Bay, Great Neck, Hempstead Harbor (particularly Glen Cove Creek), Hutchinson River, Little Bay, Little Neck Bay, Plandome, Port Washington, Rodman Neck, Roslyn Harbor, Sands Point, and Throgs Neck.

To address the frequent, less severe coastal storm risks when the Storm Suge Barriers are assumed not to be operated, approximately 62 secondary structural Risk Reduction Feature components were incorporated along with nonstructural measures and ringwalls located in clustered areas.

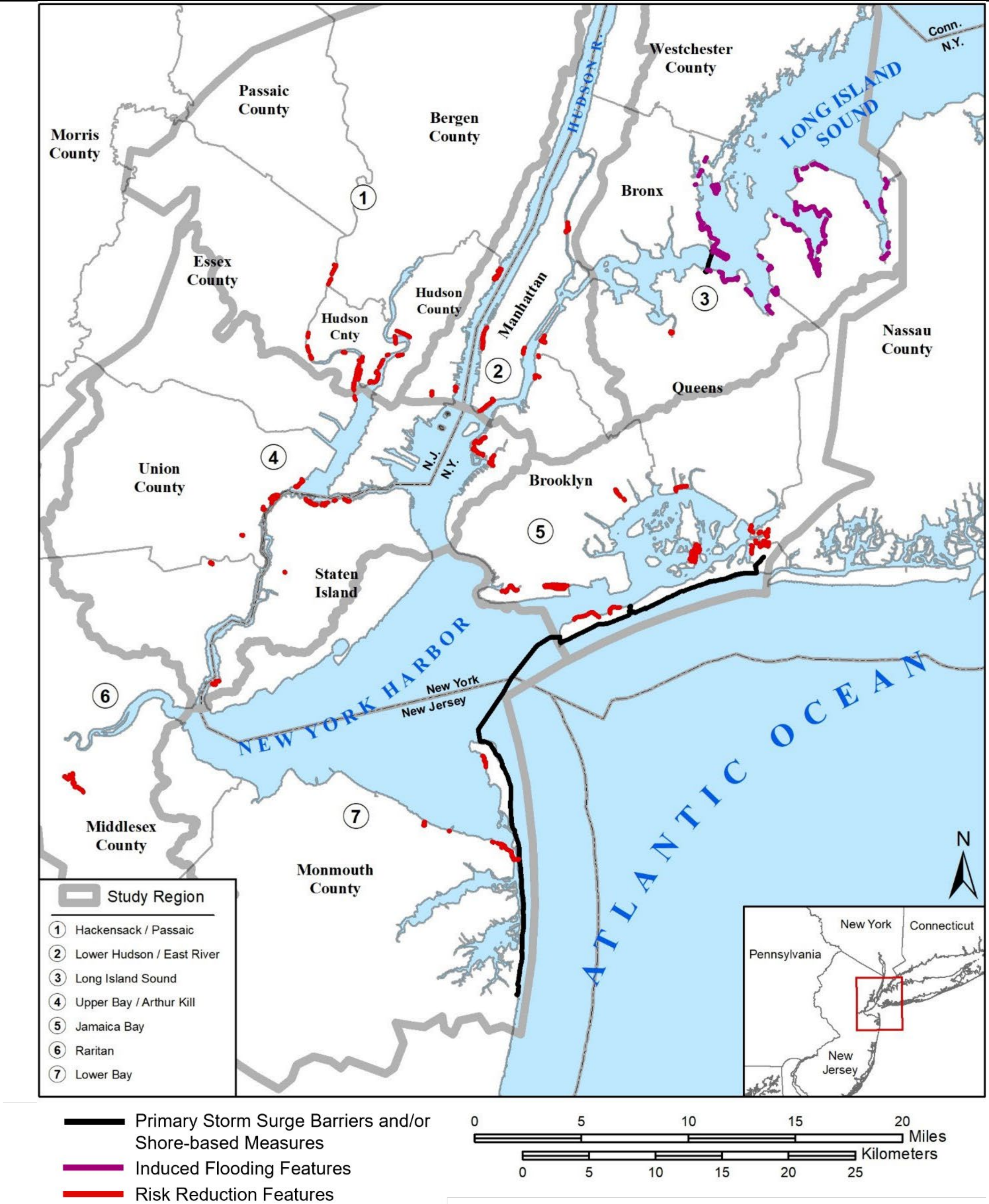


Figure 37: Alternative 2 - Harbor-Wide Storm Surge Barrier with Shore-Based Measures

4.7.3 Alternative 3A: Multi-Basin Storm Surge Barriers with Shore-Based Measures

Alternative 3A employs a strategy to impede storm surge in multiple basins within the study area. The plan includes two primary structural components: Storm Surge Barrier and shore-based measures tie-ins to address coastal storm surge for two distinct geographic areas: 1) Upper Bay, Newark Bay, Hudson River, East River, Harlem River, Passaic River, Hackensack River, Kill Van Kull and Arthur Kill (and numerous other creeks) and 2) Jamaica Bay, southern Brooklyn, Sheepshead Bay, southern Queens including the Rockaway Peninsula and numerous other creeks. Each primary structural component also has primary Induced Flooding-Mitigation Feature components to address induced flooding outside of the storm surge barrier structures as well as numerous Risk Reduction Features within the geographic areas (Figure 38).

The first primary structural component is defined by the next geographic location inside from the Lower Bay transect where surge gate measures may be conceptualized. It involves storm surge barriers and associated shore-based measure tie-ins at the southern mouth of the Arthur Kill, the Verrazano Narrows (in either the southern region of the Upper Bay or the northern area of the Lower Bay), and at the Throgs Neck, similar to Alternative 2. The navigational and auxiliary surge gate measures (along with seawall to connect to land) located at the southern mouth of the Arthur Kill between Woodbridge, NJ and Staten Island, are approximately 2,300 feet in length. The surge gate structure at the Verrazano Narrows between Brooklyn and Staten Island, NY involves approximately 6,500 feet of navigational and auxiliary surge gates along with seawalls to connect the gates to land. At the Throgs Neck between the Bronx and Queens, the surge gate structure is estimated to involve approximately 4,700 feet of navigational and auxiliary surge gates and static barrier connectors. These three surge gate structures require approximately 19,672 feet of floodwalls, levees, and operable flood gates on land to tie-in to high ground.

The second primary structural component in Alternative 3A involves a combination of shore-based measures along with multiple surge gate structures in the southern Brooklyn to the mouth of Jamaica Bay and then to Rockaway Peninsula. In the years following Hurricane Sandy, USACE identified and developed this feature under the Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet (Rockaway Beach) and Jamaica Bay, NY coastal storm risk management reevaluation study (Rockaway study). This feature includes navigational and auxiliary surge gates at the entrance to Jamaica Bay with separate surge gate and shore-based measure's connecting to Coney Island and Coney Island Creek. These surge gate structures at the mouth of Jamaica Bay, Gerritsen Creek, and Sheepshead Bay are estimated to involve navigational and auxiliary gates with associated static barriers of approximately 3,800 feet, 400 feet, and 800 feet, respectively, to connect to adjacent land. On land, this feature involves approximately 116,099 feet of floodwall, levees, seawalls, operable flood gates, elevated promenades, buried seawall/dunes, and tide gates to connect the surge gate structures and to tie-in to high ground at the feature terminuses.

ADCIRC modeling results show that this alternative has the potential to cause induced flooding in western Long Island Sound and the Lower Bay of New York Harbor. Approximately 19 complementary primary Induced Flooding-Mitigation Features components were incorporated into this alternative to reduce the impacts of induced flooding. Induced Flooding-Mitigation Features are in the following general areas: Breezy Point, Eastchester Bay, Great Kills, Great Neck, Hempstead Harbor (particularly Glen Cove Creek), Highlands, Hutchinson River, Keyport-Cheesquake, Little Bay, Little Neck Bay, Plandome, Port Washington, Raritan River, Rodman Neck, Roslyn Harbor, Sands Point, Sandy Hook Bay, South Staten Island, and Throgs Neck.

To address the frequent, less severe coastal storm risks when the storm surge barriers in this alternative were assumed not to be operated, approximately 52 secondary structural Risk Reduction Feature components were incorporated into this alternative along with nonstructural measures and ringwalls located in clustered areas.

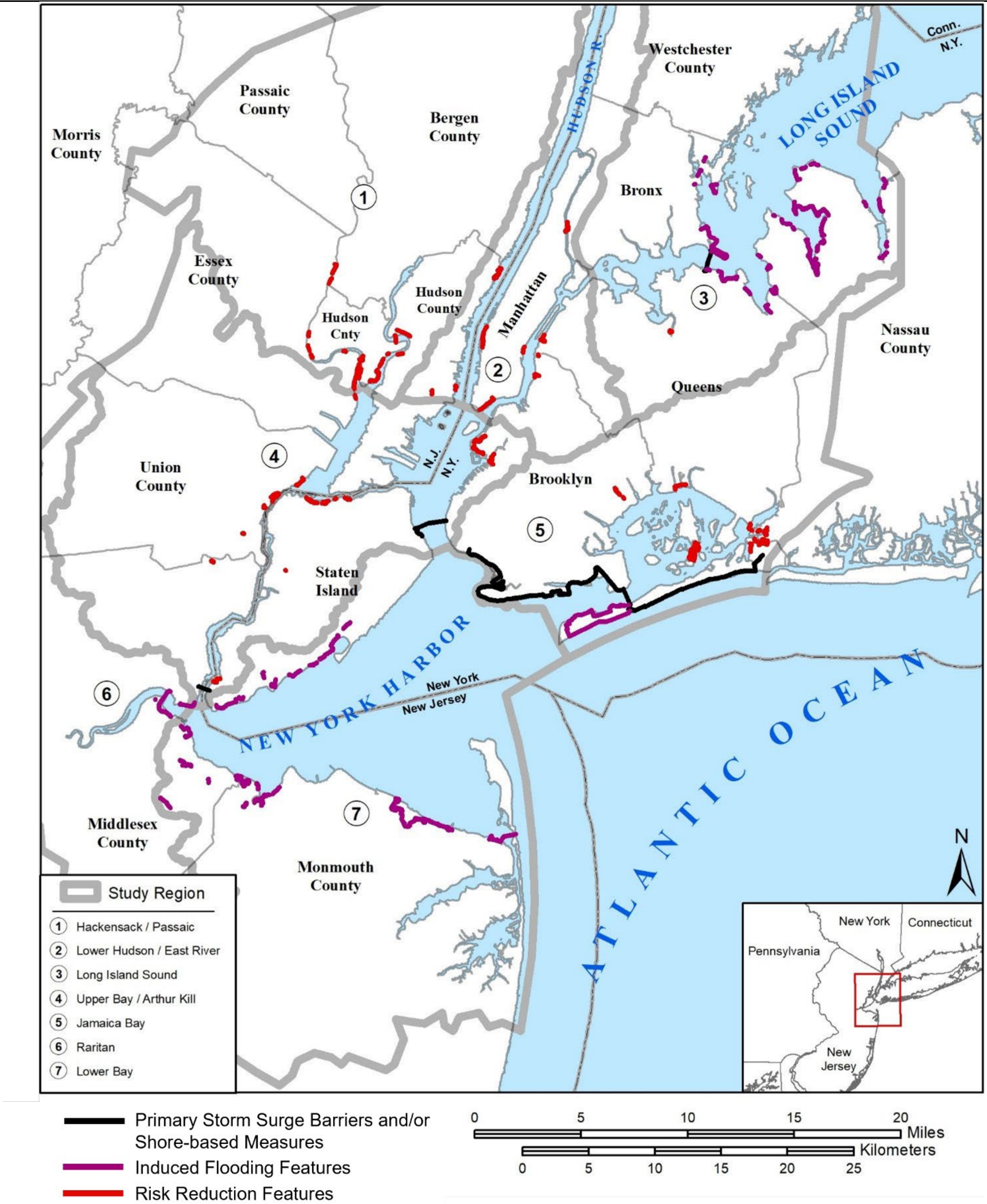


Figure 38: Alternative 3A- Multi-Basin Storm Surge Barriers with Shore-Based Measures

4.7.4 Alternative 3B: Multi-Basin Storm Surge Barriers with Shore-Based Measures

Alternative 3B employs a strategy to impede storm surge in multiple basins within the study area. The plan includes two primary structural components involving multiple storm surge barriers each, three primary structural components involving storm surge barriers on the individual creeks of Gowanus, Newtown and Flushing located in Brooklyn and Queens, and three primary structural shore-based measures in Jersey City, the lower west side of Manhattan, and East Harlem. The two primary structural components involving multiple storm surge barriers each are as follows: 1) a combination of shore-based measures along with multiple surge gate structures in the southern Brooklyn to the mouth of Jamaica Bay and then to Rockaway Peninsula, Lower Brooklyn, and 2) a combination of two storm surge barriers on the mouth of the Arthur Kill and Kill Van Kull tidal straits along with shore-based measures tie-ins to address coastal storm surge for the geographic areas of Newark Bay, Passaic River, Hackensack River, Kill Van Kull and Arthur Kill and numerous other creeks (Figure 39).

The Jamaica Bay and southern Brooklyn primary structural component involves a combination of shore-based measure's along with multiple surge gate structures in the southern Brooklyn to the mouth of Jamaica Bay and then to Rockaway Peninsula. In the years following Hurricane Sandy, USACE identified and developed this feature under the Rockaway study. This feature includes navigational and auxiliary surge gates at the entrance to Jamaica Bay with separate surge gate and shore-based measure's connecting to Coney Island and Coney Island Creek. These surge gate structures at the mouth of Jamaica Bay, Gerritsen Creek, and Sheepshead Bay are estimated to involve navigational and auxiliary gates with associated static barriers of approximately 3,800 feet, 400 feet, and 800 feet, respectively, to connect to adjacent land. On land, this feature involves approximately 116,099 feet of floodwall, levees, seawalls, operable flood gates, elevated promenades, buried seawall/dunes, and tide gates to connect the surge gate structures and to tie-in to high ground at the feature terminuses.

The Kill Van Kull and Arthur Kill storm surge barrier primary structural component is a dual storm surge gate system at the southern mouth of the Arthur Kill, and the eastern mouth of the Kill Van Kull between Bayonne, NJ and Staten Island, NY. The navigational and auxiliary surge gate structures at these locations are currently delineated to have an estimated total length of 5,600 feet, with an associated 5,588 feet of shore-based measures comprising floodwalls and deployable flood wall barriers to tie-in to high ground.

The three primary structural components involving storm surge barriers on the individual creeks of Gowanus, Newtown and Flushing located in Brooklyn and Queens have a currently estimated total length of storm surge barrier opening of 200 ft, 400 ft., and 500 ft. respectively with shore-based measure tie-ins currently estimated at lengths of approximately 18,552 feet, 15,808 feet, and 9,479 feet of deployable flood barriers, elevated promenade, floodwalls, levees and seawalls.

The three primary structural shore-based measures in Jersey City, the lower west side of Manhattan, and East Harlem are currently estimated to have total lengths of approximately 43,207 feet, 30,426 feet, and 24,912 feet, respectively. The measures incorporated into these three shore-based measure components include the following: deployable flood barriers, floodwalls, seawalls, and elevated promenades.

ADCIRC modeling results indicated that this alternative has the potential to cause limited induced flooding in four localized areas: Breezy Point, southern Bronx (along Harlem River), Inwood, and Kips Bay. Primary structural shore-based measures were incorporated into this alternative in these areas as Induced Flooding-Mitigation Features to mitigate induced flooding.

To address the frequent, less severe coastal storm risks when the storm surge barriers in this alternative were assumed not to be operated, approximately 36 secondary structural Risk Reduction Feature components were incorporated into this alternative along with nonstructural measures and ringwalls located in clustered areas.

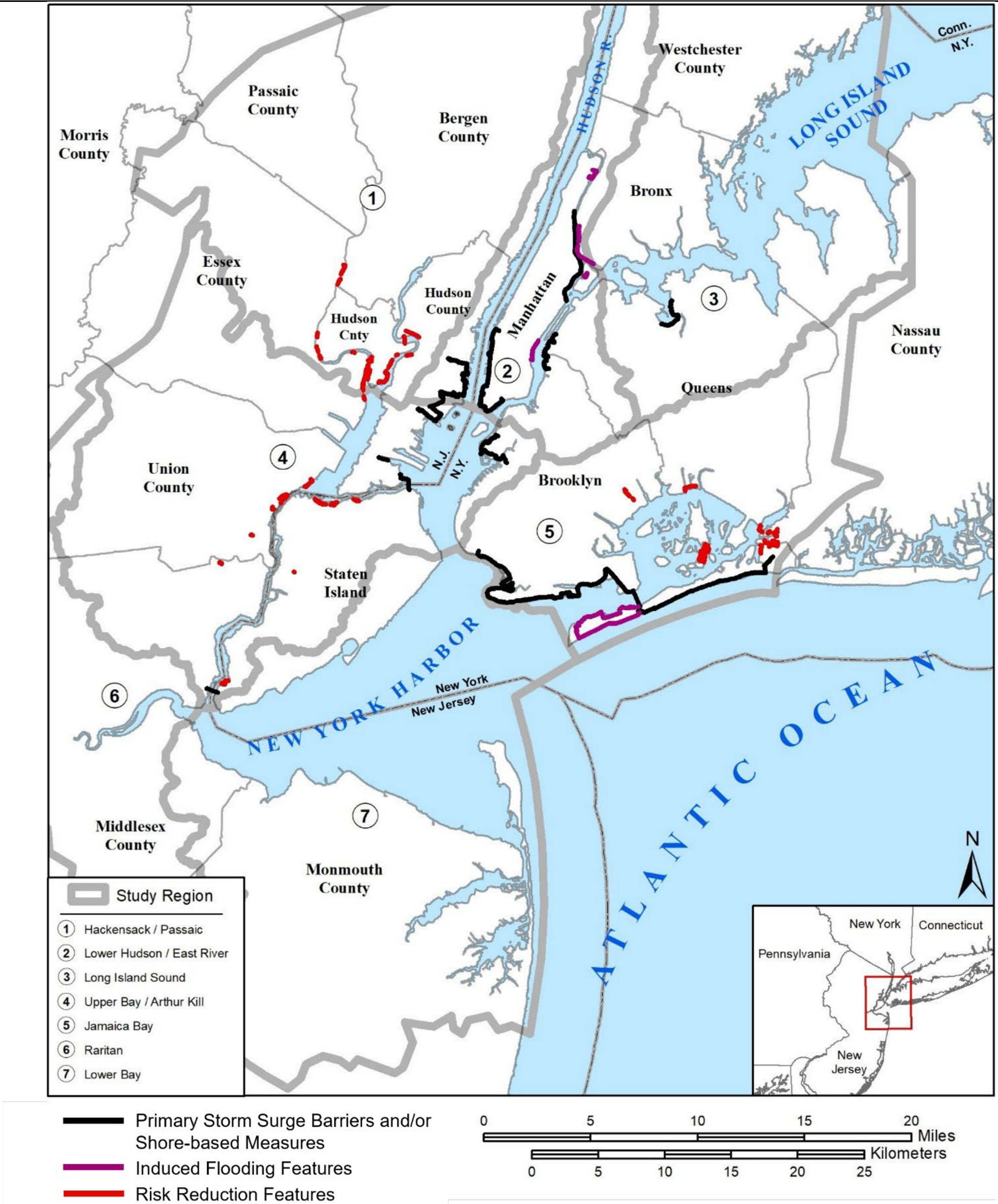


Figure 39: Alternative 3B- Multi-Basin Storm Surge Barriers with Shore-Based Measures

4.7.5 Alternative 4: Single-Basin Storm Surge Barriers with Shore-Based Measures

Alternative 4 involves one primary structural component involving multiple storm surge barriers, four primary structural components involving storm surge barriers on the Hackensack River, and the individual or creeks of Gowanus, Newtown and Flushing located in Brooklyn and Queens, and three primary structural shore-based measures in Jersey City, the lower west side of Manhattan, and East Harlem. The primary structural components involving multiple storm surge barriers involves a combination of shore-based measure's along with multiple surge gate structures in the southern Brooklyn to the mouth of Jamaica Bay and then to Rockaway Peninsula. Lower Brooklyn (the same component as in Alternatives 3A and 3B) (Figure 40).

The Jamaica Bay and southern Brooklyn primary structural component involves a combination of shore-based measures along with multiple surge gate structures in the southern Brooklyn to the mouth of Jamaica Bay and then to Rockaway Peninsula. In the years following Hurricane Sandy, USACE identified and developed this feature under Rockaway study. This feature includes navigational and auxiliary surge gates at the entrance to Jamaica Bay with separate surge gate and shore-based measure's connecting to Coney Island and Coney Island Creek. These surge gate structures at the mouth of Jamaica Bay, Gerritsen Creek, and Sheepshead Bay are estimated to involve navigational and auxiliary gates with associated static barriers of approximately 3,800 feet, 400 feet, and 800 feet, respectively, to connect to adjacent land. On land, this feature involves approximately 116,099 feet of floodwall, levees, seawalls, operable flood gates, elevated promenades, buried seawall/dunes, and tide gates to connect the surge gate structures and to tie-in to high ground at the feature terminuses.

The Hackensack River storm surge barrier primary structural component is has a storm surge barrier in the southern portion of the river with associated shore-based measure tie-ins. The navigational and auxiliary surge gate structures at this location is currently delineated to have an estimated total length of 1,900 feet, with an associated 27,101 feet of shore-based measures comprising floodwalls, levees and deployable flood wall barriers to tie-in to high ground.

The three primary structural components involving storm surge barriers on the individual creeks of Gowanus, Newtown and Flushing located in Brooklyn and Queens have a currently estimated total length of storm surge barrier opening of 200ft, 400 ft., and 500 ft. respectively with shore-based measure tie-ins currently estimated at lengths of approximately 18,552 ft., 15,808 ft., and 9,479 ft. of deployable flood barriers, elevated promenade, floodwalls, levees and seawalls.

The three primary structural shore-based measures in Jersey City, the lower west side of Manhattan, and East Harlem are currently estimate to have total lengths of approximately 43,207 feet, 30,426 feet, and 24,912 feet, respectively. The measures incorporated into these three shore-based measure components include the following: deployable flood barriers, floodwalls, seawalls, and elevated promenades.

ADCIRC modeling results indicated that this alternative has the potential to cause moderate induced flooding in eight areas: Bergen Point, Breezy Point, Elizabeth, Hackensack-Jersey City, Harrison, Kearney Point, Newark, and Port Richmond. Primary structural shore-based measures were incorporated into this alternative in these areas as Induced Flooding-Mitigation Features to address this.

To address the frequent, less severe coastal storm risks when the storm surge barriers in this alternative were assumed not to be operated, approximately 11 secondary structural Risk Reduction Feature components were incorporated into this alternative along with nonstructural measures and ringwalls located in clustered areas.

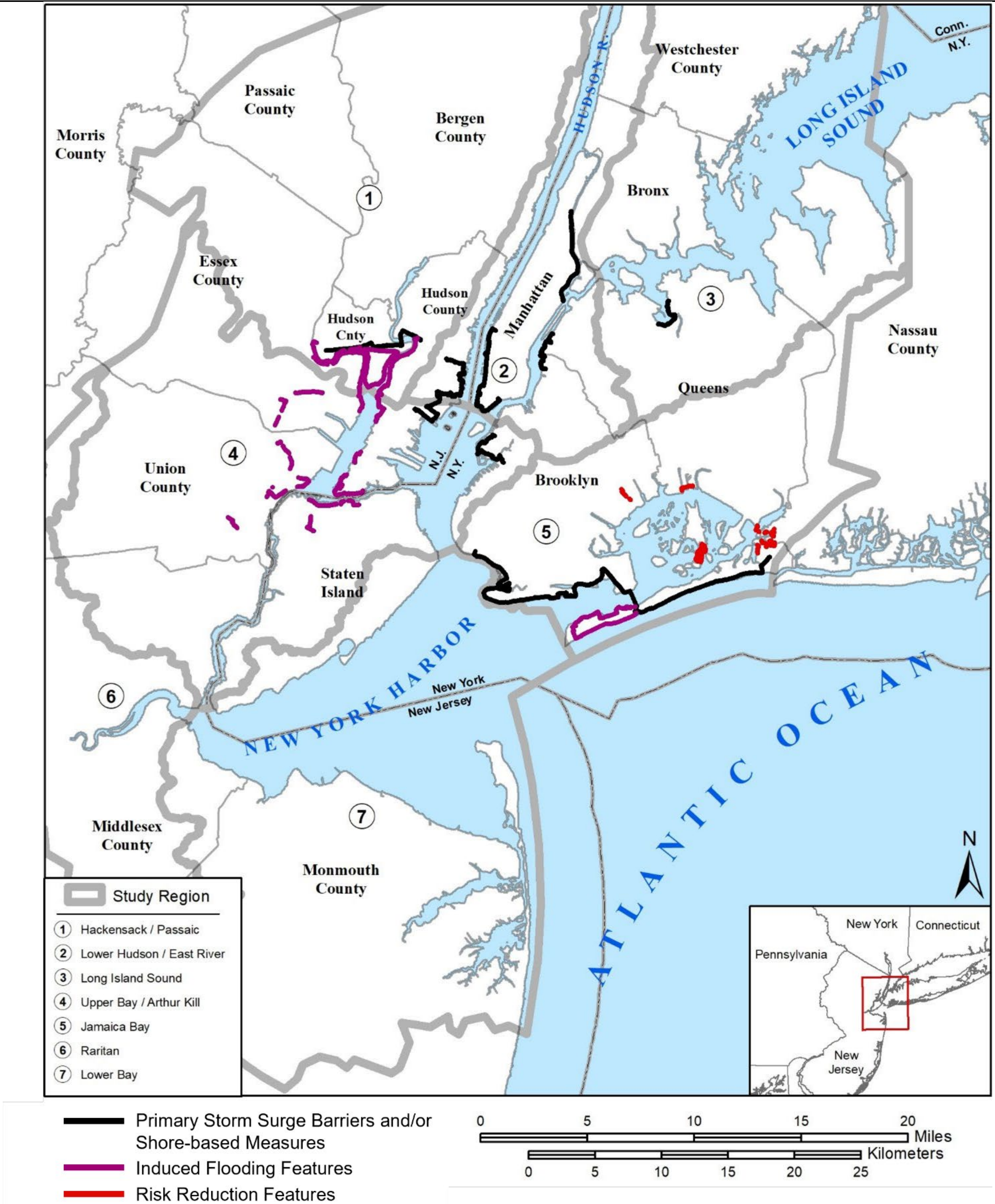


Figure 40: Alternative 4- Single-Basin Storm Surge Barriers with Shore-Based Measures

4.7.6 Alternative 5: Shore-Based Measures Only

Alternative 5 does not include any large in-water structures (Figure 41). Consequently, many areas addressed under prior with-project conceptual alternative plans are absent from this alternative as shoreline-based only measures are cost prohibitive for those areas based on prior USACE and other agencies analyses. For example, the separate USACE Rockaway/Jamaica Bay Reformulation Study conducted after Hurricane Sandy evaluated a perimeter-based approach to Jamaica Bay which determined it to pose considerable challenges with managing interior drainage, particularly around the number of inlets and creeks discharging into Jamaica Bay, at roughly twice the cost than that which could be achieved through the use of surge gate features as described in conceptual Alternatives 3A, 3B, and 4. For this reason, to again consider perimeter-based solutions in areas where they have been previously found infeasible by USACE or other agencies would require explicit request from the study non-federal sponsors as well as concurrence by USACE higher authority offices. This alternative includes four primary structural components.

The four primary structural shore-based measures are located in the Hackensack Meadowlands, Jersey City, the lower west side of Manhattan, and East Harlem are currently estimate to have total lengths of approximately 64,397 feet, 43,207 feet, 30,426 feet, and 24,912 feet, respectively. The measures incorporated into these four shore-based measure components include the following: deployable flood barriers, floodwalls, seawalls, elevated promenades and tide gates.

As this alternative categorically excludes storm surge barrier measures, it is not anticipated to cause any induced flooding. Similarly, this alternative also has no identified Risk Reduction Features.

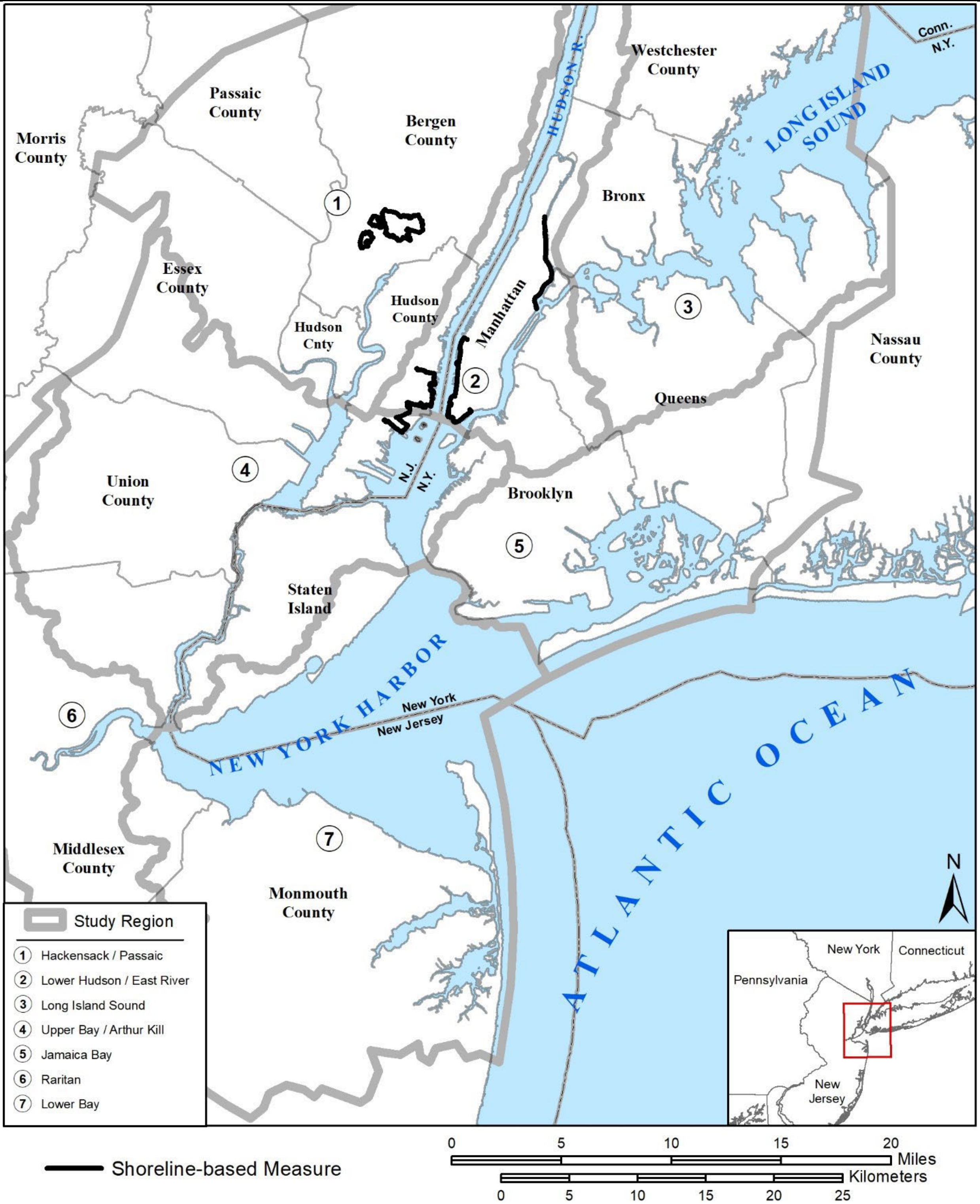


Figure 41: Alternative 5- Shore-Based Measures Only.

4.8 PLAN EVALUATION

Alternative plans were evaluated through a series of criteria to identify the best performing plans. The criteria include performance against the study objectives and constraints, the four planning criteria (completeness, effectiveness, efficiency, and acceptability), and the four benefits accounts (National Economic Development

(NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE) from the 1983 P&G. Plans are evaluated for their performance against these criteria within the Period of Analysis, which begins when the project construction is anticipated to be complete and project benefits are realized, for a period of 50 years.

4.8.1 Period of Analysis

For the initial round of plan formulation documented in the Interim Report (2019), the decision was made to compare the alternative plans using a present worth analysis (due to the complexities of comparing features with a wide range of implementation timeframes). Without project damages from 2030 to 2100 were calculated and presented in the Interim Report. Since then, construction durations have been calculated for each of the alternative plans, and the median construction duration was chosen as a reasonable balance of comprehensiveness of coverage and implementation time required. In addition to construction duration, estimates for refined designs and other construction prerequisites has been factored in, resulting in a period of analysis that begins in 2044 and concludes in 2093, allowing 50 years for assessing the potential benefits and costs of a project. It is possible that some alternative plans will have longer construction durations resulting in fewer than 50 years of benefits. This is the trade-off between more comprehensive coverage and the longer wait to realize those benefits. For smaller alternative plans, which will start producing benefits before the base year, pre-base year benefits will be calculated. All alternative plans will have no more than 50 years of benefits. The planning horizon, which is a 100-year period to account for the effects of relative sea level change, has been identified as 2016 - 2115 (starting from the initiation of this study).

4.8.2 Contributions to Planning Objectives and Constraints

Considering Planning Objectives

Alternative plans were judged upon whether or not they make significant contributions to the planning objectives and sufficiently avoid planning the constraint; some do so more efficiently than others. The study objectives were used to judge the alternative are to:

- Reduce the risk of coastal storm damage to communities, public infrastructure, important societal resources, and the environment
- Improve the community's ability to recover from damages caused by storm surges by reducing the duration of interruption in services provided by man-made and natural systems
- Enhance human health and safety by improving the performance of critical infrastructure and natural features during and after storm surge events
- Restore natural coastal features that have ability to reduce coastal storm risk for communities and ecosystems

Table 16 shows the relative contribution of each alternative plan to the study objectives. A relative comparison of alternative plans was undertaken, and ranked using a "low" (red), "medium" (yellow), "high" (green) system. Note that the contribution of Alternative 1 (No Action) is 'none' for all objectives. Alternatives 2, 3A, and 3B generally provide more contributions to the planning objectives than Alternatives 4 and 5.

Table 16: Contributions to planning objectives by alternative plan.

Objectives	Alternative Plan				
	Alternative 2	Alternative 3A	Alternative 3B	Alternative 4	Alternative 5
Reduce coastal storm risk	High	High	High	High	High
Support community resilience	High	High	High	High	High

Support critical infrastructure	High	High	High	Medium	Low
Restore natural coastal features	Unknown	Unknown	Unknown	Unknown	Unknown

**NNBFs have not yet been selected, and so this analysis cannot be completed at this time*

Considering Planning Constraints

The formulation of alternative plans has been guided by study constraints, as alignment footprints have been shifted or mitigation measures have been added to avoid or minimize impacts as possible. No alternative plans were screened for violating the planning constraints, which are:

- Minimize impacts to ongoing recovery, ecosystem restoration, and risk management efforts by others
  Strategy to avoid constraint: *The plan alignment or footprint could be refined to avoid conflicts or impacts to ongoing projects.*
- Minimize impacts to resources within the Gateway National Recreation Area
  Strategy to avoid constraint: *Achieve agreement for any alternative plan that falls within the boundaries of or impacts the resources of the Gateway National Recreation Area, which by statute must be mutually acceptable to the Department of the Interior and the Department of the Army*
- Minimize impacts to access for federal navigation channels
  Strategy to avoid constraint: *The locations of storm surge barriers could be shifted to minimize federal navigation channel disruptions, even if it means the barrier will have to be of a greater length.*
- Minimize induced flooding in areas not currently vulnerable to flooding and minimize induced additional flooding in flood-prone areas.
  Strategy to avoid constraint: *Where existing water surface elevations for the 1% flood event would be increased by more than six inches due to the presence of a proposed storm surge barrier, additional Induced Flooding-Mitigation Features would be built to mitigate the increased water surface elevations. On the interior/land side of any shore-based measure or tie-in for shore-based measures, features such as swales, detention ponds, and pump stations would be included to manage any increases in water levels as a result of the presence of the project. These features are known as minimum facilities, and their intent is to manage stormwater levels to their existing elevation, in the absence of a federal project.*
- Minimize impacts to community access and egress during emergencies
  Strategy to avoid constraint: *The plan alignment could be shifted to minimize impacts to access.*
- Minimize impacts to operations at international airports
  Strategy to avoid constraint: *The plan alignment could be shifted to minimize impacts to operations.*
- Minimize negative effects to plants, animals, or critical habitat of species that are listed under the Endangered Species Act or a state statute
  Strategy to avoid constraint: *The plan alignment could be shifted to minimize impacts to flora and fauna.*

4.8.3 Contributions to P&G Criteria

The 1983 P&G requires that alternative plans are formulated and compared in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability. Plans that require substantial activity by others, that is not likely to be forthcoming, in order to reach a “go” appraisal for critical objectives are not complete. Plans that are not appraised as a “go” for planning objectives are not effective. Plans that achieve contributions to objectives at higher costs, whether objectively or subjectively measured, are not efficient. Plans with effects that result in infeasibility are not acceptable. Minimum standards for these four criteria must be established in order to determine whether a plan is worthy of additional consideration. No alternative plans were screened out as part of the evaluation for P&G criteria.

Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planned efforts, including actions by other federal and non-federal entities. Project performance of the alternative plans is not dependent upon the completion or function of a project by another government agency or private investment. All alternative plans are complete in that they do not rely upon actions by other federal and non-federal entities to be implemented. The planning process has factored in projects that would be constructed in the absence of any action, which constitute the No Action Alternative, aka the future without-project condition.

Effectiveness is the extent to which the alternative plans alleviate the specified problems and achieves the opportunities. The alternative plans all achieve the planning opportunities to:

- Reduce the risk of coastal storm damage to communities, public infrastructure, important societal resources, and the environment
- Improve the community's ability to recover from damages caused by storm surges by reducing the duration of interruption in services provided by man-made and natural systems
- Enhance human health and safety by improving the performance of critical infrastructure and natural features during and after storm surge events
- Restore natural coastal features that have ability to reduce coastal storm risk for communities and ecosystems

Alternative plans were judged upon whether or not they make significant contributions to these opportunities; some do so more efficiently than others. The most effective plan, Alternative 2, has the lowest residual damages, although it may not be the most efficient due to high costs.

Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the objectives. All alternative plans are efficient, however, the least efficient plan is Alternative 2 because it has redundancies with respect to ongoing Hurricane Sandy resilience projects. Benefits from ongoing resilience projects were factored into the economics benefits modeling, so as to avoid double counting of benefits.

Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. The alternative plans were formulated in accordance with applicable laws, regulations, and policies. The alternative plans are equal in that there are no known issues with laws, regulations, and policies that would preclude their implementation. All alternative plans meet the criterion of acceptability to varying degrees, depending on what the exact footprint for the project will be. Currently, it appears that plans with the largest geographic reach (Alternative 2 and Alternative 3A) have the highest potential to negatively affect environmental resources and potentially conflict with existing federal laws.

4.8.4 Contributions to P&G Accounts

USACE considers the four accounts established in the Principles & Guidelines (P&G 1983) in the evaluation of alternative plans:

- **NED (National Economic Development)**: changes in the economic value of the national output of goods and services
- **EQ (Environmental Quality)**: non-monetary effects on significant natural and cultural resources
- **RED (Regional Economic Development)**: changes in the distribution of regional economic activity that result from each alternative plan
- **OSE (Other Social Effects)**: effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts

This section summarizes the contributions of the alternative plans to each P&G account. USACE is required to identify the plan with the highest net NED benefits, and the plan that maximizes benefits across all four accounts, known as the Comprehensive Benefits plan. They may or may not be the same plan.

For the Interim Report, the Study team refined the GIS analysis that was completed for the NACCS and subsequent NYNJHAT Focus Area Report. The intent of the refinement was to improve the analysis by incorporating new data (e.g., FEMA HAZUS and ADCIRC modeling), updating existing data, and ensuring that the non-federal sponsors' priorities were captured in the weighting of resources that are at risk from coastal storm impacts as a proxy for capturing all four P&G accounts. Such resources include population (especially socially vulnerable populations), property, critical infrastructure, and environmental and cultural resources, The values for each alternative plan were generated by superimposing polygons over the areas that would be landward of the potential alignments, and tabulating the values within the polygons according to the exposure weights set for this study. This method generated outputs that generally aligned with the highest performing alternative identified using the NED account only. More recently, the Study team conducted a deeper evaluation of benefits per P&G account, using USACE approved models as warranted rather than a composite GIS index. Below is a description of how the alternative plans contribute to each P&G account.

For the analysis of all alternative plans, construction was assumed to start in 2030 and a base year of 2044 was used for all economic calculations. Since the alternative plans vary greatly in scale and cost, their construction durations and periods of benefits accrual will also vary, from 32 years construction duration for Alternative 2 to five years construction duration for Alternative 5. All economic analyses associated with the evaluation of these plans used the FY2022 interest rate of 2.25% and were based on a price level of February 2022. More detail can be found in Appendix D.

National Economic Development

National Economic Development benefits were calculated through version 1.4.2 of Hydrologic Engineering Center - Flood Damage Analysis (HEC-FDA). HEC-FDA is a USACE-certified software tool which performs integrated hydrologic and economic evaluations of flood risk management plans using the structure inventory, stage-frequency, and depth damage relationships. The reason for using HEC-FDA to leverage as much of the existing investigation reports on coastal storm risk management studies and projects within the study area, which were incorporated into the future without-project condition modeling. Also, due to space constraints within the highly urbanized study area, it was assumed that much of the shoreline would be addressed through levees and floodwalls rather than beachfill, so HEC-FDA is appropriate over much of the study area compared to coastal models for beach environments. The alternative plan with the highest net benefits (costs subtracted from the benefits) is considered the NED Plan.

HEC-FDA is typically used to assess damages avoided to structures and their contents, as described in Appendix D. The structure inventory was limited to areas within maximum expected flood elevations for each economic reach. The maximum elevation has been selected as that associated with the 0.2% flood event for the closest NACCS node, plus the year 2100 Curve I relative sea level change, plus two feet. The elevation limit varied by reach, depending on the assigned stage-frequency node, and all were within the range +15 to +20 feet NAVD88. Structures in the inventory were eliminated if they are located on ground above the maximum elevation for their respective reach. Structures with zero value or categorized as outdoor recreational facilities (such as parks and sports fields), parking lots, vacant lots, agricultural land, or other parcels for which the data suggested no actual structure was present were also removed from the inventory. Structures with unusually high damages were considered outliers and were also removed. After filtering out these structures, there are approximately 272,000 buildings identified in the study area, with an estimated $394 billion in total structure replacement value.

The structures were assigned to economic reaches, which were delineated by water body, county boundaries, and shoreline type. Each reach was then assigned to one or more NACCS modeling nodes, depending on which one was closet. In some cases, a reach may contain multiple nodes, especially if it impacts multiple counties. In such cases, sub-reaches were delineated as appropriate in the flood damage models, with results combined for presentation of analysis results by economic reach. These nodes provide water surface elevations for the events of with annual exceedance probabilities of 50%, 20%, 10%, 5%, 2%, 1%, 0.5%, and 0.2% storm events for the year 1992. These nodes provide representative stage-frequency relationships used in the analysis of flood and storm damages were taken from the hydrologic modeling undertaken during the NACCS study. In addition to NACCS nodes, each reach was also assigned to one of three tide/sea level gages operated by the National Oceanic and Atmospheric Agency (NOAA), for the purposes of incorporating the impacts of relative sea level change into the analyses. These three gages are located at:

- Sandy Hook, on the spit located in Monmouth County, New Jersey, in Lower New York Bay
- The Battery, on the southernmost point of Manhattan, NY
- Kings Point, on the north shore of Long Island in Nassau County, NY, east of the Throgs Neck Bridge

In addition to stage-frequency data, which give an idea how much storm inundation may be present, the other important consideration is how much damages to expect with each foot of inundation. This process requires the assignment of appropriate depth-damage relationships to all structures in the inventory. A depth-damage function is a mathematical relationship between the depth of flood water above or below the first floor of a building and the amount of damage that can be attributed to that water depth. Depth-damage relationships are computed separately for structures and their contents. Depth-damage relationships are based on the premise that water height, and its relationship to structure height (elevation), is the most important variable in determining the expected value of damage to buildings. Similar properties, constructed, furnished, and maintained alike, and exposed to the same flood stages and forces, may be assumed to incur damages in similar magnitudes or proportion to actual values. Depth-damage relationships are generally expressed with content damage as a percentage of content value, and structure damage as a percentage of structure value, for each foot of inundation.

Depth-damage functions which express inundation damage as a percentage of the structure or content value for increments of flood depth above the main floor, and hence can be applied to multiple structures of similar use or configuration, are referred to as indirect damage functions, and are by far the most applied functions in studies similar to this one. Damage functions which express damage as a specific dollar value at each flood depth increment are referred to as direct damage functions and are developed for use with specific individual structures. These structures are typically those for which no indirect or generic depth damage function is appropriate, or for which dollar values of damage are known with a high degree of precision.

While several sets of potentially applicable indirect damage functions have been developed by USACE for use in studies such as this one, the functions selected for this study were drawn from those developed as part of the NACCS study. The depth-damage functions were assigned according to the use and configuration of the individual inventory structures as interpreted from tax parcel data or observed in the field in the case of sample survey structures. The NACCS functions applied in these analyses are presented by structure type which differentiate among single story or two-story houses, apartment buildings, high rises, commercial structures, industrial structures, and mixed-use buildings.

In addition to the typical array of buildings covered by the NACCS depth damage functions, this study includes direct damage functions for facilities owned and operated by the Port Authority of New York and New Jersey. The Port Authority of New York and New Jersey provided detailed information regarding the planned or implemented level of risk management at each facility, along with estimates of damage should the measure be overtopped. These estimates were based on documented repair costs following Hurricane Sandy or estimates by a third-party specialist consultant. The data received from the Port Authority of New York and New Jersey comprised a list of facilities and estimated damages resulting from the overtopping of new risk management measures that were anticipated to be completed by 2022. This data enabled the derivation of custom direct damage functions for each affected facility.

Yet another critical input into the analysis of NED benefits is consideration of relative sea level change. USACE guidance requires consideration of relative sea level change into Civil Works studies and projects. This is outlined in Engineer Regulation 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs. In 2030, the year in which a proposed plan is scheduled to begin construction, more than 130,000 structures with a value of

$188 billion in the study area lie within the 1% floodplain, and that if sea levels were to increase by two feet, then that floodplain would expand to impact an additional 30,000 structures with an additional $66 billion in exposed value. For the 2% floodplain, relative sea level change of the same magnitude would result in 38,000 vulnerable structures added to the total of 185,000 in 2030, with the exposed value increasing from $227 billion to $271 billion.

Conditions vary with location in the study area but, under the projections incorporated in this economic analysis, the intermediate scenario is for relative sea level to rise by two feet between the years 2102 and 2117. Under the high relative sea level change scenario a rise of two feet will occur by 2063.

The various alternative plans have significantly different completion schedules. Hence, in order to provide the flexibility to analyze a range of implementation periods, the impacts of relative sea level change were estimated for increments of relative sea level change, which can occur in different future years depending on the gage and scenario under consideration, rather than for fixed future years representing the completion schedules of plan alternative plans which are subject to change as the study progresses.

Water surface elevations under an intermediate relative sea level change scenario in 2030, when all alternative plans are assumed to begin construction, were used as a baseline and flood inundation damages were calculated for that condition and for subsequent increments of relative sea level change of one, two, four, and six feet. This allows for lifecycle damages and benefits to be calculated for all plans using a common template, covering a period ending significantly more than 50 years after the anticipated completion of any plan, even accounting for plausible future changes in the completion schedules.

Using the formulae and constants provided in Engineer Regulation 1100-2-8162, and the most recent observed trends in relative sea level change from NOAA, relative sea level change increments for low, intermediate, and high relative sea level change scenarios for all three gages were calculated for a period covering 130 years following the currently assumed start of construction for all alternative plans. The resulting curves are plotted and presented in Figure 42.

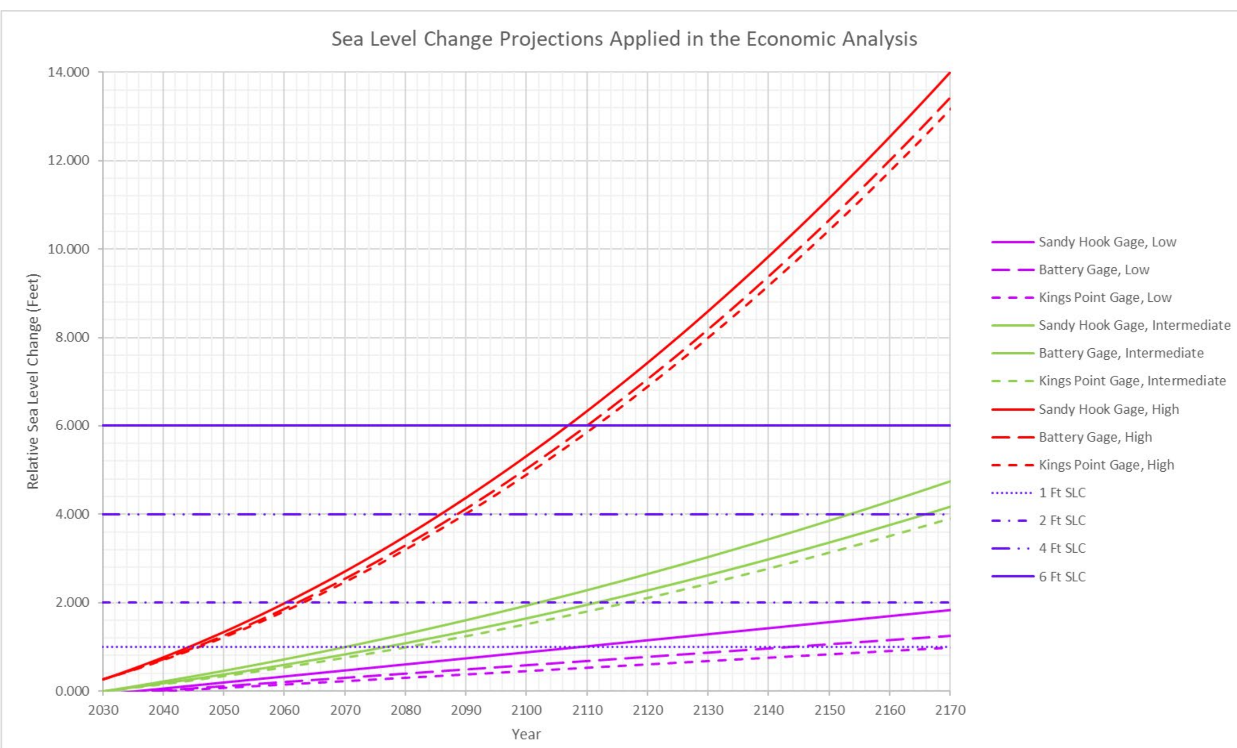


Figure 42: Relative sea level change projections applied in the economic analysis.

Expected Annual damages were calculated using HEC-FDA for a baseline condition and for subsequent increments of relative sea level change of one, two, four, and six feet. The baseline condition was taken to be 2030, when all alternative plans are assumed to begin construction. The output from HEC-FDA was input to a spreadsheet in which the damages accruing from each increment of relative sea level change were used to calculate lifecycle damages for each economic reach in present worth and annualized form. The future without-project annualized damages are $5.899 billion under the low/historic scenario, $7.948 billion under the intermediate scenario, and $16.892 billion under the high scenario.

The development of alternative plans was based on the intermediate rate of relative sea level change. Table 17 shows the future without-project damages in the intermediate scenario and the without project damages. The difference between the first two columns constitutes the benefits (third column) provided by the alternative. After the benefits column is the annualized costs. Costs are subtracted from the benefits to arrive at the net benefits. Based on the intermediate rate, Alternative 3B has the highest net economic benefits ($3.983 billion) and is the best performing plan under the NED account.

Table 17: NED benefits under the intermediate relative sea level change scenario.

Intermediate Relative Sea Level Change Scenario Annual Damages/Benefits/Costs, Billions						
Alternative	Without Project	With Project	Benefits	Cost	Net Benefits	BCR
2	$7.948	$3.366	$4.582	$5.697	-$1.115	0.8
3A	$7.948	$1.562	$6.386	$3.065	$3.321	2.1
3B	**$7.948**	**$1.689**	**$6.259**	**$2.276**	**$3.983**	**2.8**
4	$7.948	$2.943	$5.005	$1.899	$3.106	2.6
5	$7.948	$6.035	$1.914	$0.858	$1.056	2.2

Price Level February 2022, Discount Rate 2.25%, 50 year period of analysis

While Alternative 2 and Alternative 3A cover a greater proportion of the study area than Alternative 3B, they accrue lower total annual benefits than Alternative 3B due to the different anticipated timelines and scheduled completion dates of these alternative plans. Every alternative plan is anticipated to begin construction in 2030 and to accrue benefits for a period of analysis up to 50 years following the project completion year. In accordance with current USACE guidance, the period of analysis for each alternative does not extend past 50 years after the common economic base year of 2044. Alternative 2 has a construction duration of 32 years, with anticipated completion in 2062, while Alternative 3A has a construction duration of 24 years, with anticipated completion in 2054. Additionally, it should be noted that Alternative 2 had some redundancies with ongoing Hurricane Sandy recovery and resilience projects, which factored into the calculation of benefits (the team was careful not to double count benefits).

USACE is also required to consider all three scenarios of relative sea level change in accordance with ER 1100-2-8162 (Table 18). Under the low relative sea level change scenario, in which historic sea level trends are projected linearly over the period of analysis, Alternative 3B would remain the Tentatively Selected Plan. However, under a high relative sea level change scenario, in which the rate of rise is expected to accelerate over the analysis period, Alternative 3A would become the Tentatively Selected Plan.

Table 18: Comparison of Results for All Evaluated Sea Level Change Scenarios

Annual Net Benefits in Billions						
Alternative	Low Relative Sea Level Change		Intermediate Relative Sea Level Change		High Relative Sea Level Change	
	Net Benefits	BCR	Net Benefits	BCR	Net Benefits	BCR
2	-$2.485	0.6	-$1.115	0.8	$5.755	2.0
3A	$1.636	1.5	$3.321	2.1	**$11.260**	**4.7**
3B	**$2.387**	**2.0**	**$3.983**	**2.8**	$10.483	5.6

Annual Net Benefits in Billions						
4	$1.620	1.9	$3.106	2.6	$8.976	5.7
5	$0.672	1.8	$1.056	2.2	$2.300	3.7

Note: Price Level February 2022, Discount Rate 2.25%, 50 year period of analysis

The result of the analysis of NED benefits is that Alternative 3B is recommended as the Tentatively Selected Plan. Note however, that all alternative plans have very high net benefits under the intermediate relative sea level change scenario. For the purpose of evaluating contributions to the NED account, all alternative plans would be ranked high.

Regional Economic Development

The regional benefit associated with construction is the indirect and induced economic output that would be produced for an assumed construction cost. This analysis uses the USACE RECONS 2.0 input/output model, developed by the Institute for Water Resources (IWR), to estimate the regional economic impacts of proposed construction work activities.

Alternatives 2 through 5 have common work activities associated with the Construction of Earth, Concrete and Mechanical Levees and Floodwalls as defined in the RECONS model. Conceptualized annual costs are used as construction expenditures (Appendix D). Of total expenditures, a portion will be captured within the local impact area and the remainder of the expenditures will be captured within the state and the nation. Direct expenditures capture direct impacts to the area's employment and income based on the goods and services necessary to complete construction of the alternative. Construction will also generate secondary economic activity often called multiplier effects. This would be realized through companies that supply materials or services to companies engaged in construction. Local restaurateurs, for example, will have higher disposable income because an increase in clientele and as a result, they will spend their dollars to purchase appliances, do home repairs and otherwise put money back into the economy. It should be noted that the extent of the multiplier effect is dependent upon how consumers respond to the additional income, in today's climate consumers might be inclined to save for an emergency rather than spend.

In summary, the higher the expenditure, the greater the contribution to the RED account. Alternative 2, which the highest annualized expenditure of $5.7 billion, has the greatest contribution to the RED account. Alternatives 2 through 4, which are expected to generate billions in income, also score high for RED. Alternative 5 generates hundreds of millions in income and is a lesser order of magnitude in effect, thereby scoring a medium for the RED account.

Environmental Quality (EQ)

To review and compare the Alternatives for environmental acceptability, the individual resource impact assessment rating scores generated were combined into broader resource categories and averaged based on the total number of resources that fall in each resource category. The results of those calculations are considered in three forms: an impact rating showing the "initial" or "unmitigated" impact of the construction footprint, the operations and maintenance assumptions ratings, and the mitigated impact rating. Potential adverse impacts are rated on a scale of "1 to 5" with "1" representing No Impacts and "5" representing High (significant) Impacts that would be environmentally unacceptable. The following general findings are based on the environmental analysis conducted, and currently does not include the preliminary results of the New York Bight Ecological Model (NYBEM) which is presented in this Draft Integrated FR/Tier 1 EIS. The NYBEM will be incorporated in the environmental analysis for the Final Integrated FR/Tier 1 EIS, both with individual rating scores by Planning Region as the other Natural and Physical Environment resources were assessed, and additionally by utilizing the outputs of the NYBEM to inform other potential resource impacts within the Study Area. General findings of the Tier 1 Alternative comparison are presented below:

All Alternatives exhibit anticipated adverse impacts depending on resource, measure type, and existing conditions. Based on the Alternative EQ scores presented in the Plan Comparison Chapter, all Alternatives generally exhibit Low Impacts to slightly varying degrees. Utilizing the EQ rating criteria, the construction/footprint scores range from 1.3 (Alternative 5) to 1.8 (Alternative 3A). The operations and maintenance assumption scores range from 1.1 (Alternative 5) to 1.4 (Alternatives 2 and 3A). The mitigated impact scores, based on the considerations for avoidance, minimization, and mitigation, range from 1.1 (Alternative 5) to 1.3 (Alternatives 2 and 3A). Overall, Alternatives with greater expanses of in-water measures tend to produce greater impacts to aquatic species and habitat more broadly than Alternatives with less in-water measures coupled with potential impacts to terrestrial species and habitat for shore-based measures associated with that Alternative. Alternatives with greater expanses of shore-based measures, naturally tend to exhibit greater impacts to terrestrial species and habitat over aquatic. Therefore, Alternative 2 and 3A generally exhibit a larger magnitude of impact over Alternatives 3B, 4, and 5, due to the presence for larger in-water storm surge barriers.

While beneficial effects were not assessed from a quantitative perspective, they were noted where potentially occurring by placing a "+" next to the impact rating score. All Alternatives exhibit beneficial impacts either from the construction and/or placement of the structural measures, the operations and maintenance assumptions, and/or associated mitigated outcome (including best management practices). Those beneficial effects, depending on resource, measure, and existing conditions include the placement of in-water hard structures creating a "reef effect" for numerous species of algae, shellfish, and other invertebrates, the in-water and shore-based measures providing reduced risk of coastal flood damages to resources including cultural sites of significance, parks, habitat, and HTRW sites, reduced storm related erosion, social vulnerability to environmental justice communities, and health and safety.

Other Social Effects

USACE policy, specifically the Principles and Guidelines (P&G) requires consideration of "Other Social Effects," such as life, health, and safety, social vulnerability and resilience, economic vitality, social connectedness, identity and participation, and leisure and recreation to guide identification and development of water resource projects which are considered to be effective, acceptable and fair. Accordingly, an analysis was carried out to determine how alternative measures will affect resident and community well-being directly, by managing risk to injury or mortality, and indirectly by affecting factors that contribute to well-being such as the economy, infrastructure quality, community identity and cohesion, and public spaces. Although for this analysis these impacts cannot easily be monetized for inclusion in a benefit cost analysis, they were systematically assessed so that they could be considered in tandem with other information in guiding plan selection.

The USACE Institute for Water Resources (IWR) publication "Applying Other Social Effects in Alternatives Analysis" (IWR 2013) provides guidance for Districts to develop their own study-specific method for capturing and assessing the impacts of their respective projects. For each social factor to be analyzed under the Other Social Effects (OSE) account, the team identified appropriate metrics that indicate the ways in which alternative plans can have a positive or negative impact. The metrics serve to quantify how alternative plans are expected to perform with respect to different aspects of community and individual well-being. The OSE assessment team engaged with subject matter experts at NYSDEC, NJDEP, MOCEJ, and the New York City Department of Health and Mental Hygiene to select metrics that would best characterize the Study Area and for which judgment can be reasonably made about whether the information is indicative of negative or positive impact (Table 19). The OSE analysis conducted for this Study was done at a high level to provide a screening-level assessment appropriate for the scale and breadth of the study. The analysis did not include primary data collection such as interviews and was driven largely by geospatial data (demographic profile of communities, location of infrastructure with respect to areas at risk), information provided by the public and interest groups during the public comment period, and expert judgment.

The assessment measures both positive and negative impacts of the alternative plans. In general, positive impacts are related to losses that will be avoided due to risk management measures. These positive impacts materialize only when (and if) flooding conditions occur, which are many fewer days of the year than non-flood conditions. Some measures can also deliver benefits during non-flood conditions, such as flood barriers that provide elevated promenades for public enjoyment. The OSE analysis also examined "everyday effects," meaning the impacts that the flood barriers will have for the local community on days when there are no floods. The flood measure alternative features each change the landscape, with varying consequences for social effects, e.g., public space accessibility, viewsheds, and important community buildings that existed prior to flood measure construction. These impacts to the status quo tend to be negative or negatively perceived when experienced on non-flood days, at least initially (Rasmussen et al. 2021).

Table 19: OSE Matrix formulated for NYNJHAT.

Factors	Metrics	Criteria
Physical and Mental Health and Safety	Safety	Residents of Risk-Managed Areas
		Access to Healthcare
		Population with Physical Vulnerabilities in Risk-Managed Areas
	Health	Point Sources of Contamination in Risk-Managed Areas
Economic Vitality	Business Climate	Business Buildings in Risk-Managed Areas
Social Connectedness	Community Facilities	Community Buildings in Risk-Managed Areas
Identity	Identity	Community Monuments in Risk-Managed Areas
		Aesthetics of Barrier
Social Vulnerability and Resilience	Socially Vulnerable Groups	Intersection of Barrier with Environmental Justice Communities
		Environmental Justice Communities in Risk-Managed Areas
		Socially Vulnerable Groups in Risk-Managed Areas
		Life Expectancy for Residents in Risk-Managed Areas
Participation	Public Participation	Reflection of Community Priorities
Leisure and Recreation	Recreational Activities	Change in Outdoor Recreation/Leisure/Nature Space

Using the raw scores without applying weighting the analysis calculated the following scores ranging from -3 to 3 (Table 20). This weighting scheme effectively favors factors with more criteria, like Physical and Mental Health and Safety and Social Vulnerability and Resilience which each have four criteria.

Table 20: Scaled scores for alternatives by criteria (unweighted).

Criteria	Scores				
	Alt 2	Alt 3A	Alt 3B	Alt 4	Alt 5
Residents of Risk-Managed Areas	2.88	2.73	2.22	1.99	0.32
Access to Healthcare	3.00	3.00	1.62	1.38	0.92
Population with physical vulnerabilities in Risk-Managed Areas	2.87	2.68	2.21	1.99	0.27
Point Sources of Contamination in Risk-Managed Areas	2.98	2.90	2.55	1.53	0.07
Business Buildings in Risk-Managed Areas	2.89	2.76	2.15	1.86	0.37
Community Buildings in Risk-Managed Areas	2.95	2.83	2.35	2.16	0.75
Community Monuments in Risk-Managed Areas	2.88	2.84	2.15	2.03	1.35
Aesthetics of Barrier	-1	-1.5	-2.5	-3	-2
Intersection of Alternative Footprint with Environmental Justice Communities	-0.86	-1.00	-1.59	-3.00	-0.47
Environmental Justice Communities in Risk Managed Areas	2.92	2.86	2.39	2.11	0.32
Socially Vulnerable Groups in Risk-Managed Areas	2.86	2.73	2.25	2.07	0.32
Life Expectancy for Residents in Risk-Managed Areas	2.86	2.56	2.09	1.76	0.24
Reflection of Community Priorities	-1.2	-1.1	-0.7	-1.2	-1
Change in Outdoor Recreation/Leisure/Nature Space	1.87	1.93	1.77	1.00	0.69

It was recognized early on that the criteria and the factors that encompass them should not be assumed to have equal importance for the decision of which alternative to choose, and thus scoring the criteria is not enough to enable a useful comparison. Each factor must be weighted against the other factors, and the criteria within each factor must be similarly weighted against each other to establish relative importance. To obtain an idea of weights, the Study team collected data from a small group of stakeholders comprised of city and state representatives who chose the weights based on their knowledge of community concerns. From this exercise the OSE scoring was run through the following weighting schemes (Table 21):

- all the factors are deemed equally important
- all the criteria are deemed equally important
- Criteria and Factors weighted according to stakeholder feedback

Table 21: OSE Scores by alternative, for each weighting scheme

	Alt 2	Alt 3A	Alt 3B	Alt 4	Alt 5
All Criteria Equally Weighted	1.93	1.80	1.28	0.91	0.14
All Factors Equally Weighted	1.73	1.63	1.22	0.83	0.13
Stakeholder Weights	1.77	1.67	1.25	0.87	0.12

In each version of the weighing for equal importance of both the criteria and the factors the scores indicated that alternative 2 was the most beneficial. Finally, a weighting sensitivity analysis was carried out which combined scores from criteria under different areas of concern such as Physical and Mental Health and Safety and Social Vulnerability and Resilience (Table 22).

Table 22: Stress testing of OSE scores by weighting each topic at 80% of weight, and dividing the remaining 20% of weights between the remaining criteria.

	Alt 2	Alt 3A	Alt 3B	Alt 4	Alt 5
Physical and Mental Health and Safety Prioritized	2.65	2.55	1.93	1.51	0.33
Economic Vitality Prioritized	2.62	2.50	1.94	1.62	0.31
Social Connectedness Prioritized	2.66	2.55	2.09	1.85	0.60
Identity Prioritized	1.12	0.89	0.15	-0.18	-0.22
Social Vulnerability and Resilience Prioritized	1.74	1.55	1.07	0.75	0.07
Participation Prioritized	-0.52	-0.46	-0.25	-0.73	-0.74
Recreation Prioritized	1.84	1.86	1.64	0.96	0.56
Everyday Effects Prioritized	-0.47	-0.70	-1.13	-1.56	-0.88
Environmental Justice Prioritized	0.92	0.72	0.19	-0.13	-0.11
Group and Individual Vulnerabilities Prioritized	2.06	1.89	1.40	1.02	0.11

The OSE analysis found that Alternative 2 performs the best with zero or minimal weighting applied and also when weighting is applied. Additionally, the scores for Alternative 3A are often just short of the higher score for Alternative 2. This was not surprising given the proportion of the flooded areas receiving risk management under Alternative 2 and 3A. In two versions of the stress testing, 3A and 3B were ahead by a small margin for the Public Participation and Recreation criteria. Although the analysis was broadly scoped these emerging trends are warrant further study as the project moves forward to look on a more localized scale at the factors that might effect a community.

4.8.5 Summary

Table 23 provides a summary of how the alternative plans contribute to each of the four accounts, using a qualitative ranking of high, medium, and low.

Table 23: Contribution of Alternatives to P&G Accounts

	NED	**EQ**	**RED**	**OSE**
Alternative 2	High	Low	High	High
Alternative 3A	High	Low	High	High
Alternative 3B	High	Medium	High	High
Alternative 4	High	Medium	High	High
Alternative 5	High	Medium	Medium	Medium

4.9 PLAN COMPARISON

Based on an accounting of NED benefits, the TSP is Alternative 3B. Based on the consideration of the four accounts, the alternative plans that contribute the most across all accounts while minimizing impacts are Alternatives 3B and 4. When comparing Alternatives 3B and 4, there are four major factors to consider in identifying a TSP: environmental acceptability, implementation (HTRW) considerations, other critical infrastructure, and navigational impacts.

4.9.1 Environmental Acceptability

To review alternative plans for environmental acceptability for this high-level Tier 1 assessment, the individual resource impact assessment rating scores generated in Chapter 6 were combined into broader resource categories and averaged based on the total number of resources that fall in each resource category for environmental comparison purposes. The results of those calculations are presented in two forms: an impact rating showing the "initial" or "unmitigated" impact of the construction footprint rating (Table 24), the operations and maintenance assumptions ratings (Table 25) and the mitigated impact rating (Table 26). Potential adverse impacts are rated on a scale of "1 to 5" with "1" representing no impacts and "5" representing significant impacts that would be environmentally unacceptable. Note, the Air Quality and Clean Air Act rating reflects a "1" or No Impact rating, as this category reflects air emissions and greenhouse gas emissions policy requirements for each Alternative. Every Alternative has beneficially effects associated with one or more resources. Those benefits are discussed in more detail in Chapter 6. Refer to the Notes under each Table for a description of the individual resources that fall in each resource category calculated in these tables and refer to Chapter 6 for individual resource impact assessment, benefits discussion, rating criteria, and results.

Table 24: Footprint/construction impact rating by Alternative and resource category.

FOOTPRINT/CONSTRUCTION SCORE CARD	ALTERNATIVE				
RESOURCE CATEGORY	**2**	**3A**	**3B**	**4**	**5**
NATURAL AND PHYSICAL ENVIRONMENT					
Wildlife and Vegetation[A]	1.75	1.77	1.51	1.53	1.20
Special Status Species (Terrestrial)[B]	2.11	2.0	1.66	1.66	1.33
Special Status Species (Aquatic)[C]	1.63	1.77	1.5	1.44	1.05
Special Status Areas[D]	1.66	1.62	1.41	1.43	1.16
Commercial and Recreational Fishing	2.0	2.22	1.77	1.66	1.11
Physical Resources[E]	1.94	2.08	1.69	1.66	1.33
Hydrological Resources[F]	1.53	1.73	1.46	1.46	1.06
Water Quality	2.11	2.22	1.77	1.66	1.33
Ecosystems (NYBEM)	**To be incorporated for the Final FR/Tier 1 EIS*				
Air Quality and Clean Air Act[G]	1	1	1	1	1
Regional Climate and Climate Change	1	1	1	1	1
Cultural Resources[H]	2.77	2.66	2.66	2.66	2.22
Native American Lands	1	1	1	1	1
Hazardous, Toxic, and Radioactive Waste Sites	2.2	2.22	2.0	2.0	1.55
Navigation	1.22	1.44	1.22	1.11	1.0
Noise and Vibration	2.0	2.22	1.77	1.66	1.33
Environmental Justice	1.66	1.66	1.55	1.55	1.33
CALCULATION: Sum of the Footprint/Construction Impact Ratings (x) divided by the total number of resources included in each resource category (y). (x = alternative score; y = # of resources) x ÷ y = Rating (1-5)					

1 - No Impact, 2 - Low Impact, 3 - Moderate Impacts, 4 - Moderate-High Impact, 5 - High Impact					
ALTERNATIVE TOTAL: (rounded to the nearest 10th)	**1.7**	**1.8**	**1.6**	**1.5**	**1.3**

Table 25: Operations and maintenance assumptions impact rating by Alternative and resource category.

OPERATIONS AND MAINTENANCE SCORE CARD	ALTERNATIVE				
RESOURCE CATEGORY	**2**	**3A**	**3B**	**4**	**5**
NATURAL AND PHYSICAL ENVIRONMENT					
Wildlife and Vegetation[A]	1.42	1.44	1.31	1.27	1.12
Special Status Species (Terrestrial)[B]	1.77	1.77	1.51	1.55	1.33
Special Status Species (Aquatic)[C]	1.27	1.30	1.22	1.13	1.02
Special Status Areas[D]	1.26	1.25	1.23	1.18	1.05
Commercial and Recreational Fishing	1.88	1.55	1.55	1.33	1.11
Physical Resources[E]	1.30	1.38	1.25	1.30	1.08
Hydrological Resources[F]	1.20	1.42	1.17	1.17	1.0
Water Quality	1.66	1.55	1.44	1.22	1.0
Ecosystems (NYBEM)	**To be incorporated for the Final FR/ Tier 1 EIS*				
Air Quality and Clean Air Act[G]	1	1	1	1	1
Regional Climate and Climate Change	1	1	1	1	1
Cultural Resources[H]	2.0	1.55	1.22	1.55	1.22
Native American Lands	1	1	1	1	1
Hazardous, Toxic, and Radioactive Waste Sites	1.66	1.44	1.33	1.33	1.0
Navigation	1.22	1.44	1.22	1.11	1.0
Noise and Vibration	1.0	1.0	1.0	1.0	1.0
Environmental Justice	1.77	1.66	1.55	1.55	1.33
CALCULATION: Sum of the Operations and Maintenance Assumption Ratings (x) divided by the total number of resources in each resource category (y). (x = alternative score; y = # of resources) x ÷ y = Rating (1-5) 1 - No Impact, 2 - Low Impact, 3 - Moderate Impacts, 4 - Moderate-High Impact, 5 - High Impact					
ALTERNATIVE TOTAL: (rounded to the nearest 10th)	**1.4**	**1.4**	**1.3**	**1.2**	**1.1**

Table 26: Mitigated impact rating by Alternative and resource category.

MITIGATED IMPACT SCORE CARD	ALTERNATIVE				
RESOURCE CATEGORY	**2**	**3A**	**3B**	**4**	**5**
NATURAL AND PHYSICAL ENVIRONMENT					
Wildlife and Vegetation[A]	1.51	1.53	1.37	1.35	1.12
Special Status Species (Terrestrial)[B]	1.16	1.05	1.05	1.05	1.0
Special Status Species (Aquatic)[C]	1.50	1.5	1.33	1.25	1.02
Special Status Areas[D]	1.12	1.11	1.07	1.08	1.06
Commercial and Recreational Fishing	2.11	2.11	1.77	1.66	1.11
Physical Resources[E]	1.41	1.52	1.33	1.41	1.11
Hydrological Resources[F]	1.24	1.33	1.13	1.13	1.06
Water Quality	1.11	1.0	1.0	1.0	1.0
Ecosystems (NYBEM)	**To be incorporated for the Final FR/ Tier 1 EIS*				
Air Quality and Clean Air Act[G]	1	1	1	1	1
Regional Climate, Climate Change, and RSLC	1	1	1	1	1
Cultural Resources[H]	1.2	1.33	1.11	1.22	1.11
Native American Lands	1	1	1	1	1
Hazardous, Toxic, and Radioactive Waste Sites	1.88	1.88	1.55	1.77	1.44
Navigation	1.22	1.44	1.22	1.11	1.0
Noise and Vibration	1.22	1.44	1.22	1.11	1.0
Environmental Justice	1.0	1.0	1.0	1.0	1.0
CALCULATION: Sum of the Footprint/Construction impact ratings and Operations and Maintenance Assumption Ratings (x) divided by the total number of resources. (x = alternative score; y = # of resources) x ÷ y = Rating (1-5) 1 - No Impact, 2 - Low Impact, 3 - Moderate Impacts, 4 - Moderate-High Impact, 5 - High Impact					
ALTERNATIVE TOTAL: (Rounded to the nearest 10th)	**1.3**	**1.3**	**1.2**	**1.2**	**1.1**

Table 27: Definitions to Support Impact Rating Tables

A	Wildlife and Vegetation Category	=	Wildlife, Fish, Migratory Fish, Terrestrial Vegetation, Submerged Aquatic Vegetation, Invasive and Aquatic Nuisance Species
B	Special Status Species (Terrestrial)	=	Threatened and Endangered Species (terrestrial), Migratory Bird Treaty Act and Bald and Golden Eagle Act Species
C	Special Status Species (Aquatic)	=	Threatened and Endangered Species (aquatic), Marine Mammal Protection Act Species, Sea Turtles, Essential Fish Habitat, Migratory Fish, Special Status Fisheries
D	Special Status Areas	=	Wetlands, Floodplains, Wild and Scenic Rivers, Designated Critical Habitat, Critical Environmental Areas (State), Marine Protected Areas, Coastal Zone Management Act Areas, Coastal Barrier Resources System Areas, NPS Land, Wildlife Refuge Land
E	Physical Resources	=	Topography and Geology, Surface Waters, Sediment, Land Use
F	Hydrological Resources	=	Bathymetry; Inland Hydrology; Coastal Hydrology, Currents, and Circulation; Tides, Tidal Exchange, and Tidal Range; Sediment Transport
G	Air Quality and Clean Air Act	=	Air Quality and Clean Air Act, Greenhouse Gas Emissions
H	Cultural Resources	=	Aboveground Resources, Archaeological and Submerged Resources, Landmarks

4.9.2 Implementation (HTRW) Considerations

Alternatives 3B and Alternative 4 are similar, however that Alternative 3B includes a storm surge barrier on the Arthur Kill and Hackensack River. Alternative 4 does not include a storm surge barrier on the Arthur Kill or Hackensack River. As the storm surge barrier on the Hackensack River is larger than a Risk Reduction Feature, its tie-in features have a longer extent. This longer extent reaches into known areas of Hazardous, Toxic, and Radioactive Waste (HTRW). USACE would not be able to proceed with construction on these areas until the non-federal sponsor provides a clean, remediated site. The time frame for providing a clean site cannot be estimated at this time.

4.9.3 Other Critical Infrastructure

There are 2,281 above ground storage tanks (AST) in municipalities bordering Arthur Kill, Kill Van Kul, and the Port of Newark. These tanks contain petroleum products, gasoline, diesel fuel, and other commodities, and are critical to the function of the New York Metropolitan Area. After Hurricane Sandy, impacts to commodities storage and distribution contributed to widespread shortages of gasoline and hampered vehicular movements for about two weeks. There are NED benefits in terms of replacement costs avoided and environmental clean up costs avoided with respect to providing coastal storm risk management for these above ground storage tanks. Depth damage data have been developed for these tanks (see Economics sub-appendix on Critical Infrastructure), but have not yet been incorporated into the HEC-FDA model. Alternative 3B provides coastal storm risk management for the reaches that include the ASTs (although these benefits have not yet been factored into the analysis), while Alternative 4 does not. It is anticipated that once these benefits are calculated, after the draft report, the net benefits for Alternative 3B will increase.

4.9.4 Navigational Impacts

Alternative 3B has a storm surge barrier on the Arthur Kill, which is narrow and busy navigation channel. Work on a storm surge barrier on the Arthur Kill will disrupt navigation traffic and port operations while the storm surge barrier is under construction. The storm surge barrier on the Hackensack is less likely to impact port operations. Alternative 4 will have less of a navigational impact.

4.10 IDENTIFICATION OF THE TSP

Based on the overall contributions to the P&G accounts, and further consideration of implementation considerations and other critical infrastructure, the alternative plan that maximizes benefits across all four accounts is Alternative 3B. The alternative plan that maximizes NED net benefits is Alternative 3B. Accordingly, the TSP is Alternative 3B.

5 TENTATIVELY SELECTED PLAN*

This Chapter presents a summary of important components and factors regarding Alternative 3B, which is the TSP. Further technical engineering, environmental, and economic details can be found in the appendices. Chapter 6 describes the impacts of the plan to the environmental and human environment.

5.1 PLAN OVERVIEW

After careful evaluation of the alternatives and their tradeoffs, the Study team selected Alternative 3B – Multi-basin Storm Surge Barriers With Shore-Based Measures as the Tentatively Selected Plan. The Tentatively Selected Plan manages coastal storm risk through suite of CSRM measures that function as a system including: primary structural components consisting of storm surge barriers at the entrance to Jamaica Bay, Arthur Kill, and Kill Van Kull to provide CSRM on a multi-basin basis, three primary structural components involving storm surge barriers on the individual water bodies of Gowanus Canal, Newtown Creek and Flushing Creek located in Brooklyn and Queens, and three primary structural shore-based measures in Jersey City, the lower west side of Manhattan, and East Harlem. Portions of the study area that directly benefit from the Tentatively Selected Plan include portions of the Hackensack and Passaic River watersheds, Upper Bay and Arthur Kill, Lower Hudson River, East River, Long Island Sound and Jamaica Bay Planning Regions.

In addition to the primary storm surge barriers and shore based measures, there are also nonstructural measures, natural and nature-based features, land and water based measures to mitigate any anticipated induced flooding from the project (known as Induced Flooding Features), and small scale measures located behind the storm surge barriers that can be implemented quickly to address high frequency flooding at the most vulnerable potions of the study area (known as Risk Reduction Features). In the instance of a large severe storm, storm surge barriers, navigable gates, and deployable flood barriers would help to reduce risk to vulnerable areas from flood damages relating to flooding, including the loss of human life and damage to existing infrastructure. Within areas of reduced risk are schools, parks, energy and transportation infrastructure, container and other cargo terminals, that would all see significant benefit through implementation of the tentatively selected measures.

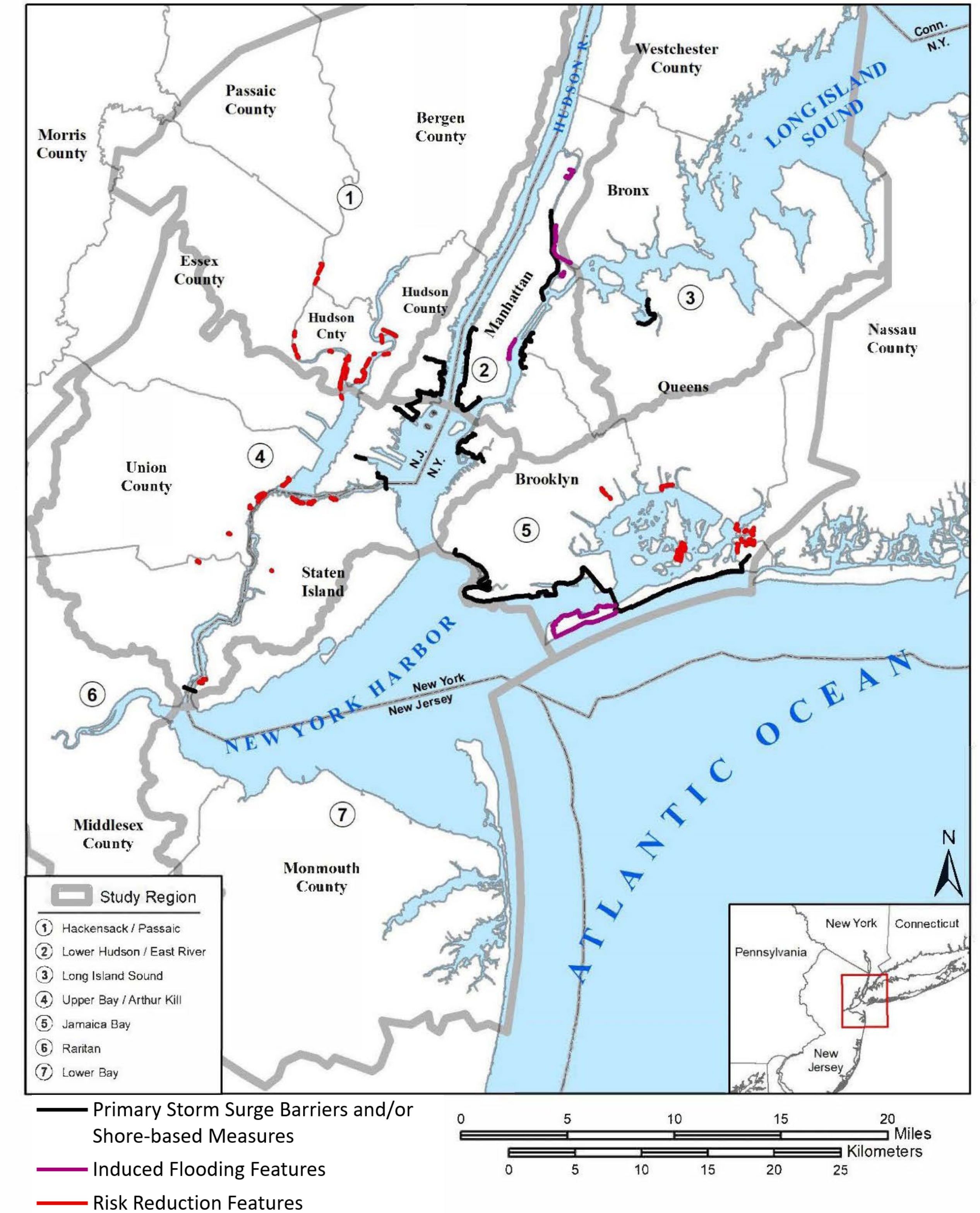


Figure 43: The Tentatively Selected Plan

5.1.1 Structural Measures by Planning Region

The structural measures in the TSP are present in five of the Planning Regions (Table 28). The storm surge barriers, shore-based measures, complementary Induced Flooding-Mitigation Features and Risk Reduction

Features components of the TSP are presented below by Planning Region. Some focused figures are presented below. More detailed figures of the TSP components can be found in Appendix E.

Table 28: Structural measures included in the TSP, by Planning Region

Planning Region	Storm Surge Barriers	Tide Gates	Floodwalls	Levees	Elevated Promenades	Buried Seawalls/Sand Dunes	Seawalls	Revetments	Berms	Bulkheads	Pedestrian/Vehicular Gates	Road Raising
Capital District												
Mid-Hudson												
Lower Hudson/East River	●		●	●	●		●				●	
Upper Bay/Arthur Kill	●	●	●	●			●	●	●		●	
Lower Bay												
Hackensack/Passaic			●					●	●		●	●
Raritan Region												
Long Island Sound	●		●		●		●					
Jamaica Bay	●	●	●	●	●	●	●	●	●	●	●	●

● = Included in the Planning Region

Note: Ringwalls are not included in this table, as their potential locations have not yet been selected.

Lower Hudson/East River Region

In the Lower Hudson and East River Planning Region, the structural components of the TSP include one storm surge barrier across Newtown Creek and adjoining shore-based measures to provide coastal storm risk management to communities in Long Island City, Queens, and in Greenpoint, Brooklyn and the greater Newtown Creek area. The storm surge barrier would include a navigable conventional sector gate (Figure 44). It would span approximately 400 feet from shore to shore and have one gated navigable passage 130 feet wide, with a sill elevation at -26 feet NAVD88. The proposed structure crest elevation is +17 feet NAVD88.

On the south side of the storm surge barrier, shore-based measures extend along the East River shoreline and tie into higher ground at Greenpoint Avenue. On the north side of this storm surge barrier, shore-based measures are proposed along the waterfront of Long Island City. The storm surge barrier and shore-based measure alignments could provide coastal storm risk management to the low-lying areas of Long Island City, Greenpoint, and the larger Newtown Creek area. These shore-based measures may potentially include elevated promenades, deployable flood barriers, floodwalls, levees, and seawalls.

Shore-based measures are proposed in East Harlem, Manhattan between approximately East 88th Street and West 165th Street in Manhattan to provide coastal storm risk management to the low-lying and flood prone areas along the Harlem River (Figure 45). These shore-based measures may potentially include a combination of a combination of elevated promenades, floodwalls, deployable flood barriers, and seawalls.

Along the southern and western shorelines of Manhattan, NY, a shore-based measure alignment is proposed that runs from the Brooklyn Bridge along the waterfront to Battery Park, around Battery Park and Battery Park City, along the West Side Highway and Hudson River Park up to West 34th street to then terminate at high ground on West 34th Street (Figure 46). These shore-based measures may potentially include elevated promenades, deployable flood barriers, floodwalls, levees, and seawalls.

In Jersey City, NJ, shore-based measures are proposed following approximately the southern extent of the rail yard between Jersey City and Hoboken and connect to shore-based measures along the Jersey City waterfront (Figure 46). Shore-based measures are proposed all along the Jersey City waterfront and along the southern shoreline of the Paulus Hook neighborhood to then continue and connect to shore-based measures proposed the Upper Bay/ Arthur Kill Region in Liberty State Park. This section of the alignment may potentially include elevated promenades, deployable flood barriers, floodwalls, and levees.

The TSP includes shore-based measures in the following areas that could reduce the risk of induced flooding that may be caused by the storm surge barriers included in the tentatively selected plan:

- Along the Harlem River in the Bronx divided over two reaches that each tie to high ground and run along the south side of the Mott Haven neighborhood and extend north up to the 153rd Street subway station near Yankee Stadium
- Along the Harlem River between Sherman Creek and just North of University Heights Bridge (West 207th Street, Manhattan)
- Along the shoreline of Randall’s Island around Icahn Stadium, tied into high ground on either end
- Along the East River between East 25th and East 44th in neighborhoods of Kips Bay, Murray Hill, and Midtown East.

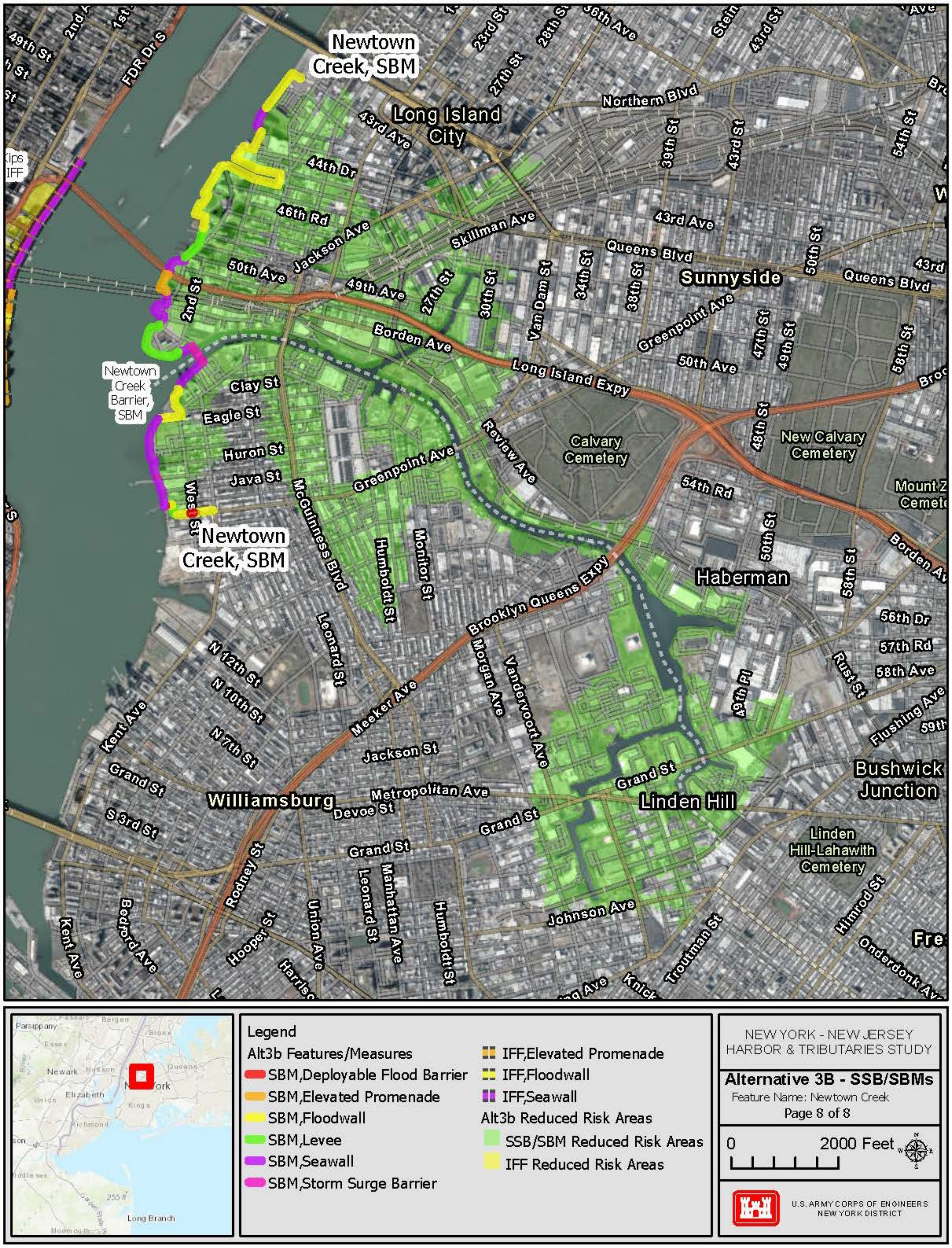


Figure 44: Tentatively Selected Plan Components Surrounding Newton Creek

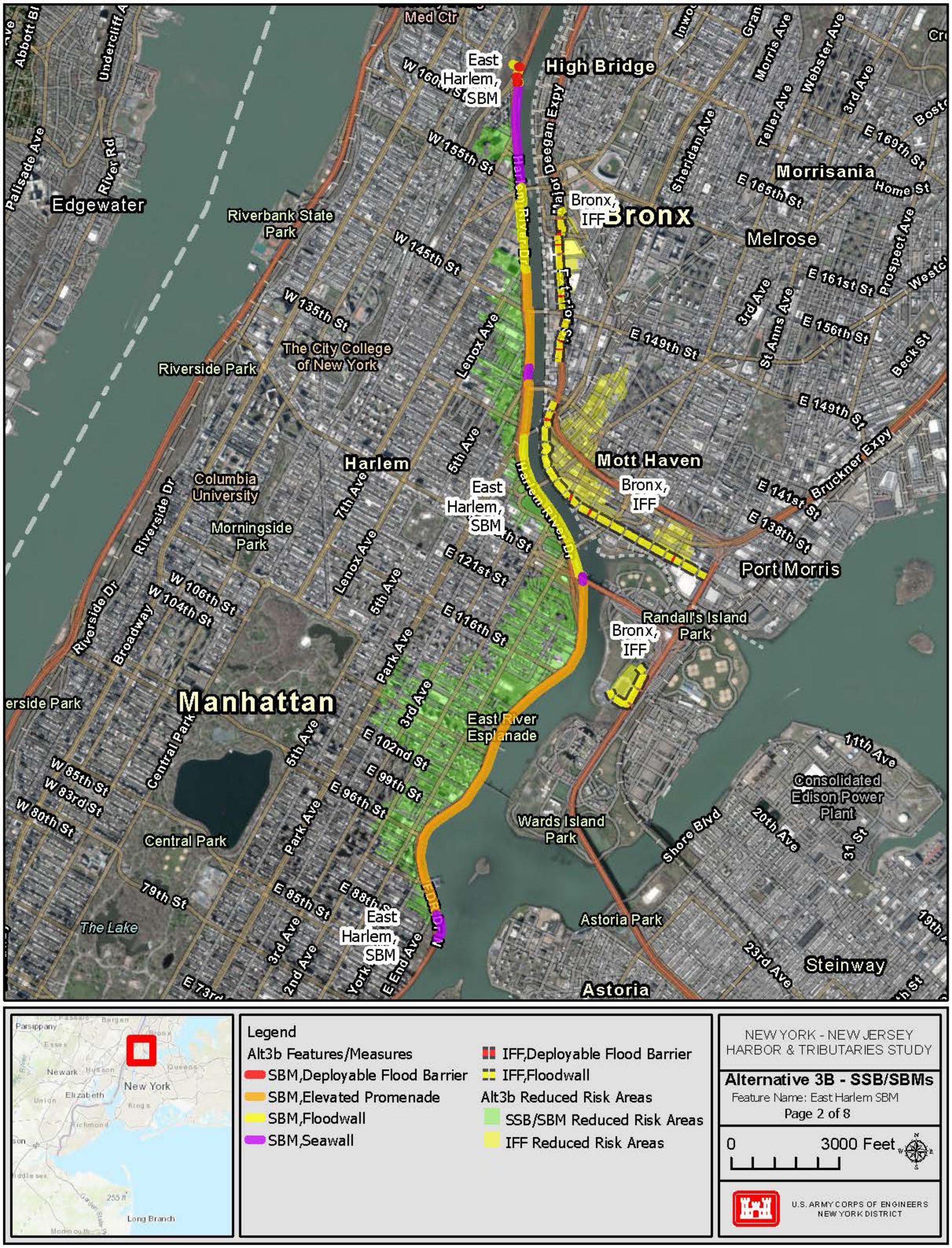


Figure 45: Tentatively Selected Plan Components Along Harlem River

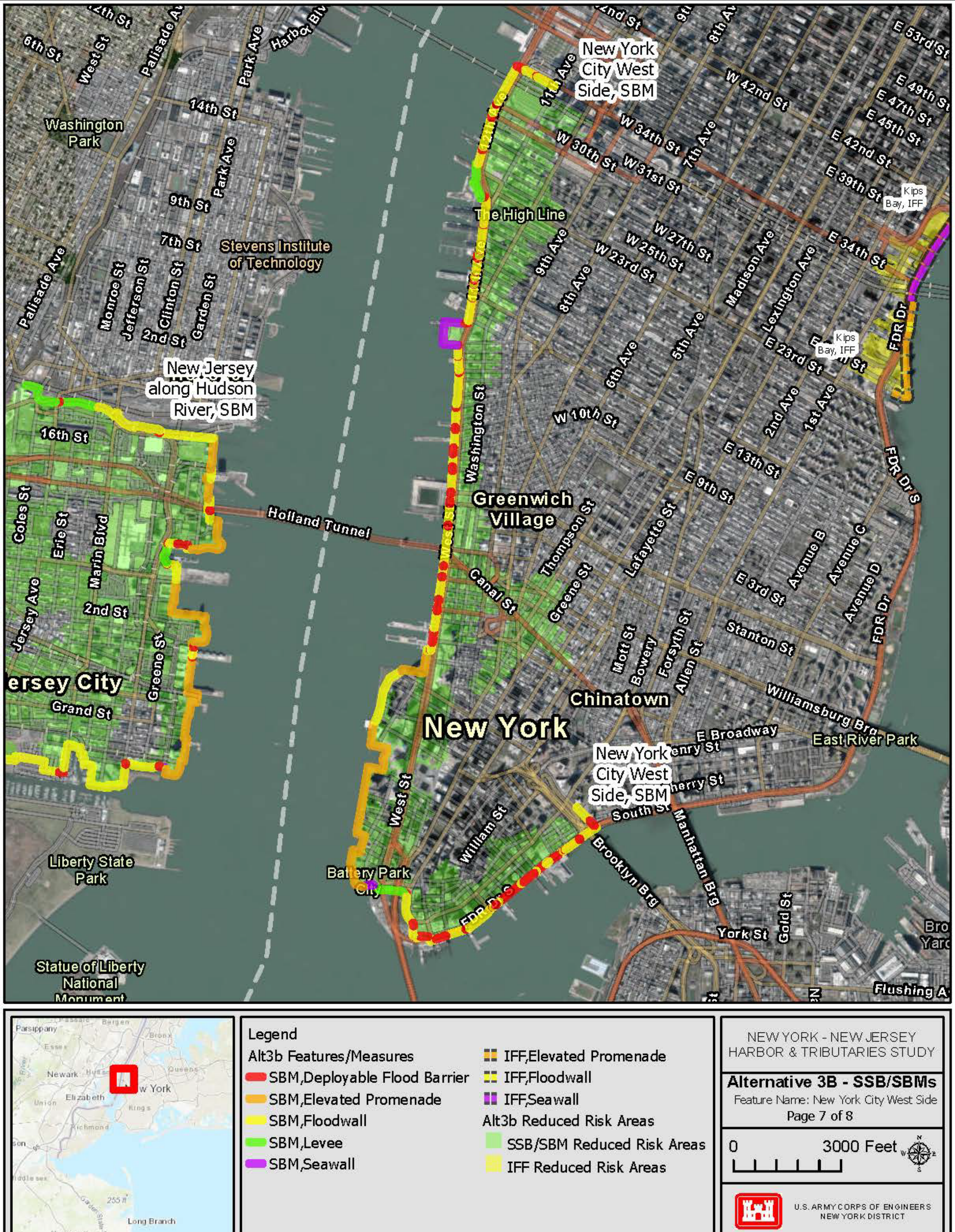


Figure 46: Tentatively Selected Plan Components in Lower Manhattan and Jersey City Waterfront

Hackensack/Passaic Region

In the Hackensack and Passaic Region, the structural components of the TSP include a combination of shore-based measures and storm surge barriers as a Risk Reduction Feature from frequent storm events, when the primary storm surge barrier measures on the mouths of the Kill Van Kull and Arthur Kill are not operated/closed, to provide further coastal storm risk management to communities in Hudson, Essex, Passaic, and Bergen Counties, New Jersey (Figure 47).

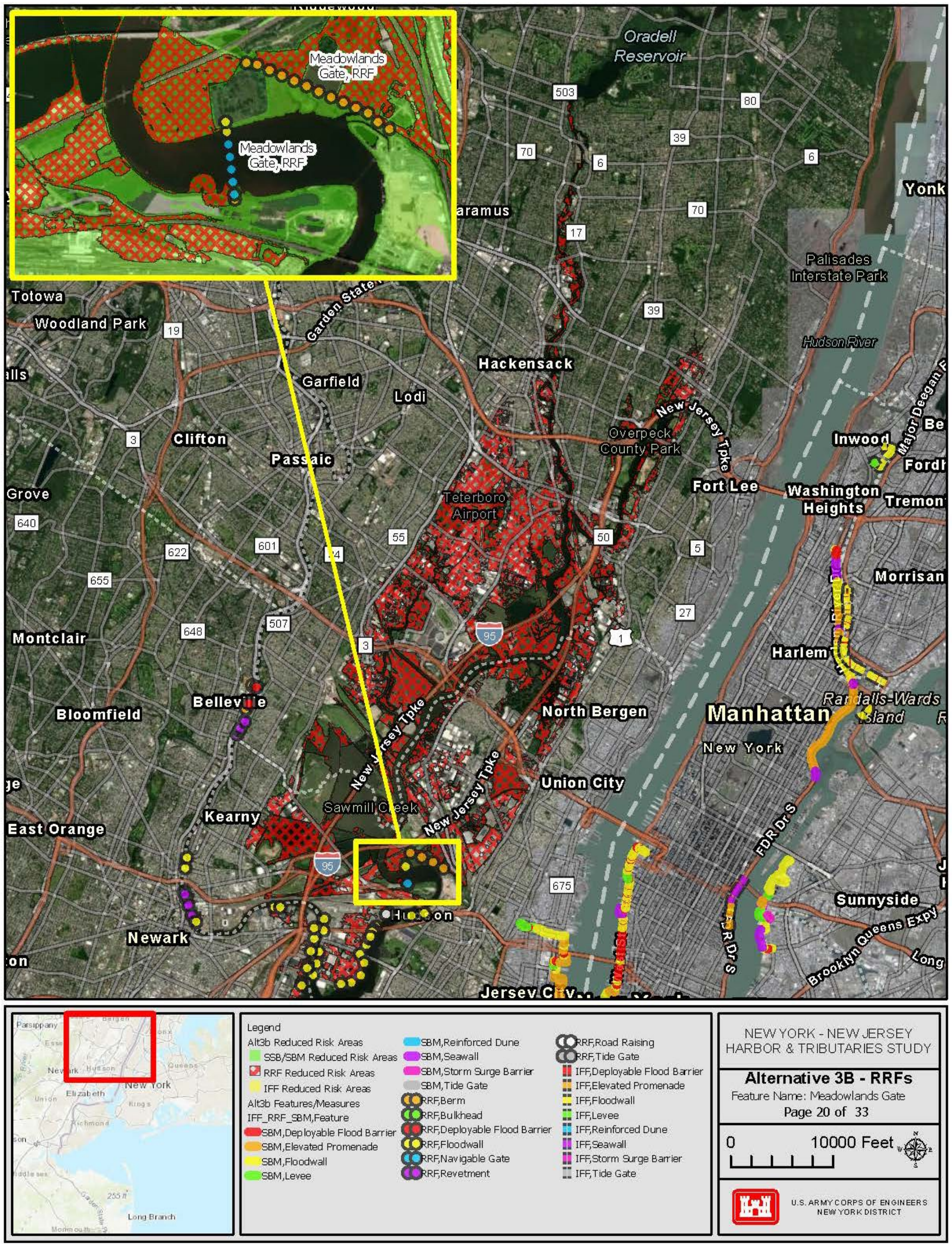


Figure 47: Tentatively Selected Plan Components in the Hackensack/Passaic Region

The Hackensack River storm surge barrier would provide coastal storm risk management upriver of the barrier along the Hackensack River, including Secaucus, Kearney, and Lyndhurst, NJ areas to the north. The storm surge barrier would include a navigable sector gate and five non-navigable auxiliary flow vertical lift gates. It would span approximately 1,900 feet from shore to shore and has one gated navigable passage 100 feet wide, with a sill elevation at -23 feet NAVD88. The proposed structure crest elevation is +10 feet NAVD88. This gated structure with tie in floodwalls provides flood risk reduction to the low-lying and flood prone areas in the Meadowlands that are upstream of this structure. This Hackensack River storm surge barrier and tie-ins may also have potential fluvial flood risk management benefits but that application and use has not been evaluated to date in this study.

Additional Risk Reduction Feature shore-based measures are proposed along the shorelines the Passaic River and Hackensack River. These shore-based measures may potentially include deployable flood barriers, bulkheads, berms, floodwalls, revetments, and road raisings.

- A series of floodwalls along the Newark, NJ shoreline near the confluence of the Passaic River and Newark Bay
- A series of floodwalls and road raising along Kearny Point's shoreline of the Hackensack and Passaic Rivers
- A berm on the northern side of the Hackensack River and the southern extent of the New Jersey Meadowlands in Secaucus, NJ
- An alignment of floodwalls, berms, and deployable flood barriers is proposed along the Passaic River in Belleville, NJ
- A series of revetments along the Passaic River in Harrison, NJ
- Revetment and floodwall along the Passaic River in Harrison, NY
- A revetment along the Passaic River in North Arlington, NJ
- A floodwall along the Passaic River in western Kearny, NJ
- A floodwall along the Hackensack River in Jersey City, NJ

Upper Bay/Arthur Kill Region

In the Upper Bay/ Arthur Kill Region, the primary structural components of the TSP include three storm surge barriers and shore-based measures to provide coastal storm risk management to communities in Staten Island and Brooklyn, New York, and include the Hackensack/Passaic Region, noted above as well as areas of Hudson, Essex, Middlesex, Morris, and Sommerset Counties in New Jersey (Figure 48).

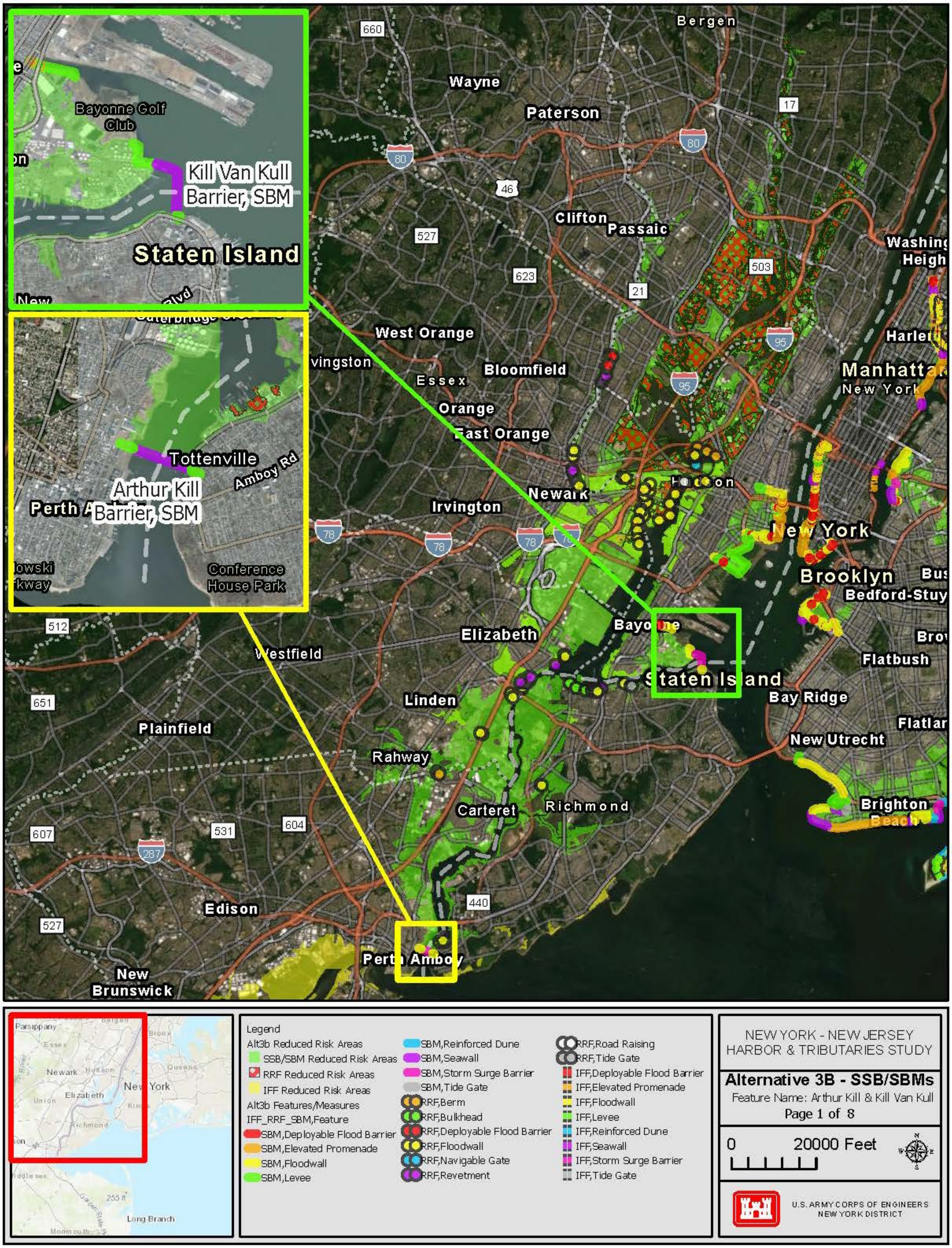


Figure 48: Tentatively Selected Plan Components in Upper Bay/Arthur Kill Region.

The Arthur Kill storm surge barrier, when operated in conjunction with the Kill van Kull storm surge barrier, would provide coastal storm risk management to upstream adjoining water bodies and low lying areas around it. This includes the Arthur Kill, Kill van Kull, Newark Bay, Hackensack River, and Passaic River. These storm surge barriers reduce risk to Staten Island, as well as communities in New Jersey including Perth Amboy, Carteret, Linden, Elizabeth, Newark, Bayonne and the multiple communities in the Hackensack Meadowlands. The Arthur Kill storm surge barrier would include a navigable floating sector gate, as well as non-navigable auxiliary flow vertical lift gates. It would span approximately 2,300 feet from shore to shore and has one gated navigable passage at 600 feet wide, with a sill elevation at -40 feet NAVD88 and two gated auxiliary flow openings each at 75 feet wide. The proposed structure crest elevation is +19 feet NAVD88. The Kill Van Kull storm surge barrier would include navigable floating sector gates, as well as non-navigable auxiliary vertical lift flow gates. It would span approximately 3,300 feet from shore to shore and would have one gated navigable passage 800 feet wide, with a sill elevation at -55 feet NAVD88 and five gated auxiliary flow openings each 150 feet wide. The proposed structure crest elevation is +19 feet NAVD88.

The Gowanus Canal storm surge barrier would provide coastal storm risk management in the neighborhoods of Gowanus, Red Hook, and Park Slope, Brooklyn (Figure 49). The storm surge barrier would include a navigable miter gate. It would span approximately 200 feet from shore to shore and would have one gated navigable passage 100 feet wide, with a sill elevation at -21 feet NAVD88. The proposed structure crest elevation is +16 feet NAVD88. On the east side of the storm surge barrier, shore-based measures such as deployable flood barriers and floodwalls tie into higher ground. On the west side of this storm surge barrier, shore-based measures are proposed to provide flood risk reduction for the Red Hook neighborhood and are placed in proximity to, or at the coastal edge. These shore-based measures may potentially include seawalls, levees, floodwalls, and deployable flood barriers.

In Jersey City, NJ, an alignment of levees, floodwalls, and deployable flood barriers in and south of Liberty State Park is proposed to tie into the Jersey City waterfront alignment proposed in the Lower Hudson Region (Figure 50). The Upper Bay/ Arthur Kill Region section of the proposed alignment runs along through Liberty State Park and then tie-off to high ground in the vicinity of Bayview Avenue and Garfield Avenue.
Additional Risk Reduction Features are proposed along the Arthur Kill and Kill van Kull and lower Newark Bay to further mitigate flood risk:

- Floodwalls, bulkheads, and revetments are proposed in Tottenville, Staten Island, NY
- A tide gate and berms are proposed along Casey’s Creek, off the Rahway River, to provide coastal storm risk management to Carteret, NJ.
- An alignment of floodwall and revetment wrapping the southern entrance to the Elizabeth River near the junction of Newark Bay and Arthur Kill in Elizabeth, NJ
- A floodwall on the northern side of the Elizabeth in Elizabeth, NJ
- A floodwall along the entrance of Morses Creek and along Carringer Road in Elizabeth, NJ
- In New Jersey, additional floodwalls are proposed along Morses Creek and floodwalls and revetments are proposed along the shorelines of the Elizabeth River.
- A floodwall and tide gate are proposed in Tremley, NJ, off the Morses Creek, a tributary to the Arthur Kill.
- A floodwall is proposed in Newark, NJ near the junction of the Passaic River and Newark Bay
- Along the Kill van Kull, bulkheads, floodwalls, and revetments are proposed along Mariner’s Harbor on Staten Island, NY.
- Along the Kill van Kull, floodwalls and tide gates are proposed along Bergen Point on Staten Island, NY.
- A floodwall is proposed within the Fresh Kills neighborhood of Staten Island.

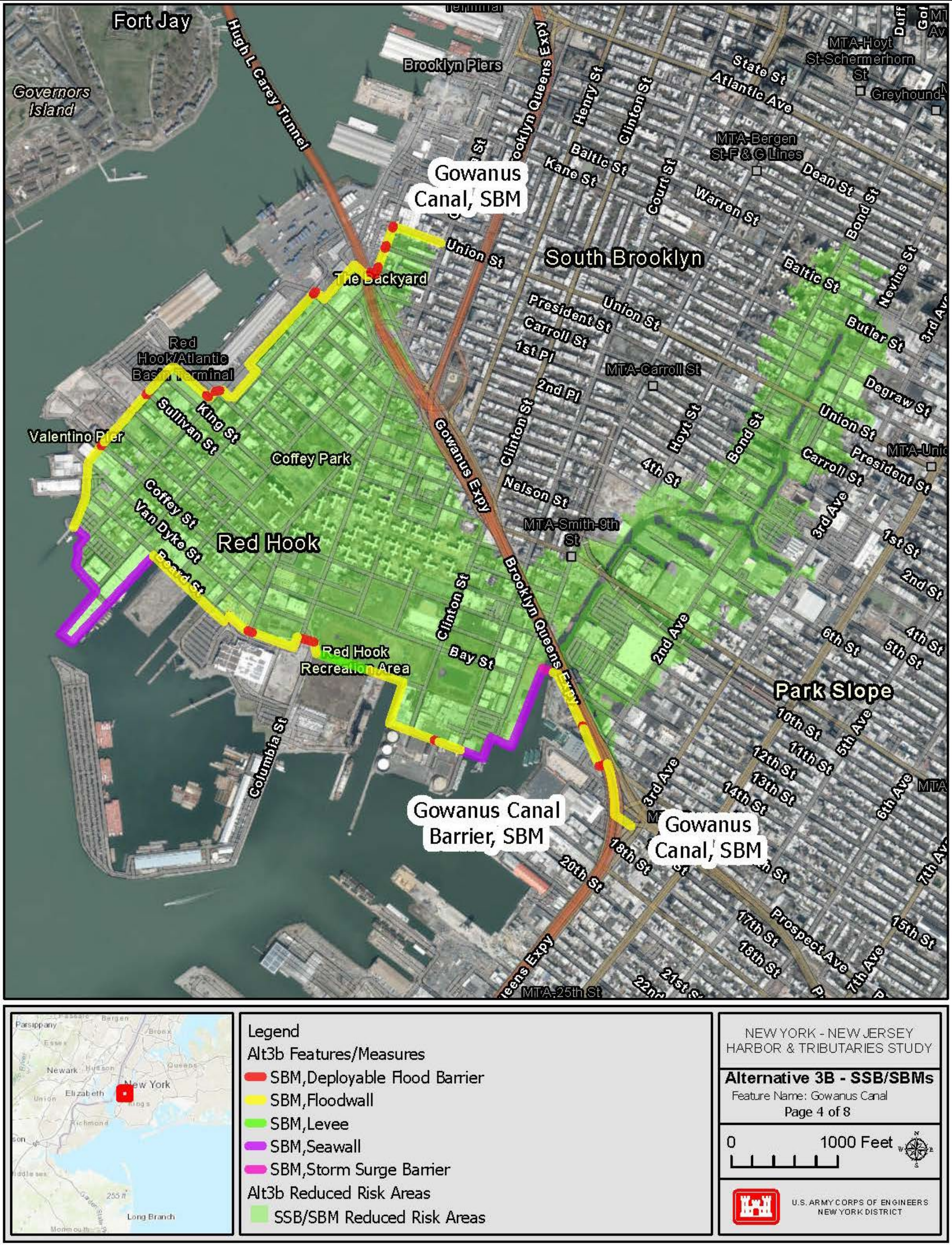


Figure 49: Tentatively Selected Plan Components Along the Gowanus Canal in Brooklyn

Figure 50: The Tentatively Selected Plan Components in Jersey City, NJ

Jamaica Bay Region

In the Jamaica Bay Region, the structural components of the TSP includes five storm surge barriers and shore-based measures to provide coastal storm risk management to communities in Brooklyn, Queens, and Nassau Counties (Figure 51).

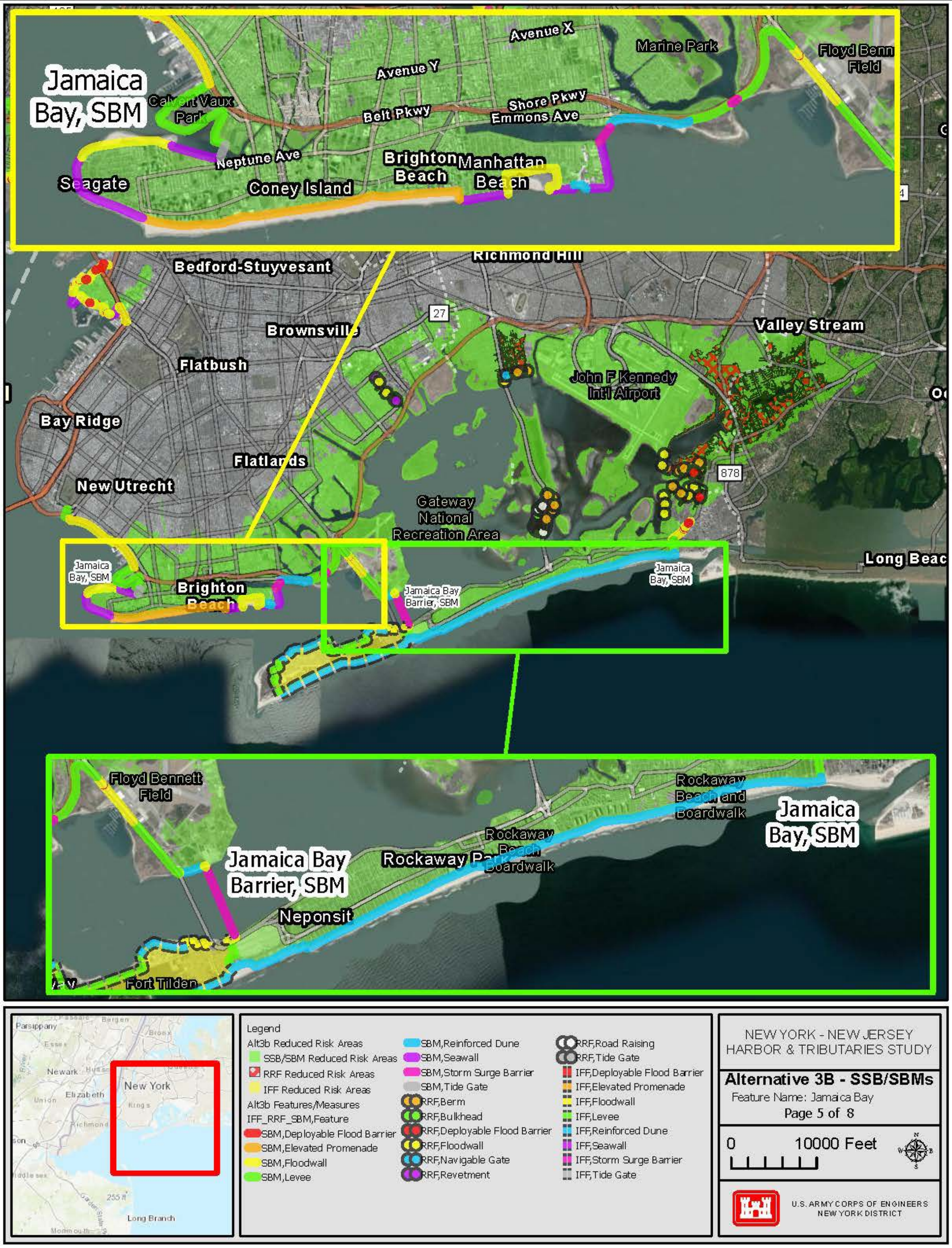


Figure 51: Tentatively Selected Plan Components in Jamaica Bay Region

The Jamaica Bay storm surge barrier would provide coastal storm risk management, in conjunction with adjoining shore-based alignments, to areas around and within Jamaica Bay, including the Rockaway Peninsula, Queens and southern Brooklyn. The storm surge barrier would include navigable conventional sector gates, as well as vertical lift auxiliary flow gates. It would span approximately 3,800 feet from shore to shore, and would include two gated navigable passages, each 200 feet wide, and 15 gated auxiliary flow openings each 150 feet wide.

The proposed structure crest elevation is +18 feet NAVD88. Due to induced flooding impacts from the storm surge barriers in the tentatively selected plan, an alignment of floodwalls, reinforced dunes, and levees wrapping the shoreline of Breezy Point, Queens is included within the storm surge barrier and shoreline-based system to mitigate for the induced flooding.

The Sheepshead Bay storm surge barrier would provide coastal storm risk management in surrounding areas including the neighborhood of Sheepshead Bay, Brooklyn. The storm surge barrier would include a navigable sector gate and two non-navigable auxiliary flow vertical lift gates. It would span approximately 800 feet from shore to shore and has one gated navigable passage 100 feet wide, with a sill elevation at -9 feet NAVD88. The proposed structure crest elevation is +17 feet NAVD88.

The Gerritsen Creek storm surge barrier would provide coastal storm risk management in areas around Gerritsen Creek, including the neighborhoods of Marine Park and Gerritsen Beach, Brooklyn. The storm surge barrier would include a navigable vertical lift gate and two non-navigable auxiliary flow vertical lift gates. It would span approximately 800 feet from shore to shore and has one gated navigable passage 115 feet wide, with a sill elevation at -19 feet NAVD88. The proposed structure crest elevation is +17 feet NAVD88.

The Head of Bay storm surge barrier, in conjunction with tie ins, would provide coastal storm risk management as a Risk Reduction Feature in areas along and up the Head of Bay on the eastern portion of Jamaica Bay Inwood, Cedarhurst, Woodmere, Hewlett, and Valley Stream in Nassau County, NY (Figure 52). The storm surge barrier would include a navigable sector gate and two non-navigable auxiliary flow vertical lift gates. It would span approximately 900 feet from shore to shore and has one gated navigable passage 60 feet wide, with a sill elevation at -10 feet NAVD88. The proposed structure crest elevation is +10 feet NAVD88.

The Old Howard Beach East storm surge barriers, in conjunction with adjoining berms and floodwall, would provide coastal storm risk management as a Risk Reduction Feature to the Rockwood Park, Old Howard Beach, and Hamilton Beach neighborhoods (Figure 53). One sector gate is located at the head of Hawtree Basin, the other sector gate is located at the head Shellbank Basin, west and east of Old Howard Beach respectively. Both navigable structures have a crest elevation of +10 ft NAVD88 and have one gated navigable passage 60 ft wide, with a sill elevation at -10 ft NAVD88.

In addition to the storm surge barriers, the following features are included in the region:

- Reinforced dunes proposed on the Atlantic Ocean side of the Rockaway peninsula.
- A shoreline alignment from New Utrecht, Brooklyn to the location of the proposed Jamaica Bay storm surge barrier at Floyd Bennett Field. This alignment is proposed to consist of elevated promenades, floodwalls, levees, reinforced dunes, seawall, floodwalls, and a tide gate across Coney Island Creek, and connects to the Sheepshead Bay storm surge barrier and the Gerritsen Creek storm surge barrier.
- An alignment of bulkheads, floodwalls, berms, and deployable flood barrier near the Inwood Marina in Inwood, Nassau County.
- A bulkhead and a floodwall on the eastern and northern shores of Motts Basin, respectively, in Inwood, Nassau County.
- An alignment of floodwalls, berms, and deployable flood barrier along Motts Basin in Far Rockaway, Queens.
- A berm along the southern shore of Motts Basin and a bulkhead near the energy center in Bayswater, Queens.
- A floodwall along the shoreline of Norton Basin in Bayswater, Queens.
- Bulkheads, berms, and road raisings and ramps in Broad Channel, Queens.
- Floodwall and revetments on the southwestern shore of Fresh Creek in Canarsie, Brooklyn.

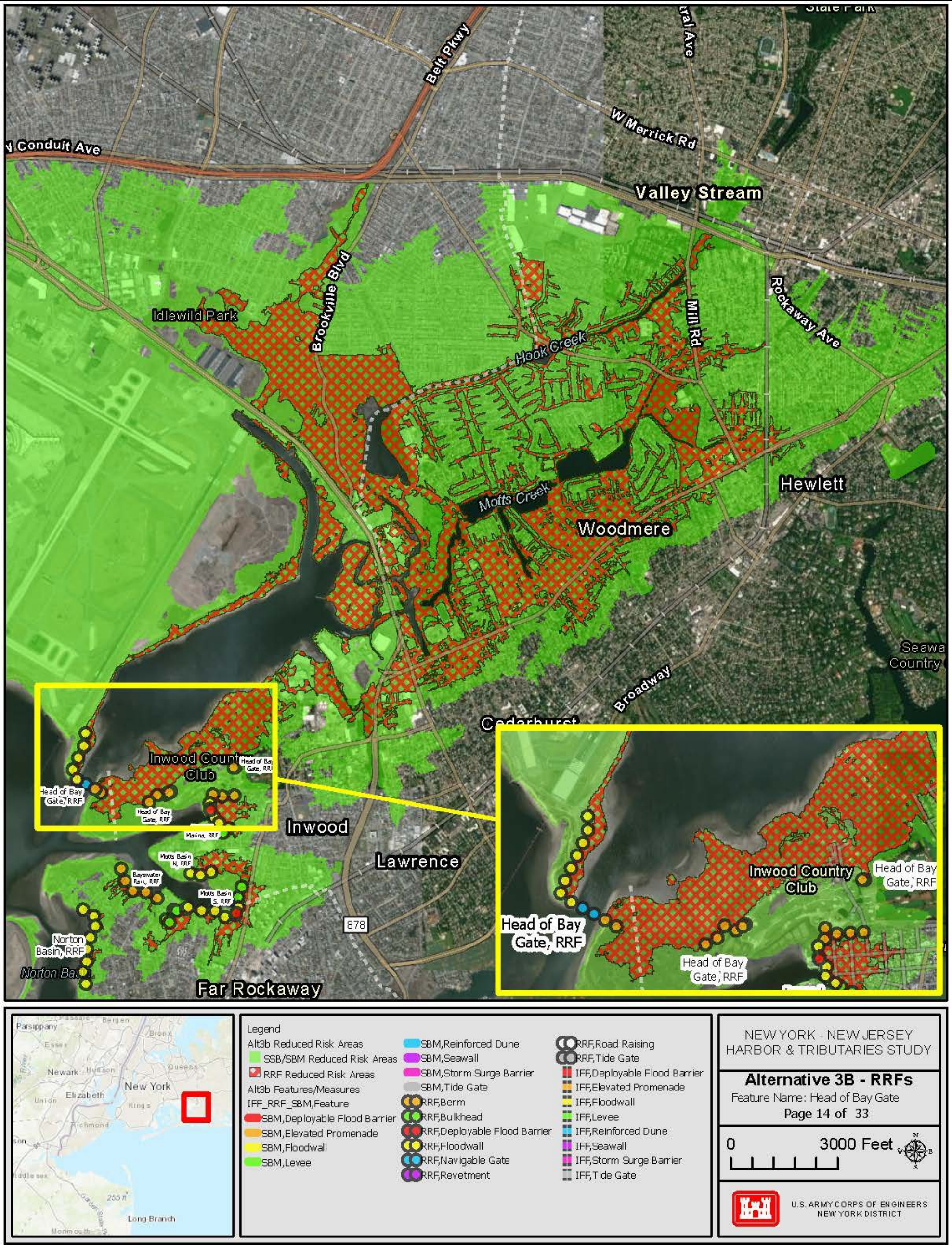


Figure 52: Tentatively Selected Plan Components Along the Border of Queens and Nassau County

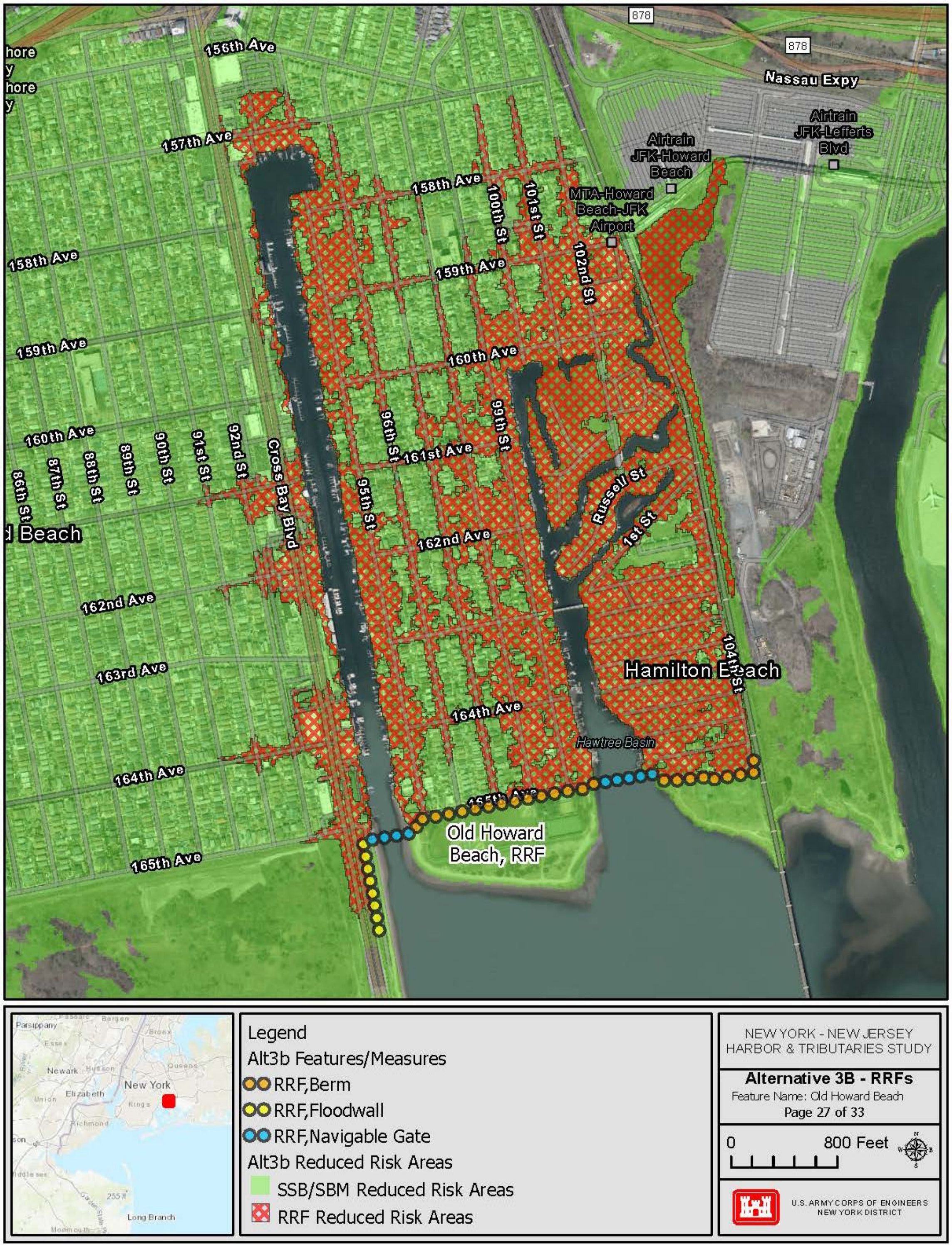


Figure 53: Tentatively Selected Plan Components near Howard Beach, Queens

Long Island Sound Region

In the Long Island Sound Region, the structural components of the TSP includes one storm surge barrier across Flushing Creek and adjoining shore-based measures. A combination of structural and nonstructural measures that could provide coastal storm risk management to communities in Queens, New York.

The Flushing Creek storm surge barrier would provide coastal storm risk management in areas around Flushing Creek, including Flushing, Queens. The storm surge barrier would include a navigable vertical lift gate and two non-navigable auxiliary flow vertical lift gates. It would span approximately 500 feet from shore to shore and has one gated navigable passage 135 feet wide, with a sill elevation at -19 feet NAVD88. The proposed structure crest elevation is +18 feet NAVD88.

Shore-based measures follow the shoreline on both the north and south side of the storm surge barrier and collectively provide flood risk reduction for the low-lying areas around Flushing Creek. These shore-based measures may potentially include a combination of an elevated promenade, floodwall, seawall, and deployable flood barrier.

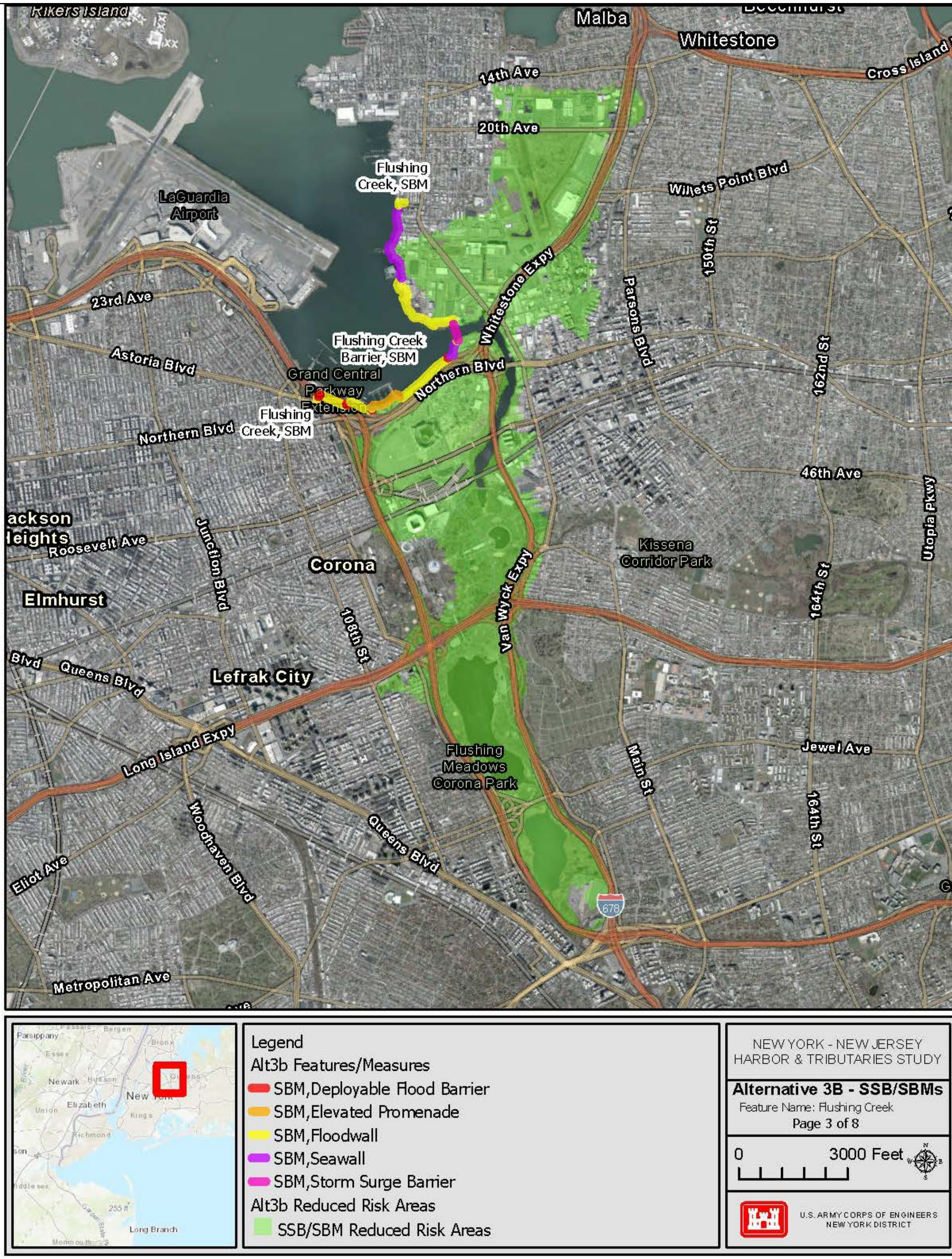


Figure 54: Tentatively Selected Plan Components in the Long Island Sound Region

5.1.2 Nonstructural Measures

Nonstructural measures included in the TSP may include structure elevations and floodproofing, as described in Chapter 4. Currently, conceptual nonstructural measure locations are located throughout the study area (Figure 55). Specific structures and nonstructural treatments have not yet been chosen. The following sites are potential areas that will be investigated in a future study phase or during Preconstruction Engineering and Design as more information is made available. This list is non-exhaustive and other opportunities for nonstructural measures may be identified.

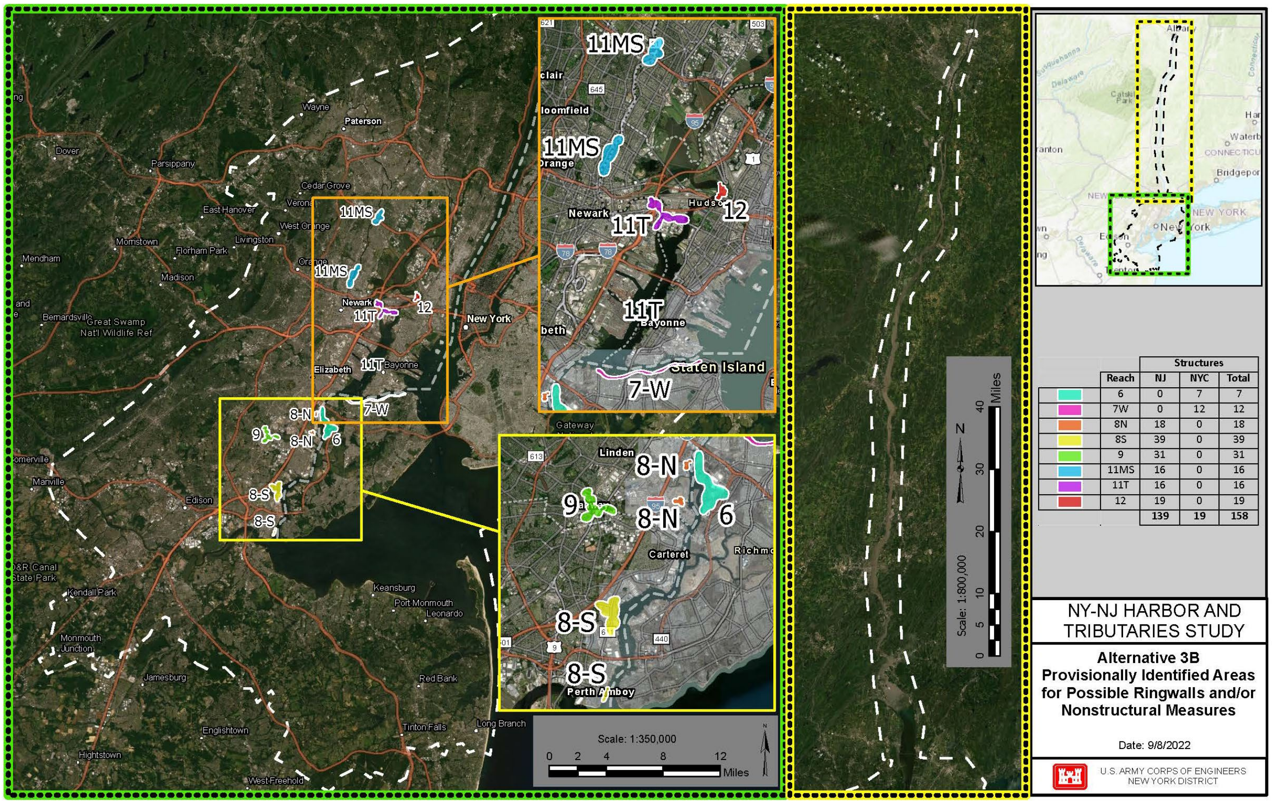


Figure 55: Conceptual Nonstructural Measures to Be Refined

5.1.3 Natural and Nature-Based Features

NNBFs include natural features such as wetlands and living shorelines that may provide both coastal storm risk management and ecological enhancement. Specific NNBF types and locations have not been chosen. The Study team will be identifying and investigating opportunities to implement NNBFs in a future study phase or during Preconstruction Engineering and Design as more information is made available. The Hudson-Raritan Estuary Ecosystem Restoration Feasibility Study Final Integrated Feasibility Report and Environmental Assessment (USACE, 2020) identified possible sites that may have possible CSRM benefits. These sites will be among those considered for NNBFs.

5.1.4 Risk Communication

The TSP will not eliminate flood risk, and so residual risk of flooding will remain a threat to life and property. It is essential that flood risk be proactively communicated to residents in accessible and thoughtful ways.

There are numerous existing agencies and programs that can be leveraged to communicate flood risk in the study area. The New Jersey Office of Emergency Management and New York Office of Emergency Management are responsible for coastal storm flood risk communication in New Jersey and New York, respectively. New York City Emergency Management plays a similar role for the City of New York. These agencies provide real-time flood information, emergency alerts, and information about hurricane evacuation zones to residents, and assist with hurricane preparation, response, and recovery. USACE coordinated with these agencies, FEMA, and the National Weather Service through the National Hurricane Program, which provides data, resources and technical assistance for hurricane evacuation planning and response for state, local, tribal, territorial, and Federal government partners.

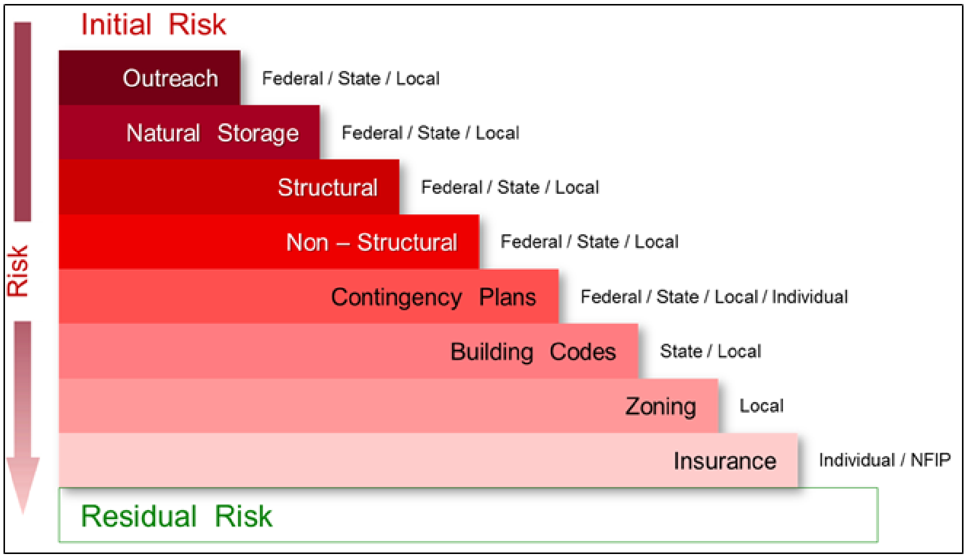


Figure 56: Shared Responsibility of Flood Risk Management.

5.2 COSTS

Plan costs were estimated using the MicroComputer Aided Cost Estimating System, Second Generation (MCACES 2nd Generation, or MII) cost engineering model. The detailed cost estimate is based on a combination of MII's Cost Book, estimator-created site-specific cost items, and local subcontractor and material supplier cost quotes. Cost contingencies were developed through a standard Cost and Schedule Risk Analysis (CSRA). Appendices C and F include details of the engineering and real estate cost estimates, respectively.

At current price levels (Fiscal Year 2022 price level), the Tentatively Selected Plan has an estimated project first cost of $52,627,325,000 and an annualized cost of $2,551,663,000 (based on 2.25% discount rate). The annualized cost includes planning, engineering and design, construction management, interest during construction, and operation and maintenance, including contingencies. The Tentatively Selected Plan provides an estimated $3,707,484,000 in annualized net benefits, and has a benefit-cost ratio of 2.5. The plan would be cost shared as 65 percent Federal ($34,207,761,000) and 35 percent Non-Federal ($18,419,564,000). Within the non-federal share, the costs for the value of lands, easements, rights-of-way, and relocations are estimated to be $5,805,739,000. The cost of operation and maintenance is estimated at $346,764,000 annually.

Table 29: Tentatively Selected Plan Cost (FY22 Price Level)

	Tentatively Selected Plan
First Cost	**$52,627,320,000**
Lands and Damages	$5,805,740,000
Relocations	$2,367,470,000
Fish & Wildlife Facilities	$5,045,100,000
Breakwaters and Seawalls	$17,934,480,000
Levees & Floodwalls	$14,145,890,000
Cultural Resource Preservation	$152,220,000
Buildings, Grounds & Utilities	$34,440,000

Planning, Engineering & Design	$5,654,080,000
Construction Management	$1,487,910,000

FY22 price level and discount rate of 2.25%.

Table 30: Project annual costs (FY22 Price Level).

First Cost	$52,627,320,000
Interest During Construction	$13,154,510,000
Fully Funded Cost	$77,346,380,000
Annual Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R)	$346,764,000
Total Annual Cost	**$2,551,660,000**

Average annual costs include interest during construction, 2.25% interest rate

5.3 ECONOMIC BENEFITS

The TSP would manage the risk of flooding from the 1% annual exceedance probability event including RSLC under the USACE intermediate scenario in the year 2095.

The plan provides economic benefits quantified by the USACE Flood Damage Reduction Analysis economic model developed by the USACE Hydrologic Engineering Center (HEC-FDA). HEC-FDA is a USACE-certified software tool that performs integrated hydrologic and economic evaluations of CSRM plans using a structure inventory, and stage-frequency and depth damage relationships. Appendix D includes details of the economic analysis.

Economic benefits were calculated as the difference in damages under the future with- and without-project conditions. Benefits were then amortized over a 50-year period (2045 – 2094) starting at the project base year of 2044 to identify equivalent annual benefits using the FY22 price level (P.L.) and the Federal FY22 interest rate of 2.25%. HEC-FDA computes Expected Annual Damage at the base year, as well as Equivalent Annual Damages over the period of analysis.

Future Without-Project Economic Damages. Economic damages caused by coastal storms were estimated for the future without-project condition to use as a comparison against plan performance. The economic analysis used the FY22 P.L. and the Federal FY22 interest rate of 2.25%. A measure of average annual damages under the USACE intermediate RSLC scenario was used for the analysis. Under the future without-project condition, average annual damages are $7,948,000,000 (FY22 price level). This means the Study Area will experience an estimated $7,948,000,000 in annual damages.

Future With-Project Economic Benefits. Economic benefits provided by the plan were estimated for the future-with project condition. It is assumed construction will begin in 2030 and end in 2044, over a 14-year construction duration. The plan's first year of fully realized economic benefits would be 2045. Assuming a 50-year period of analysis, economic benefits were estimated from 2044 to 2093. The economic analysis used the FY22 price level and the Federal FY22 interest rate of 2.25%. A measure of Average Annual Benefits under the USACE intermediate sea level change scenario was used for the analysis. Under the future with-project condition, Average Annual Benefits are $6,259,000,000 (FY22 price level). This means the plan will provide an estimated $6,259,000,000 in annual benefits.

Future With-Project Residual Damages. Average annual damages under the future with-project scenario are an estimate of residual annual economic damages. The economic analysis used the FY22 price level and the Federal FY22 interest rate of 2.25%. A measure of average annual damages under the USACE intermediate RSLC scenario was used for the analysis. Average annual damages under the future with-project condition are

$1,689,000,000 (FY22 price level). This means the Study Area will experience $1,689,000,000 in annual economic damages with the project in place.

Net Economic Benefits and Benefit-to-Cost Ratio. A comparison of the future with- and without-project economic benefits was completed ty calculate the plan's net economic benefits. Annual net benefits provided by the plan are estimated to be $3,707,000,000 (FY22 price level). The benefit-to-cost ratio is 2.5.

Table 31: TSP Economic Summary (FY22 price level, rounded).

Annual Future Without-Project Damages	$7.95 billion
Annual Future With-Project Damages	$1.69 billion
Annual Benefits	$6.26 billion
Annual Costs	$2.55 billion
Annual Net Benefits	$3.71 billion
Benefit-to-Cost Ratio	2.5

Average annual costs include interest during construction, 2.25% interest rate

5.4 ENVIRONMENTAL AND SOCIAL BENEFITS

The NYNJHAT Study included a semi-qualitative approach to calculating environmental and social benefits in accordance with the January 5, 2021 policy directive Comprehensive Documentation of Benefits in Decision Documents. The directive emphasizes and expands upon policies and guidance to ensure the USACE decision framework considers, in a comprehensive manner, the total benefits for project alternatives, including equal consideration of economic, environmental, and social categories. An estimate 62.75% of the future without project flood extent is expected to experience risk reduction from the TSP. Environmental benefits calculated for the TSP include reduced risk to important historic and cultural sites, NPS Land, CBRAs, CEAs, coastal wetlands, and migratory shorebirds, SAV, and EFH through reduction in flooding, potential water quality impacts, creation of habitat and reduced erosion from coastal storms. In addition, the TSP is expected to reduce the potential for migration or resuspension of contaminants in the areas of reduced risk. Social benefits were calculated for factors contributing to physical and mental health and safety, economic vitality, community identify, and social vulnerability, resilience, and environmental justice. A detailed discussion of the other social effects and Environmental Justice impacts and benefits is provided in Appendix A12. An assessment of environmental effects and benefits is discussed in Chapter 6.

5.5 RISK AND UNCERTAINTY ANALYSIS

There remains risk and uncertainty in project planning, engineering design, and environmental compliance at this phase of the Study. Risk and uncertainty will be managed as more information is known and analyses are refined throughout the Study, and into the Preconstruction Engineering and Design phase and construction. This Section presents major areas of risk and uncertainty known at this time.

5.5.1 Implementation Risk

A potential project has not been authorized by the U.S. Congress, and funding has not yet been appropriated for design and construction by the Federal government nor non-Federal sponsors. The project schedule (Appendix C) assumes authorization and funding will be provided in a timely manner. The schedule was estimated for Study analysis purposes and is dependent on Congressional authorization, Federal and non-Federal budgeting, and the execution of legal agreements. There is a risk that implementation be delayed if authorization and funding are not provided within the construction schedule, or at all. Appendix C includes information about implementation risk.

5.5.2 Residual Risk

Flood risk is the function of flood hazard at a location, and exposure and vulnerability to the flood hazard. Residual risk is the flood risk that remains after a project is in place. It is the exposure to loss remaining after other known risks have been countered, factored in, or managed or addressed.

The TSP will not eliminate all flood risk to life and property. Flood damages from coastal flooding will not be totally prevented, only managed. While there would still be properties and infrastructure that are vulnerable to coastal storm flood damages, this flood damage would be significantly managed with the TSP in place. However, the TSP will not provide as many economic benefits for coastal storms that exceed project design criteria. Average annual damages under the future with-project condition are $1,689,000,000 (FY22 price level). This means the Study Area will experience $1,689,000,000 in annual economic damages with the project in place.

The storm surge barriers will be operated when the closure criteria of +7 feet NAVD88 is met. There is a risk that coastal storms may cause flooding even when this criterion is not met. This is generally true for areas that would be provided risk management with the storm surge barriers in operation.

In the areas where nonstructural measures such as elevations and floodproofing would be implemented, the fundamental risk is that access to and from the structures would be limited. In these areas, access routes would still become inaccessible due to flooding since the plan would not reduce street flooding. This would result in the stranding individuals who choose not to evacuate when directed to prior to storms. Emergency services would likely not be able to reach stranded residents who are in need during high water events.

The TSP complements other ongoing efforts in the Study Area to manage the risk of coastal storm damage, as described in Chapters 1 – 5. Post-disaster assistance and aid for owners of these properties may come from other Federal agencies, such as FEMA and USHUD, or from programs run by the States of New Jersey and New York.

5.5.3 Risk to Life Safety

Life safety is the risk to individuals who may be affected by coastal storms and other events. Individual life risk is influenced by location, exposure, and vulnerability within a leveed area. Communities in the Study Area have always experienced flooding from coastal storms. Residents generally understand the severe implications of staying in harm's way when a coastal storm is forecasted to affect the area. Because there is typically two to seven days' notice prior to hurricanes and tropical storms, residents are typically given sufficient warning to evacuate. However, residents typically have only a few hours warning before the arrival smaller storms and rain events that cause flash flooding. Residents should evacuate prior to storms to avoid being stranded, which could pose a danger to their welfare. Emergency vehicles may not be able to reach residents in distress due to the flooding of roads and homes. In addition, there is an increased risk of fire in communities due to the potential compromising of electrical and natural gas systems.

The inherent erratic nature and unpredictability of a storm's path and intensity requires early and safe evacuation. A policy of early, total evacuation should be continued even with the project in place.

Appendix D includes supplemental information about risk to life safety.

5.5.4 Induced Flooding

Induced flooding is the flooding of properties resulting from the implementation of a project. It is the flooding on the ocean side of a project's structural measures, such as storm surge barriers, that is anticipated to have worse flood risks resulting from the implementation and/or operation of the project. USACE guidance requires attention be paid to induced flooding caused by proposed projects. When a project plan would result in induced flooding, guidance requires that mitigation measures be investigated and implemented when economically justified, when there are overriding reasons of safety or economic or social concerns, or when it is determined that the induced flooding rises to the level of a real estate "takings" of private property rights.

Storm surge barriers included in the Tentatively Selected Plan may induce flooding in some areas when in operation. However, these areas will not experience induced flooding. Induced Flooding-Mitigation Features were included in the TSP to mitigate for induced flooding in these areas. Details about Induced Flooding-Mitigation Features are included in Chapters 4 and 5, and also Appendix B.

5.5.5 Climate Change Adaptation

Climate change adaptation is an approach to managing risks and vulnerabilities related to the potential effects of climate change. It includes evaluating climate change related risks to, and vulnerabilities in, project operation and management – and taking action when appropriate to manage risks. The TSP includes a framework for climate change adaptation, with a conceptual estimate of adaptation features included in the cost estimate. Appendix B presents information about adaptability of the TSP, including detailed information about climate change, RSLC, and approaches.

Considering New Closure Criteria

Projected climate change and increases in relative sea level may present a need to adapt the plan's features and operation over time. Most significantly, projected increases in relative sea level could result in the storm surge barrier closure criterion being met more frequently with progressively higher-frequency storm surges. The closure criterion for the storm surge barriers is defined as the still water level at which the barrier will be operated to close. This may result in more frequent operation of the storm surge barriers in the future. Table 32 shows decreasing average interval between storm surge barrier closures over time.

Table 32: Effective average recurrence intervals (in years) of storm surge barrier closure with RSLC, and occurrence year of RSLC projections.

Closure Criterion*	+1 foot RSLC	+2 feet RSLC	+3 feet RSLC	+4 feet RSLC	+5 feet RSLC	+6 feet RSLC
+7 feet	3.5	1.5	<1	<1	<1	<1
+8 feet	7.5	3.5	1.5	<1	<1	<1
+9 feet	16	7.5	3.5	1.5	<1	<1
+10 feet	32	16	7.5	3.5	1.5	<1
USACE RSLC Projection						
Low	2096	-	-	-	-	-
Intermediate	2057	2098	2130	2157	-	-
High	2033	2054	2070	2084	2096	2107

The recurrence interval (also called the return period) is based on the probability that the given event will be equaled or exceeded in any given year. For example, there is a 1 in 50 chance that a model storm will occur every year. Thus, this event is said to have a 50-year recurrence interval.
**Closure criteria shown in feet NAVD88*

As the Annual Exceedance Probability of a given still water level increases with time due RSLC, the long-term exceedance probability of the closure criterion indicating the likelihood of a closure event also increases for future time periods. The long-term exceedance probabilities of the closure criteria over the hundred-year planning period (2045 to 2145) based on RSLC projections are shown in Table 33. The long-term exceedance probability provides the likelihood of at least one operation of the storm surge barrier over the 100-year planning horizon.

Table 33: Long-term exceedance probability (%) of closure criteria, 2045 to 2145.

Closure Criteron	Low RSLC Projection				Intermediate RSLC Projection				High RSLC Projection			
	2046-2070	2071-2095	2096-2120	2121-2145	2046-2070	2071-2095	2096-2120	2121-2145	2046-2070	2071-2095	2096-2120	2121-2145

+7 feet	99.2	99.7	99.9	100	99.8	100	100	100	100	100	100	100
+8 feet	90.4	93.9	96.4	100	99.8	100	100	100	100	100	100	100
+9 feet	68.0	74.0	79.9	85.2	78.0	90.3	98.0	99.9	97.8	100	100	100
+10 feet	44.8	50.1	55.6	61.3	53.8	67.9	84.7	96.7	84.7	99.8	100	100

**Closure criteria shown in feet NAVD88*

Figure 57 shows the projected fall in average closure interval under the intermediate RSLC scenario and possible future adaptation through closure criterion adjustments and expanded/new Risk Management Features. One adaptation approach is to accept the shortened average interval between closures so that the existing measures can be left unchanged. However, it is assumed that the closure criterion is adjusted up correspondingly for every foot of RSLC. For example, the closure criterion would be increased from +7 feet NAVD88 to +8 feet NAVD88 in 2057, and again from +8 feet NAVD88 to +9 feet NAVD88 in 2098 to match the 2 feet of RSLC (intermediate RSLC projection). At each of these points in time, the closure criterion adjustment would also need to be accompanied with a modification of the plan to "bridge the gap" in flood management levels caused by raising the closure criterion. Such a plan modification could include adaptation of Risk Reduction Features or nonstructural measures. Modifications to Risk Reduction Features may involve height adjustments of designed measures or the construction of additional measures to provide CSRM to areas newly at risk from the higher basin design water levels.

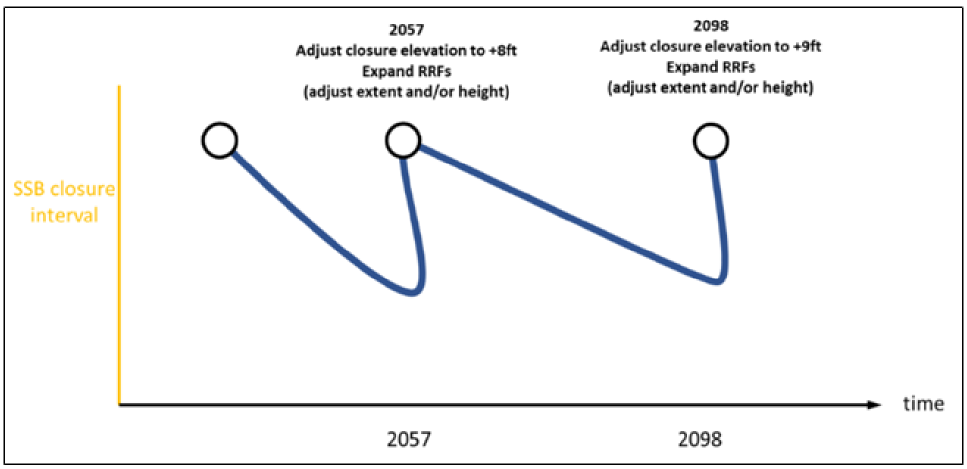


Figure 57: Adaptive management considering closure criteria (intermediate RSLC scenario).

Figure 58 shows a similar relationship to that presented in Figure 57, but under the high RSLC projection. For this scenario, the closure criterion adjustments and corresponding Risk Reduction Feature adaptations would be projected to take place within a more compressed timeline due to a faster rate of RSLC. For example, if the future adjustments in closure criterion and accompanying Risk Reduction Feature adaptations are triggered on subsequent steps by foot of RSLC, such steps would then be needed in 2033 (closure criterion change from +7 feet NAVD88 to +8 feet NAVD88), 2054 (+8 feet NAVD88 to +9 feet NAVD88), and 2070 (+9 feet NAVD88 to +10 feet NAVD88).

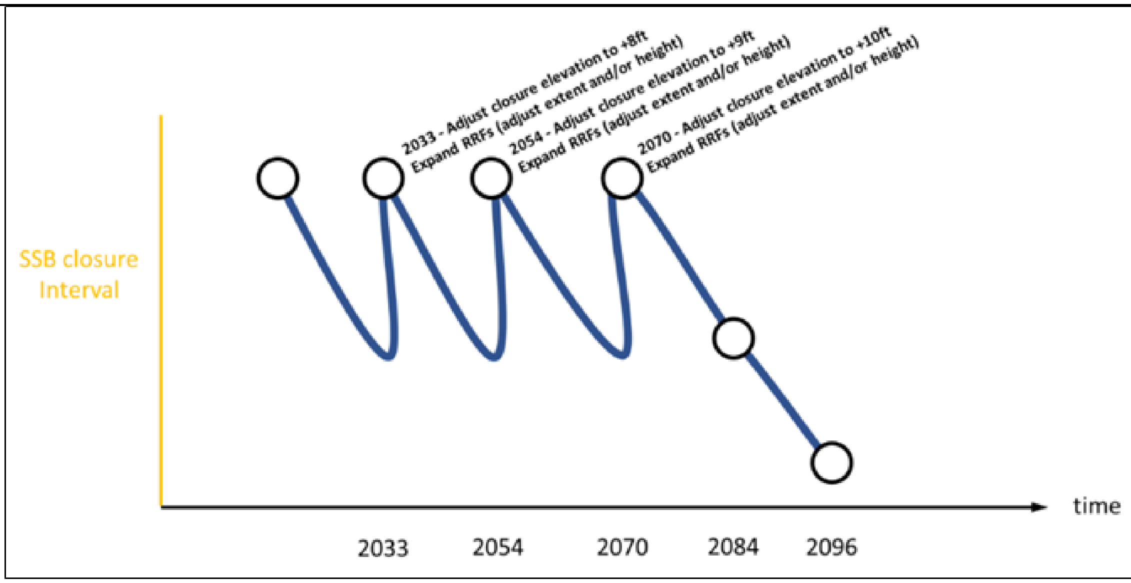


Figure 58: Adaptive management considering closure criteria (high RSLC scenario).

A schematic of two potential adaptative management pathways is shown in Figure 59 and Figure 60, two of many potential pathways. The figures show possible actions on the y-axis and time on the x-axis. The possible sequence of adaptive management actions is shown using colored lines, with possible decision points (shown as circles) potentially triggering a new action. Potential decision points are assumed for every foot increase in RSLC, although their time of occurrence may vary depending on the future observed RSLC. Their times of possible occurrence are shown in blue (intermediate RSLC scenario) and red (high RSLC scenario). Decision points branch into two parallel adaptation management pathways (shown in purple and blue).

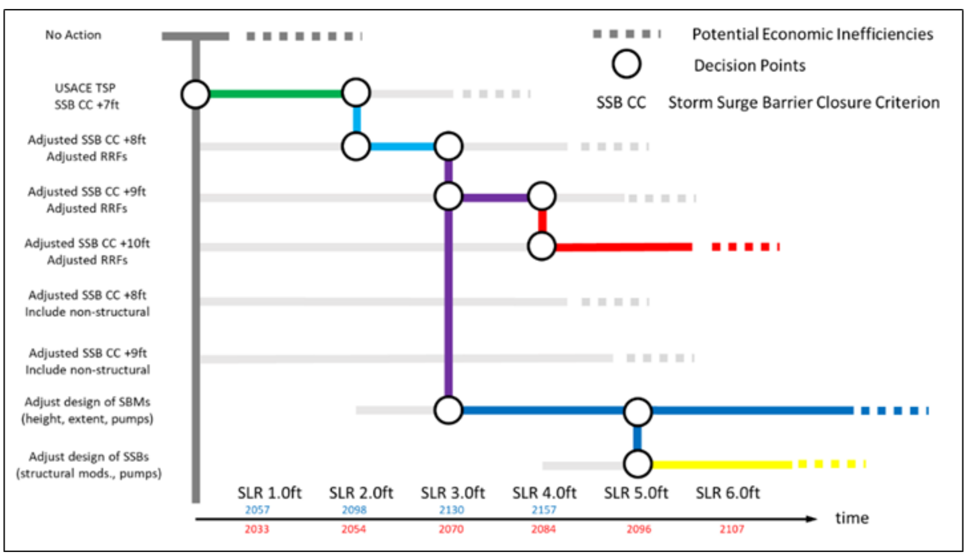


Figure 59: Adaptive management pathways with a focus on Risk Management Features.

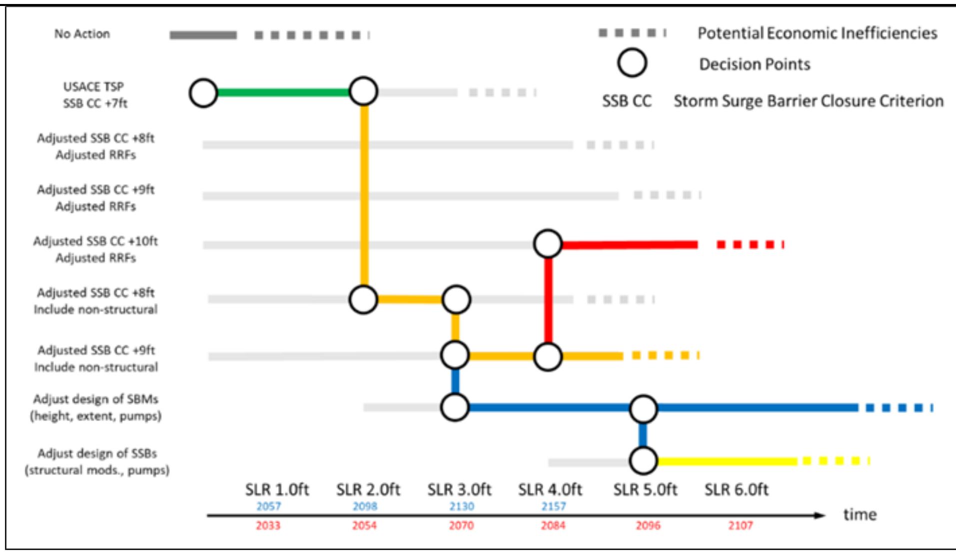


Figure 60: Adaptive management pathways with a focus on nonstructural measures.

In summary, it may be necessary in the future to adjust the closure criterion to a higher measured water surface elevation to avoid unacceptably frequent closures that may affect the environment and navigation. Doing so may expose the basin area to flooding from storms with intermediate surge, where surge height is in the range between the original closure criterion an updated closure criterion.

Even under the high RSLC projection, the current conceptual storm surge barrier designs could be adapted to maintain project performance over a 100-year planning horizon. Adaptation may include the modification or construction of additional structural and nonstructural measures, and natural and nature-based features to maintain the plan's level of risk management. Because the TSP's design level has not been optimized, the quantitative triggers for adaptation and quantitative data to define the potential adaptation measures have not been defined yet. A better definition of the possible triggers for adaptation and adaptation options will be established after optimization of the TSP, which will be documented in the final report.

5.5.6 Economic Risk & Uncertainty

Risk and uncertainty have been explicitly factored into the economic analysis, as described in detail in Appendix D. As described in this Chapter, the HEC-FDA economic model was used to formulate and evaluate the project in a life-cycle approach. HEC-FDA integrates the engineering and economic analyses and incorporates uncertainty in both physical parameters and storms, which enables quantification of risk with respect to project evolution and economic costs and benefits of project implementation. The analysis indicated that equivalent annual project net benefits can range from $2.109 billion and a benefit to cost ratio of 1.8 with the low RSLC scenario to equivalent annual project net benefits of $10.205 billion and a benefit to cost ratio of 5.0. While further refinements will be made to the project and the economic analysis as new information becomes available and the Study team receives feedback, there is low risk that the project would become economically unjustified – that is, the Benefit to Cost Ratio will be less than 1.0.

The hydrologic and hydraulic performance of a project may be described by annual exceedance probability, long-term risk and assurance, or conditional non-exceedance probabilities. The TSP effectively reduces almost certain probability of flooding during a 1% storm in virtually every economic. Economic project performance is detailed in Appendix D.

5.5.7 Construction and Engineering Risk

Construction and engineering risks relate to hurdles to construction, and risks assumed with the project in place. There is a risk that construction may be delayed due to factors such as poor weather, unexpected HTRW findings, and consideration of restrictions related to protected environmental resources. Delays may also be caused by inadequate or untimely receipt of funding.

There is a risk that constructed engineering structures may fail. The degree of this risk is currently unknown, as the probability of failure is not known. Because the project area is densely developed and includes many nationally and regionally important resources, the consequence of failure would generally be high. Project engineers will ensure project designs meet or exceed USACE life safety guidance. Non-Federal sponsors will ensure the project is maintained through OMRR&R activities.

5.5.8 Nonstructural Participation Rate

Per USACE planning guidance, implementation of many nonstructural measures such as structure elevation, floodproofing, flood warning systems, and floodplain development zoning changes/enforcement is voluntarily agreed to with property owners. However, guidance requires that acquisition, relocation, and permanent evacuation not be voluntary and that sponsors must have the option to use eminent domain. For voluntary nonstructural measures, it was assumed that participation in a voluntary nonstructural project would be popular with many property owners in communities. Based on coordination with non-Federal and local interests, and current building strategies, a 100% participation rate was assumed during initial plan formulation. However, there is a risk actual participation rates may be lower, and so benefit calculations for the nonstructural plan portion may be overestimated. As nonstructural measures are a relatively small portion of the TSP, this is a relatively low risk.

5.6 IMPLEMENTATION CONSIDERATIONS

Should this project be authorized by the U.S. Congress and funding appropriated for construction, the project design will be updated and modified during later stages of the planning process, and ultimately throughout the Preconstruction Engineering Design phase and construction. The public, stakeholder groups, and resource agencies will have the opportunity to share feedback that may change project design. Such modifications may require supplemental investigations into environmental and social benefits and impacts.

USACE will complete detailed analyses and design in the Preconstruction Engineering Design phase that will inform the final design and ultimately construction. The Preconstruction Engineering Design phase could begin after completion of this Study, and when the U.S. Congress authorizes a project. Detailed analyses include but are not limited to:

- A review of changed conditions since the completion of the study that may affect project design
- Updated engineering modeling
- Detailed surveys of physical and engineering data
- Detailed environmental and cultural resources surveys
- Detailed assessment of structures identified for nonstructural measures
- Additional environmental coordination that may be required if there are environmental, cultural, and/or historic resource impacts that were not identified during this Study

Current estimated construction schedules show that it will take approximately 14 years to fully implement the TSP. Different increments of the project may be completed as funding allows during this timeframe. Phased implementation will consider the priorities of the non-Federal sponsors, communities benefitted by the project, resource agencies, and efficiencies in the construction and/or contracting process.

Federal, state, and local governmental agencies, as well as non-profit and private interests will continue to implement coastal resilience projects throughout the Study Area. It will be important to reassess existing conditions prior to construction to ensure the TSP accounts for any changes to the Study Area that may have occurred after the study is completed.

5.7 OPERATION, MAINTENANCE, REPAIR, REPLACEMENT & REHABILITATION

Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) includes actions to sustain the constructed project and to maintain the stated level of benefits at the completion of construction and into the future. The non-federal sponsors are responsible for OMRR&R costs and actions. Generally, the non-Federal sponsors are required to repair, rehabilitate or provide replacement of components to maintain the original project benefits. A detailed OMRR&R manual will be developed during the Preconstruction Engineering and Design phase to outline the expected OMRR&R requirements for each project component. Appendix B includes more details about OMRR&R.

The total estimated annual OMRR&R cost is $346,764,000. A majority of the annual OMRR&R costs are based upon sustaining the storm surge barriers. OMRR&R requirements would also include but are not limited to, annual exercising of gates and closure structures, grass mowing of levee and floodwall right of way, painting of metal surfaces, pump station O&M, and general maintenance of drainage and navigation structures. Additionally, this includes renourishment activities for beach and dune systems after the 50-year construction period in order to maintain project performance.

5.8 COMPENSATORY MITIGATION

Mitigation will be required due to unavoidable temporary or permanent environmental impacts to habitat. The following habitat types are anticipated to be impacted by the project: marine/estuarine deepwater and subtidal habitat, marine/estuarine intertidal habitat, submerged aquatic vegetation, wetlands, and uplands and riparian habitat, all to varying degrees depending on measure type, location, and existing conditions. Compensatory mitigation has been estimated parametrically for this Tier 1 level assessment. Currently, the estimated conceptual parametric mitigation costs for the TSP, which was used to inform Cost Engineering, is around $1.8B (roughly <6% of construction costs) and includes monitoring and a 35% contingency. This parametric estimate does not include CAA mitigation (as the analysis indicates the TSP will not trigger General Conformity), cultural mitigation, or any offsets for EFH. The parametric numbers will be further refined for the Final Integrated FR/Tier 1 EIS. Further analysis and refinement is necessary, including modeling efforts undertaken by USACE (e.g. NYBEM) to further inform the compensatory mitigation plan, of which will be incorporated in the Final integrated FR/Tier 1 EIS. As this is a Tier 1 assessment, with a preliminary level of design, compensatory mitigation will be further refined in subsequent phases of the Study and in coordination with the appropriate Federal, state, and local agencies. Impacts that cannot be avoided or minimized will be mitigated, either through the restoration and/or enhancement of habitat, purchasing of credits from a mitigation bank, or an in-lieu fee program. The USACE New York District anticipates there may be affected habitat with limited opportunities for in-kind mitigation for a Study of this scale, and therefore, out-of-kind mitigation will require a greater level of coordination with Federal, state, and local agencies. Potential mitigation sites may be identified through the Comprehensive Restoration Plan for the Hudson Raritan Estuary (USACE 2016), among other sources, as necessary. If none such sites exist, out-of-kind and/or out-of-place sites would be used. Details of the mitigation plan are included in Appendix A10.

5.9 USACE ENVIRONMENTAL OPERATING PRINCIPLES

The USACE Environmental Operating Principles (EOP) (ER 200-1-5) were developed to ensure USACE missions include integrated sustainable environmental practices, corporate responsibility, and accountability. These Environmental Operating Principles are:

- Foster sustainability as a way of life throughout the organization;
- Proactively consider environmental consequences of all USACE activities and act accordingly;
- Create mutually supporting economic and environmentally sustainable solutions;
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments;
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs;

- Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner; and,
- Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

The TSP meets the USACE Environmental Operating Principles as documented within this FR/Tier 1 EIS through the USACE planning process and NEPA requirements for Federal agencies to assess the reasonably foreseeable environmental effects of federally funded projects. The USACE New York District has proactively considered environmental consequences (and benefits) of the Alternative plans, at a Tier 1 EIS level, and will continue to do so for the Final FR/Tier 1 EIS and Tier 2 EIS(s). Scientific, economic, and social knowledge was leveraged in the preparation of this Report, through special expertise of preparers, subject matter experts, public engagement, resource Agency coordination, and with the support of the USACE Engineering Research and Development Center (ERDC) to conduct a comprehensive analysis and/or modeling support for the New York Bight ecosystems, hydrodynamics, other social effects, and environmental justice. Refer to Appendix G for additional information on stakeholder engagement and public and agency coordination.

5.10 NATIONAL FLOOD INSURANCE PROGRAM COMPLIANCE

Communities participating in a CSRM project with USACE are required to participate in FEMA's National Flood Insurance Program (NFIP) and to comply with the land use requirements of the program. Communities in the Study participate in and are in compliance with the NFIP. Because the plan would help manage coastal storm flood risk, it will inherently support the communities' compliance with the NFIP. As a Participating Agency, FEMA has been briefed about the plan. USACE will notify FEMA Region II once the project is authorized for construction by the U.S Congress. FEMA could choose to update flood maps and flood profiles to depict post-project conditions, which may affect flood insurance rates for homeowners and business owners who would benefit from the project. It is important to note that flood insurance rates are not set by USACE nor the States of New Jersey or New York.

6 EFFECTS AND CONSEQUENCES OF THE ALTERNATIVE PLANS*

In the sections below, the potential direct, reasonably foreseeable indirect, and beneficial effects of the NYNJHAT Study Alternative plans have been assessed based on the current level of design. Cumulative impacts are assessed at the end of this Chapter. The scope of this Draft Tier 1 assessment is based on the following assumptions and conditions:

- The No Action Alternative (also known as the FWOP) has significant impacts to the majority of resources including health and safety, an assessment of the No Action Alternative consequences by resource type is presented in Table x.
- This Tier 1 assessment is primarily focused on the structural measures of each Alternative including the TSP. Structural measures include combinations of levees, storm surge barriers, tide gates, seawalls, floodwalls, elevated promenades, buried seawalls/dunes, berms, bulkheads, pedestrian/vehicular gates, and road raising.
- Potential impacts and benefits are based on the preliminary conceptual design of the NYNJHAT Study measures, which focuses on impacts within the structural measure's footprint of construction relative to placement, clearing and general disturbance within that footprint. As this is a Tier 1 level assessment, the measures and measure locations are subject to change as engineering is further developed and as public, Agency, and local stakeholder comments on this Draft Integrated FR/Tier 1 EIS are incorporated. This assessment will be updated and the potential impacts and benefits will be re-evaluated for the Final Integrated FR/Tier 1 EIS and in the Tier 2 EIS(s). Where additional information (i.e. modeling or site-specific studies or surveys) is needed, consideration for how that information may be collected and assessed is provided.
- Nonstructural and NNBFs are part of Alternative plans 2, 3A, 3B, 4, and 5 in the NYNJHAT Study; however, as of the date of this Draft Feasibility Report/Tier 1 EIS, both nonstructural and NNBFs require additional development and design which will take place between the Draft and Final Feasibility Report/Tier 1 EIS. Currently, conceptual nonstructural measure locations are in review and require further analysis. Additionally, a collection of NNBFs locations and measures from recent USACE studies are being screened for applicability to CSRM and require further analysis. Therefore, the following sections may mention nonstructural measures and natural and nature-based features generally; however, those types of measures will be further developed and assessed for potential impacts and benefits in the Final Feasibility Report/Tier 1 EIS.
- Further, ringwalls, which are considered a structural measure, are to be further refined under the nonstructural plan and will be assessed in the Final Integrated FR/Tier 1 EIS.
- Storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm even) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure.
- The USACE Engineer Research and Development Center (ERDC) developed a New York Bight Ecological Model (NYBEM) of the NYNJHAT Study Area, which is presented in this Integrated FR/Tier 1 EIS for Agency and public review to further inform model development and the preliminary results of the open storm surge barrier gates and other measures proposed in the NYNJHAT Study Alternative plans. At this time, the NYBEM results are not fully incorporated into all aspects of this Tier 1 assessment. Feedback received on the NYBEM will inform further model development and thereafter the NYBEM results will be incorporated in the Final Integrated FR/Tier 1 EIS and these sections will be updated. Refer to Appendix A11 for additional information.
- The AdH Model was used to inform the NYBEM, and included an assessment of open gate storm surge barrier data to inform relevant sections of the EIS including potential physical changes to flow, tidal range, and water elevations in both storm and non-storm conditions, as well as sediment budget. The results of the AdH model can be found in Appendix B.

- Projects that are within the NYNJHAT Study Area that are being developed under separate authorizations are considered in the cumulative impacts assessment.

This assumption-based assessment will be further refined in the Final Tier 1 EIS and in the Tier 2 EIS(s). Refer to Chapter 7 for a discussion of potential mitigation and compensatory mitigation under consideration for impacts identified.

6.1 NATURAL AND PHYSICAL RESOURCES

This Section is organized to present a high-level Tier 1 assessment of the NYNJHAT Study Alternative plans, starting with an initial screening to identify *if* there is a potential for adverse impacts (i.e. Yes or No) by measure type (Table 34), followed by an assessment of the magnitude of those identified potential adverse impacts, rated on a scale of 1 (No Impacts) to 5 (Significant Impacts), by Alternative. Each Natural and Physical Resource starts with a summary discussion of the overall potential impacts and benefits to the resource relative to the construction, operations, and maintenance assumptions, followed by an Alternative-specific discussion of potential impacts and benefits, additionally reflected by numerical magnitude ratings. Measures that also have a potential beneficial effect are marked with a "+" in these Sections to identify those added beneficial effects without muting the potential adverse impact identification and associated rating scores.

Table 34: Potential for impacts by resource and structural measure type.

RESOURCE	STORM SURGE BARRIERS	TIDE GATES	FLOODWALL	FLOODWALLS WITH PARK	LEVEES	ELEVATED PROMENADES	BURIED SEAWALL/SAND DUNES	SEAWALLS	REVETMENTS	SEAWALLS WITH REVETMENTS	DEPLOYABLE FLOOD BARRIERS	BERMS	BULKHEADS	PEDESTRIAN/VEHICULAR GATES	NAVIGABLE GATES	ROAD RAISING
Wildlife	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fish	Y+	Y+	Y+	Y+	N	Y+	Y+	Y+	Y+	Y+	Y+	N	Y+	N	Y+	N
Migratory Fish	Y	Y	Y	Y	N	Y	Y	Y	N	N	Y	Y	Y	N	Y	N
Terrestrial Vegetation	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y
Submerged Aquatic Vegetation	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Invasive and Aquatic Nuisance Species	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N
Threatened and Endangered Species Terrestrial	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y

RESOURCE	STORM SURGE BARRIERS	TIDE GATES	FLOODWALL	FLOODWALLS WITH PARK	LEVEES	ELEVATED PROMENADES	BURIED SEAWALL/SAND DUNES	SEAWALLS	REVETMENTS	SEAWALLS WITH REVETMENTS	DEPLOYABLE FLOOD BARRIERS	BERMS	BULKHEADS	PEDESTRIAN/VEHICULAR GATES	NAVIGABLE GATES	ROAD RAISING
Migratory Bird Treaty Act Species and Bald Eagles	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y
Threatened and Endangered Species Aquatic	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Marine Mammal Protection Act Species	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sea Turtles	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Essential Fish Habitat (EFH) and EFH-Designated Species	Y+	Y+	Y+	Y+	N	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	N	Y+	N
Wetlands	Y	Y	Y	Y	Y+	Y	Y	Y	Y	Y	Y	Y+	Y	Y	Y	N
Floodplains	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y
Wild and Scenic Rivers	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Designated Critical Habitat	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Critical Environmental Areas (State)	Y	Y	Y	N	Y	N	Y+	Y	N	N	N	Y	N	N	N	Y
Marine Protected Areas	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Coastal Zone Management Act Areas	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	N
Coastal Barrier Resources System Areas	Y+	Y+	Y+	N	Y+	N	Y+	N	Y+	N	N	Y+	Y+	N	N	N

RESOURCE	STORM SURGE BARRIERS	TIDE GATES	FLOODWALL	FLOODWALLS WITH PARK	LEVEES	ELEVATED PROMENADES	BURIED SEAWALL/SAND DUNES	SEAWALLS	REVETMENTS	SEAWALLS WITH REVETMENTS	DEPLOYABLE FLOOD BARRIERS	BERMS	BULKHEADS	PEDESTRIAN/VEHICULAR GATES	NAVIGABLE GATES	ROAD RAISING
National Park Service Land	Y+	Y+	Y+	N	Y+	N	Y+	N	Y+	N	N	Y+	Y+	N	N	Y
Wildlife Refuge Land	N	N	Y	N	N	N	N	N	N	N	N	Y	N	N	N	N
Commercial and Recreational Fishing	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Topography and Geology	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y
Surface Waters	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	N	Y+	Y
Sediment	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y
Land Use	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y
Bathymetry	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Inland Hydrology	Y+	Y+	Y	Y	N	Y	Y	Y	Y	Y	Y	Y+	Y	Y	Y	N
Coastal Hydrology, Currents, and Circulation	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y+	Y	Y	Y	N
Tides, Tidal Exchange, and Tidal Range	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y+	Y	Y	Y	N
Sediment Transport	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y+	Y	Y	Y	N
Water Quality	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y
Marine Deep (NYBEM)^	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Marine Subtidal (NYBEM)^	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Marine Intertidal (NYBEM)^	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Estuary Subtidal (NYBEM)^	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N

RESOURCE	STORM SURGE BARRIERS	TIDE GATES	FLOODWALL	FLOODWALLS WITH PARK	LEVEES	ELEVATED PROMENADES	BURIED SEAWALL/SAND DUNES	SEAWALLS	REVETMENTS	SEAWALLS WITH REVETMENTS	DEPLOYABLE FLOOD BARRIERS	BERMS	BULKHEADS	PEDESTRIAN/VEHICULAR GATES	NAVIGABLE GATES	ROAD RAISING
Estuary Intertidal (NYBEM)^	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Fresh (NYBEM)^	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Regional Air Quality and Clean Air Act	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenhouse Gas	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Regional Climate, Climate Change, and RSLC	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+
Cultural Resources – Aboveground	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+
Cultural Resources – Archaeological and Submerged	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+
Cultural Resources – Landmarks	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+
Native American Lands	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Hazardous, Toxic, and Radioactive Waste	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+
Navigation	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Noise and Vibration	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Environmental Justice	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+	Y+

Notes:

Y - Measure type has potential to adversely impact resource

RESOURCE	STORM SURGE BARRIERS	TIDE GATES	FLOODWALL	FLOODWALLS WITH PARK	LEVEES	ELEVATED PROMENADES	BURIED SEAWALL/SAND DUNES	SEAWALLS	REVETMENTS	SEAWALLS WITH REVETMENTS	DEPLOYABLE FLOOD BARRIERS	BERMS	BULKHEADS	PEDESTRIAN/VEHICULAR GATES	NAVIGABLE GATES	ROAD RAISING

N - Measure type is not anticipated to adversely impact resource
\+ - Measure type anticipated to also have beneficial effects to resource
^ - Regional Ecosystems will be further informed and refined by the results of the NYBEM in the Final Integrated FR/Tier 1 EIS.

As indicated above there are potential adverse impacts to resources from structural measures, as well as potential benefits, depending on structure type, location, and existing conditions. Structural measures are anticipated to have greater direct impacts to resources than other measure types (i.e. nonstructural) of which may require compensatory mitigation, agency coordination, and regulatory review. For each resource, the impact producing factors have been identified and a summary of impacts is provided. In some instances, measures are discussed by location as a “shore-based” structural measure or “in-water” structural measure to distinguish between particular relative potential impacts.

The following impact rating criteria has been implemented to assess the magnitude of adverse effects to Natural and Physical resources; a different rating system is used for the Built Environment (Infrastructure), as described later in this Chapter. Anticipated benefits are not included numerically in the impact rating score; rather, where potential benefits are identified, those benefits are discussed throughout this Section, and are additionally noted with a “+” on the impact rating scorecard for that resource. Note, it is possible for a resource to have both adverse impacts and benefits associated with the Alternative measures assessed.

Table 35: Applied scoring methodology for Natural and Physical Environment

Impact Rating Definitions	
Impact Rating and Numerical Score	**Description**
High (5)	Effects to the resource would have substantial consequences, locally and/or regionally. Impacts would exceed regulatory standards. Mitigation measures to offset the adverse effects would not be enough to reduce the significance of effect and therefore, effects to the resource would not be environmentally acceptable.
Moderate to High (4)	Effects to the resource would be locally and/or regionally significant. Impacts would be within regulatory standards; however, existing resource conditions are expected to be affected in the near-term, but not necessarily in the long term. Mitigation measures to manage any potential adverse impacts would be necessary.

Moderate (3)	Effects to the resource are expected to be moderate in the near-term and localized. Impacts would be within or below regulatory standards, as applicable, and the use of mitigation measures would manage potential adverse impacts, if applicable.
Low (2)	Effects to the resource would either be negligible or, if detectable, have minor temporary impacts locally to the resource. The impacts would be well below regulatory standards, as applicable, and mitigation measures may be implemented to sustain low to no impact to the resource.
No Impact (1)	There would be no impacts to the resource because the resource would not be affected.

6.1.1 No Action Alternative

This No Action Alternative Section serves as a baseline comparison to the following Alternative plans impact assessment, including the TSP. While the No Action Alternative would have no additional impacts from construction or operation and maintenance of coastal flood risk measures under the NYNJHAT Study, it would leave the NYNJHAT Study Area vulnerable to continued damages, loss of life, and destruction of Study Area resources caused by severe coastal storms and compounded by RSLC. A summary of potential No Action Alternative impacts to each resource is provided Table 36 below.

Table 36: Summary of Potential impacts of the No Action Alternative.

RESOURCE	SUMMARY OF NO ACTION POTENTIAL IMPACTS
Wildlife	Continued loss of habitat and food species based on repeated flooding due to storms and RSLC. Based on coastal erosion, habitat may be removed or changed including transitional areas which are critical for coastal wildlife species.
Fish	Changes in water quality (e.g. salinity and DO) and flow patterns could disrupt fish use and cause a shift in plankton and benthic communities which are food sources for fish species. Fish species could be impacted by ocean acidification which is anticipated to continue with climate change.
Migratory Fish	Changes in water quality (e.g. temperature, salinity and DO), flow patterns, and habitat due to extreme events could disrupt migratory fish patterns and cause a shift in plankton and benthic communities which are food sources for fish species.
Terrestrial Vegetation	Existing land use trends may increase development pressure on undeveloped terrestrial habitats and continue with conversions of some upland habitats to urban lands within areas zoned for development. RSLC may convert some lower lying upland areas into transitional wetlands.
Submerged Aquatic Vegetation	Due to urbanization of shorelines and water quality degradation from run off and flooding, SAV in the Study Area has decreased over time. However, climate change and RSLC introduce greater uncertainty of continued trends where changes in temperature, precipitation and flooding patterns, and chemical changes could impose additional impacts on water quality, algal blooms, and SAV/macroalgae distribution and abundance. Additionally, RSLC could potentially impact seagrass beds by increasing water depths resulting in reductions in light penetration, photosynthesis, and productivity (Strange, 2008; USACE, 2014).
Invasive and Aquatic Nuisance Species	Future coastal flooding may assist in the spread of invasive or aquatic nuisance species.
Threatened and Endangered Species Terrestrial	Climate change and RSLC may exacerbate conditions for some of these species. RSLC may contribute to loss of intertidal foraging habitats critical for rufa red knots by converting them to open water. For piping plovers, RSLC may directly impact beach habitats in areas where beach erosion is persistent, with beach migration and overwash curtailed by human development, limiting available nesting and foraging habitat. According to Cooper et. al (2005). Seabeach amaranth is highly susceptible to the effects of RSLC, and likely to be irreversibly damaged (USACE, 2014). Saltwater intrusions may impact freshwater wetlands therefor impacting swamp pink and or Knieskern's beakrush and faunal species.

RESOURCE	SUMMARY OF NO ACTION POTENTIAL IMPACTS
Migratory Bird Treaty Act Species and Bald Eagles	Climate change and RSLC may exacerbate conditions for some of these species by contributing to the loss of critical habitat.
Threatened and Endangered Species Aquatic	NOAA Fisheries (2014) considered the effects of climate change on Atlantic sturgeon, and concluded that projections of rising sea temperatures of 3-4° C by 2100 could, "over the long term, affect Atlantic sturgeon by affecting the location of the salt wedge in rivers, distribution of prey, water temperature and water quality. However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which Atlantic sturgeon will be able to successfully adapt to any such changes." Ocean acidification could impact shellfish species development.
Marine Mammal Protection Act Species	Climate change and RSLC may exacerbate conditions for marine mammal species migrations and habitat use from rising seawater temperatures and ocean acidification. It is uncertain that long-term habitat changes would have indirect effects to available prey.
Sea Turtles	Climate change and RSLC may exacerbate conditions for sea turtle species. NOAA Fisheries (2014) concludes that for sea turtles, "the temperature changes are unlikely to be enough of a change to contribute to shifts in the range or distribution of sea turtles even though, theoretically, it is expected that as waters in the action area warm, more sea turtles could be present, or sea turtles could be present for longer periods of time." Additionally, it is uncertain that long-term habitat changes to SAV beds would have any indirect effects on species like green sea turtles that venture into the shallow areas to feed on marine algae and eelgrass.
Essential Fish Habitat (EFH) and EFH-Designated Species	EFH impacts would be focused on the loss of shallow nearshore areas including SAV. The NYNJHAT Study Area supports a diverse fish community including essential EFH. Shellfish resources are being impacted by ocean acidification which will continue with climate change. Impacts to water quality during storm events will occur in addition to the changes in temperature, precipitation and flooding patterns along with chemical changes.
Wetlands	Continued wetland losses including size and type and degradation due to water quality and erosion.
Floodplains	Study Area will continue to be at risk to flooding or could become more at risk due to RSLC and climate change. Without local or non-Federal interventions, it is expected that nuisance flooding in low-lying areas will continue, where the potential impacts from tidal and/or rainfall flooding will likely increase and worsen over time with climate change and RSLC These areas would also become more susceptible to catastrophic flooding from storm surges.
Wild and Scenic Rivers	No impact as Wild and Scenic Rivers are not designated within the NYNJHAT Study rea.
Designated Critical Habitat	Designated Critical Habitat for Atlantic sturgeon in the NYNJHAT Study Area will continue to be impacted by climate change and RSLC, especially in the Hudson River extending from the Battery and upriver to Troy at the northern end of the Study Area. See also Aquatic Threatened and Endangered Species.
Critical Environmental Areas (State)	CEA in New York State and New Jersey will continue to be impacted by coastal flooding and the increasing threats of climate change and RSLC, especially in the Jamaica Bay Region which is designated as a CEA for protection of ecosystems and wildlife.
Marine Protected Areas	MPAs will continue to be impacted by climate change and RSLC including MPAs in Jamaica Bay and the Lower Bay Regions of the NYNJHAT Study rea. Long-term changes in habitat quality and use from rising seawater temperatures, changes in salinity and ocean acidification may increasingly impact critical cultural and natural resources in these areas.
Coastal Zone Management Act Areas	CZMA areas within the NYNJHAT Study Area in both New York and New Jersey are extensive and will continue to be impacted by coastal flooding and the increasing threats of climate change and RSLC, especially in the Jamaica Bay, Breezy Point Tip, the Hudson River on the western side of Manhattan, and several other habitats within Long Island Sound which are designated as Significant Coastal Fish and Wildlife Habitats (SCFWH) under New York's CMP. In New Jersey, Coastal Facility Review Act (CAFRA) zones encompass Raritan Bay and areas located from Highlands Beach south to Long Branch Beach will continue to be impacted.
Coastal Barrier Resources System Areas	CBRS Areas will continue to be impacted by coastal flooding and the increasing threats of climate change and RSLC, especially in mapped along the Sandy Hook peninsula and the entirety of Jamaica Bay.

RESOURCE	SUMMARY OF NO ACTION POTENTIAL IMPACTS
National Park Service Land	NPS Land, primarily at Gateway National Recreation Area, will continue to be impacted by coastal flooding and the increasing threats of climate change and RSLC which will increasingly impact critical cultural and natural resources in these areas.
Wildlife Refuge Land	Wildlife Refuge Land within the NYNJHAT Study Area will continue to be impacted by coastal flooding and the increasing threats of climate change and RSLC including the critical natural resource areas of the Jamaica Bay Wildlife Refuge and William T. Davis Wildlife Refuge as well as non-designated refuge areas such as the Hackensack/Meadowlands complex in New Jersey.
Commercial and Recreational Fishing	Potential impacts to commercial and recreational fishing include changes in species abundance and numbers due to direct and indirect impacts from flooding and RSLC. In addition, risk of coastal flooding increases may impact facilities that support commercial and recreational fishing thereby limiting ability to fish.
Topography and Geology	No significant impacts are expected on the underlying geology or geologic processes. Continued RSLC would likely increase flooding and wave attack, resulting in increased soil erosion. RSLC rates may also exceed normal sediment accretion rates in the saltmarshes resulting in increased inundation and subsidence. Additionally, groundwater may become more susceptible to saltwater intrusion.
Surface Waters	Continued sea level RSLC would likely increase flooding and wave attack, resulting in increased soil erosion. RSLC rates may also exceed normal sediment accretion rates in the saltmarshes resulting in increased inundation and subsidence. Additionally, groundwater may become more susceptible to saltwater intrusion.
Sediment	No significant impacts are expected on the underlying sediment type. Sediment quality will continue to be impacted due to coastal flooding which potentially introduces contaminants into surface waters and nearby waterbodies.
Land Use	Majority of the Study Area land use has been converted to developed urban areas which are heavily developed. There are portions of the Study Area that remains protected lands (parks, wildlife management areas), wetlands, and beaches. These areas would continue to be vulnerable to coastal storm risks from storm surges and flooding. Coupled with RSLC there is the potential to continue to devastate communities, tourist areas, and associated transportation, commercial, industrial, health –related and educational activities, which could potentially have significant effects on land use. Low-lying areas would be increasingly susceptible to flooding, making these locations inaccessible at times to residents and visitors. Impacts on recreation are expected. Water-based recreation activities are not expected to change significantly under climate change and RSLC scenarios. However, RSLC may increase vulnerability of land-based recreational facilities such as athletic fields to flooding. RSLC would subject the communities in the Study Area to increased vulnerabilities to coastal storms, and thus, any damages experienced by the communities from coastal storms would result in temporary and possibly long-term degraded tourism opportunities as experienced during Hurricane Sandy. Roads, bridges, and tunnels would remain exposed to coastal flood risk. In particular, the lowest lying coastal communities, such as Red Hook in Brooklyn are likely to experience significant and increasingly more frequent surface road flooding under the future without-project condition. Major highways in the region would remain exposed to coastal flood risk which is expected to become increasingly more frequent and severe with expected RSLC. Tidal current-induced bridge abutment scour would also become increasingly frequent. Particularly under the higher RSLC expected towards the end of the century, major vehicular tunnels in the Study Area would also be increasingly exposed to coastal flood risk in the future without-project condition, though it is assumed the ongoing Holland Tunnel rehabilitation and resilience improvements would provide substantive CSRM in the future without-project condition (PANYNJ, 2020).
Bathymetry	No significant impacts are expected to existing bathymetry.
Inland Hydrology	Continued RSLC would likely increase flooding, resulting in increased soil erosion and modifications to the shoreline. RSLC rates resulting in increased inundation and subsidence. Additionally, hydrology patterns may be impacted.

RESOURCE	SUMMARY OF NO ACTION POTENTIAL IMPACTS
Coastal Hydrology, Currents, and Circulation	Continued RSLC would likely increase flooding and wave attack, resulting in increased soil erosion and modifications to the shoreline. RSLC rates may also exceed normal sediment accretion rates in the saltmarshes resulting in increased inundation and subsidence. Additionally, hydrology patterns may be impacted. Continued water temperature rises and trends in Atlantic Ocean circulation patterns will continue.
Tides, Tidal Exchange, and Tidal Range	No significant impact to tides are expected. Tidal exchange and tidal range may be impacted based on RSLC.
Sediment Transport	Overall coastal trends in the shift of sediment transport would continue.
Water Quality	Water quality will remain undisturbed in its current conditions, considering existing trends and future conditions such as climate change and RSLC. It is reasonable to conclude that current water quality trends will continue without any significant interventions such as changes in land use or improvements through implementation of new water quality improvement programs such as TMDLs administered by Federal, State, and local agencies. Climate change and RSLC introduce greater uncertainty of continued trends where changes in temperature, precipitation and flooding patterns, and chemical changes such as ocean acidification and increases in salinity could impact water quality.
Regional Ecosystems (NYBEM)	*To be incorporated in the Final Integrated FR/Tier 1 EIS.*
Regional Air Quality and Clean Air Act	Air emissions and climate change related impacts are anticipated to continue to be a concern for air quality. Clean Air Act attainment and non-attainment zones could change depending on future air emissions data and societal trends.
Greenhouse Gas	Air emissions and climate change related impacts are anticipated to continue to be a concern for greenhouse gas emissions.
Regional Climate, Climate Change, and RSLC	The trends within the NYNJHAT Study Area are described in existing conditions section will continue. Climate change could lead to increased ocean temperatures, ocean acidification, RSLC, changes in currents, and upwelling and weather patterns, and has the potential to cause changes in the nature and character of the estuarine ecosystem (USACE, 2017). Climate change is expected to result in more intense and frequent extreme precipitation events by the end of the century, which would cause flooding, streambank erosion, and increases in the rate and amount of nutrients and sediments entering the estuary (BBP, 2016; IPCC, 2013).
Cultural Resources – Aboveground	Irreplaceable cultural resources would continue to be at risk for future flooding and coastal storm impacts if no CSRM measures are taken to prevent future damages that are expected to be exacerbated by RSLC. Loss of individual contributing resources within a District or damage to key contributing elements could degrade historic districts over time.
Cultural Resources – Archaeological and Submerged	Thousands of archaeological and aboveground resources in the Study Area would continue to be at risk from damage or destruction from coastal flooding and sea-level rise. Additionally, submerged resources may be affected by underwater storm action and changes in seawater flow that accompany sea-level rise and flooding.
Cultural Resources – Landmarks	National Historic Landmarks would continue to be vulnerable to the effects of coastal storms and climate change/relative RSLC.
Native American Lands	No impact is expected to Native American Lands, however, Native American archaeological sites in the Study Area are most often located near low-elevation sources of water, such as coastlines, estuaries, and rivers; and therefore may continue to be at risk of coastal storm flood impacts and RSLC in some areas.
Hazardous, Toxic, and Radioactive Waste	HTRW areas may be exposed due to continual flooding and erosion from RSLC. This could release contamination which could impact water, soil, and sediment quality.
Navigation	No direct impacts associated with navigation is expected to occur. Indirect impacts would include Port facility closures due to flooding which would impact navigation.

RESOURCE	SUMMARY OF NO ACTION POTENTIAL IMPACTS
Noise and Vibration	No impacts to noise are expected. Assuming no significant changes in land use or the introduction of new activities that emit noise, it is expected that noise levels in the communities and wetland bay habitats would remain the same as current conditions. Climate change and RSLC is not expected to be a significant factor in future noise impacts.
Environmental Justice	As there is a significantly sized vulnerable populations within the NYNJHAT Study Area, it is anticipated that under the future without-project condition, these communities will be disadvantaged by coastal storms at a higher rate. Communities that cannot easily bounce back will continue to struggle to recover a following storm event and may never completely bounce back so that they can return to their communities.

6.1.2 Wildlife and Vegetation

The following sections discuss the potential adverse impacts and beneficial effects to wildlife, fish, terrestrial vegetation, SAV, and invasive and aquatic nuisance species. In Chapter 4, these resource categories are combined into one collective wildlife and vegetation category, and their associated magnitude scores are averaged together, to compare the Alternative plans environmental acceptability.

Wildlife

Impacts to wildlife are anticipated in the Study Area during construction, and operations and maintenance, activities depending on the measure and existing conditions. The following are impact producing factors to wildlife: physical habitat disturbance, air emissions, habitat conversion, noise, visible structures, land use, and economic change.

Construction Impact Summary

Minor short-term direct impacts on wildlife from potential tree clearing and vegetation removal during construction site preparation activities could occur. Most species of wildlife that inhabit the Study Area are anticipated to move away from active construction areas and use adjacent suitable habitat until construction is complete. Due to the highly developed and urbanized nature of the Study Area, the presence of sensitive wildlife may not be a common occurrence. Those that may be within the area are likely accustomed to human activity and noise. No impacts to terrestrial wildlife species are anticipated from storm surge barrier and tide gate measures as majority of the construction of these impacts are in water. Impacts to aquatic species are discussed further in subsequence sections. The structural Shore-Based Measures are anticipated to have a low impact rating on wildlife species described in the Existing Conditions Section.

Permanent direct impacts to wildlife habitat could occur where measure foundations are installed, converting upland or vegetated habitat to hard structures.

Dredging, sand nourishment, excavation and fill activities may temporarily cause indirect impacts to feeding areas and the potential loss of forage organisms for birds and other wildlife, in the immediate vicinity of the placement of new structures.

Operations and Maintenance Impact Summary

Temporary impacts to wildlife are anticipated during potential maintenance of Shore-Based Measures due to the presence of equipment. These impacts would be minor, short-term, and localized as most wildlife would be able to move to suitable adjacent habitat for the duration of maintenance activities. During operation of storm surge barriers and tide gate closures, no direct impacts to wildlife are anticipated as these measures are located offshore.

Beneficial indirect impacts could occur through management of risk to terrestrial wildlife and their habitats from coastal flooding and erosion damage associated with storm surge. Wetland creation and restoration that may be implemented through mitigation would have long term beneficial impacts to wildlife via the creation or enhancement of wetland habitats with the development of natural based features.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to wildlife associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Wildlife

TSP Wildlife Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	2
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wildlife under the TSP range from No Impact to Low impact. Low direct impacts are expected from construction of buried seawall and dune features which will impact wildlife communities that inhabit dunes. These features are only planned for the Jamaica Bay Planning Region under the TSP. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to wildlife are expected to be Low. Impacts associated with road raising include habitat disturbance and noise; however, wildlife are expected to return to the area when construction is complete. Construction of the remaining Shore-Based Measures are anticipated to have a Low impact to wildlife located in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Planning Regions. Floodwalls, elevated promenades, and levees are the most common features in the TSP. The placement of these features will occur in very urbanized areas. Any wildlife that may be present is expected to avoid areas of construction.

Indirect impacts to wildlife may occur in the Jamaica Region from construction of the storm surge barrier and buried seawall/dune features and may impact feeding areas and may cause potential loss of forage organisms for birds and other wildlife.

Operations and maintenance impacts associated with the TSP are expected to range from No impact to Low impact to wildlife in the NYNJHAT Planning Regions where measures are proposed, based on the use of BMPs.

The overall mitigated impact to wildlife from implementation of the TSP is expected to range from No Impact to Low impact. Low impacts are still possible after avoidance, minimization, and mitigation as a result of conversion of existing habitat to hard structure. However, implementation of the TSP will also provide a benefit to this resource, by managing the risk of flooding and erosion damages associated storm surges, RSLC, and coastal flooding.

No impacts to wildlife are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structural measures are proposed in these Planning Regions under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts to wildlife associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Wildlife

ALT 2 Wildlife Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	2	2	2	2	2
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wildlife under Alternative 2 range from No to Low impact. Impacts to wildlife are expected to be Low within the Long Island Sound Planning Region from construction of levees, seawalls, floodwalls, and berms. The extent of these structures is greatest within this Region under Alternative 2.

Construction of the buried seawall and dune features are also expected to have a Low impact to wildlife. These features are proposed for the Jamaica Bay and Lower Bay Planning Regions under Alternative 2. Road raising is proposed along Broad Channel in Jamaica Bay and impacts to wildlife are expected to be Low. Impacts associated with road raising include habitat disturbance and noise; however, wildlife are expected to return to the area when construction is complete.

Impacts to wildlife from construction in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Raritan Region are expected to be Low. The impacts in these Regions are mostly associated with floodwalls, berms, and levees. The placement of these features is mostly in highly urbanized areas. Any wildlife that is present is expected to avoid areas of construction.

Indirect impacts to wildlife may occur in the Jamaica and Low Bay Regions from construction of the storm surge barrier and buried seawall/dune features and may impact feeding areas and cause potential loss of forage organisms for birds and other wildlife.

Operations and maintenance associated with Alternative 2 are expected to have a Low impact on wildlife and vegetation in the NYNJHAT Regions where measures are proposed.

The overall mitigated rating to wildlife from implementation of Alternative 2 is expected to be No impact to Low impact. Low impacts are still possible from Shore-Based Measures after avoidance, minimization, and mitigation as a result of conversion of habitats to hard structures. However, the implementation of Alternative 2 would provide a benefit to wildlife, by managing the risk of flooding and erosion damage associated storm surges, RSLC, and coastal flooding.

No impacts are expected in the Capital District and Mid-Hudson Planning Regions because no structural measures are proposed in these Planning Regions under Alternative 2.

Alternative 3A

Alternative 3A is anticipated to have the following impacts to wildlife associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Wildlife

ALT 3A Wildlife Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	2	2	2	2	2
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wildlife under Alternative 3A range from No Impact to Low impact. Impacts to wildlife are expected to be Low within the Long Island Sound and Lower Bay Planning Regions from construction of levees, seawalls, floodwalls, and berms. Construction of buried seawall and dune features are expected to have a Low impact to wildlife and terrestrial vegetation. These features are planned for the Jamaica Bay and Lower Bay Planning Regions under Alternative 3A. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to wildlife are expected to be Low. Impacts associated with road raising include habitat disturbance and noise, and wildlife are expected to return to the area when construction is complete.

Construction impacts in the Lower Hudson/East River, Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic, Long Island Sound, and Raritan Regions are expected to be Low. Impacts in these Regions are mostly associated with floodwalls, berms, and levees. The placement of these features is mostly in highly urbanized. Any wildlife that is present is expected to avoid areas of construction.

Indirect impacts to wildlife may occur in the Jamaica Region from construction of the storm surge barrier and buried seawall/dune features that may impact feeding areas and the potential loss of forage organisms for birds and other wildlife.

Operations and maintenance associated with Alternative 3A are expected to have a Low impact on wildlife in the Planning Region in Regions where structural measures are proposed.

The overall mitigated impact to wildlife from implementation of Alternative 3A is expected to range from No to Low impact. Low impacts are also still possible from Shore-Based Measures after avoidance, minimization and mitigation by conversion of habitats to hard structures. However, the implementation of Alternative 3A will provide a benefit to wildlife, by managing the risk of flooding and erosion damage associated storm surges, RSLC, and coastal flooding.

No impacts are expected in the Capital District and Mid-Hudson Planning Regions because no structural measures are proposed in these Planning Regions under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Wildlife

ALT 4 Wildlife Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	2
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wildlife under Alternative 4 range from No to Low impact. Construction of buried seawall and dune features are expected to have a Low impact to wildlife communities that inhabit dunes. These features are only proposed for the Jamaica Bay Planning Regions under Alternative 4. Road raising is also proposed along Broad Channel in Jamaica Bay and impacts to wildlife are expected to be Low. Impacts associated with road raising include habitat disturbance and noise, and wildlife are expected to return to the area when construction is complete.

Construction of the remaining Shore-Based Measures are anticipated to have a Low impact to vegetation and wildlife in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Planning Regions. Floodwalls, elevated promenades, and levees are most common shore-based features in Alternative 4. The placement of these features is mostly in highly urbanized. Any wildlife that is present is expected to avoid areas of construction.

Indirect impacts to wildlife may occur in the Jamaica Region from construction of the storm surge barrier and buried seawall/dune features that may impact feeding areas and the potential loss of forage organisms for birds and other wildlife.
Operations and maintenance associated with Alternative 4 are expected to have a Low impact on wildlife in the Study Area in Regions where measures are proposed.

The overall mitigated impact to wildlife from implementation of Alternative 4 is expected to range from No to Low impacts. Low impacts are still possible after avoidance, minimization and mitigation by conversion of habitats to hard structures. However, implementation of Alternative 4 will provide a benefit to this resource, by managing the risk of flooding and erosion damage associated storm surges, RSLC, and coastal flooding.

No impacts are expected to wildlife in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structural measures are proposed in these Planning Regions under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Wildlife

ALT 5 Wildlife Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	2	2	1	2	1	1	1
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

The construction of the shore-based structural measures included in Alternative 5 are anticipated to range from No to Low impact to wildlife in the Lower Hudson/East River, Upper Bay/Arthur Kill and Hackensack/Passaic Planning Regions. Floodwalls and levees are most common structural measures in Alternative 5. The placement of these features is generally mostly in highly urbanized areas. Any wildlife that is present is expected to avoid areas of construction.

Indirect impacts to wildlife may occur in the Hackensack/Passaic Region from construction levees that may impact feeding areas and the potential loss of forage organisms for birds and other wildlife.

Operations and maintenance associated with Alternative 5 are expected to have a Low impact on wildlife in the Planning Region Regions where measures are proposed.

The overall mitigated impact to wildlife from implementation of Alternative 5 is expected to range from No to Low impacts. Low impacts are still possible after avoidance, minimization and mitigation by conversion of habitats to hard structures in the Planning Regions where the structures are proposed. However, implementation of Alternative 5 will provide a benefit this resource, by managing the risk of flooding and erosion damage associated storm surges, RSLC, and coastal flooding.

No impacts are expected in the Capital District, Mid-Hudson, Lower Bay, Raritan, Long Island Sound, and Jamaica Bay Planning Regions because no structural measures are proposed there under Alternative 5.

Fish

Impacts to fish are anticipated during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors to fish found in the Study Area: physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and noise. Below is a summary of the potential impacts to finfish. Most of the impacts to fish species are discussed in other Natural and Physical Environment Resource Sections.

Atlantic menhaden (*Brevoortia tyrannus*), anchovies (*Anchoa spp.*), silversides (*Menidia spp.*), and killifish (*Fundulus spp.*) are important forage species found in the NYNJHAT Study Area. An abundance of these important prey species within the Lower Bay, Jamaica Bay, Upper Bay/Arthur Kill, and Lower Hudson/East River makes each Region important foraging and nursery habitat for several migratory, EFH designated and commercially and recreationally important fish species such as summer flounder, winter flounder, tautog, bluefish, and weakfish. For example, juvenile summer flounder prey upon silversides and killifish within the nursery habitat provided by estuaries such as Jamaica Bay (NOAA 2018). Prey species displacement is an indirect impact of both construction and operations and maintenance activities on fish in the Study Area.

Atlantic croaker is a bottom-feeding species of fish that relies upon benthic habitat which may be temporarily altered and disturbed during construction and operations and maintenance activities.

Construction Impact Summary

Impacts to fish during construction are the same as those discussed for similar EFH-designated species (demersal and pelagic) in a subsequent Section of this Chapter and are primarily associated with in-water measures such as the storm surge barrier and tide gates. Temporary direct impacts include altered habits associated with noise, vibration, and physical disturbance. Fish species are expected to actively avoid most in-water work areas, opting for another appropriate habitat nearby. This avoidance behavior would occur only in those areas where construction is underway. Fish are expected to return to the area when construction is completed.

Operations and Maintenance Impact Summary

Operations and maintenance impacts to fish are primarily associated with in-water measures such as the storm surge barriers. During operations of in-water structures, fish may be impeded during barrier closure. Direct impacts and potential mortality may occur based on the duration of the closure of flood structures during extreme events. Storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure. This assumption will be updated as the barrier closure details are refined. Fish are expected to swim away from the barrier while it is closing but there is potential for individuals to be injured or killed as the structures close. Fish species are anticipated to avoid the barriers during operation, then return when the barrier is upright in the closed position, or down and open once again.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to fish associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Fish

TSP Fish Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3	3+	1	2	1	2+	3+
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*3*	*3*	*1*	*2*	*1*	*2*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to fish under the TSP range from No to Moderate impacts. The construction of the storm surge barrier and tide gates in the Jamaica Bay and Upper Bay/Arthur Kill Regions are expected to have

Moderate impacts on fish species, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and noise. Construction noise may cause short-term impacts to the presence of fish species, but fish are expected to return to the area once construction is completed. Physical habitat disturbance is expected to impact demersal and benthic fish species, however, most fish are expected to avoid active in-water work zones and move to appropriate nearby habitat, then return when construction is completed.

Fish species that are expected to be impacted the most by construction of the TSP are bottom-feeding species, or benthic species, such as Atlantic croaker. Demersal and benthic species found in bottom habitat will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates in Jamaica Bay and the Upper Bay/Arthur Kill Region; Low to Moderate impacts are expected, depending upon seasonal abundances and the extent of the measure. Impacts are expected to be localized and species will return when construction is completed. One storm surge barrier is planned within the Long Island Sound Region under the TSP, however, the barrier will be located in a small creek (Flushing Creek) so impacts are expected to be localized; therefore, Low impacts are expected.

Construction activities would include bottom habitat disturbance and the potential loss of forage species, such as Atlantic menhaden, silversides, killifish, and anchovies, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.
Construction of the elevated promenade is expected to have Low to Moderate impact on fish species, depending on the extent of the measure. The elevated promenade will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls planned in the Hackensack/Passaic, planned under the TSP. There is one exception, Levees, which are set back from the shoreline and not expected to impact fish. Construction of the elevated promenade in Jamaica Bay and the Lower Hudson/East River will likely produce noise or disturbance to shoreline habitat that may impact fish in the area.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates that provide shelter and foraging opportunities for many species of fish.

Two storm surge barriers, one of the south end of the Arthur Kill and one of the east end of the Kill Van Kull, are anticipated to have Low impacts during operation and maintenance. Similarly, the Jamaica Bay Region has a storm surge barrier planned across the main inlet. Within the Long Island Sound Region, a storm surge barrier is proposed at the mouth of Flushing Creek, a small tributary in the Region. Impacts to the creek and the fish that inhabit it are anticipated to be localized and minor. Impact producing factors during operations and maintenance are similar to those described for construction: physical habitat disturbance, prey species displacement, and noise.

The overall mitigated impact to fish under the TSP is Low to Moderate Impact. No impacts are expected in the Lower Bay, Raritan, Mid-Hudson, and Capital District because no in-water measures are proposed there under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts to fish associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Fish

ALT 2 Fish Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	4+	2	1	3+	3
O&M Assumptions	1	1	1	1	3	2	1	2	2
Mitigated Rating	*1*	*1*	*2*	*2*	*3*	*2*	*1*	*3*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to fish under Alternative 2 range from No to Moderate-High impacts. The construction of the storm surge barrier and tide gates in the Lower Bay and Long Island Sound Regions are expected to have Moderate to Moderate-High impacts on fish species, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and noise. No storm surge barriers are planned in the Jamaica Bay Region, however, the extensive barrier planned in the adjacent Lower Bay Region is expected to impact fish species that may utilize Jamaica Bay. Construction noise may cause short-term impacts to the presence of fish species, but fish are expected to return to the area once construction is completed. Physical habitat disturbance associated with the in-water measures is expected to primarily impact demersal and benthic fish species, however, most fish are expected to avoid active in-water work zones and move to appropriate nearby habitat, then return when construction is completed.

Fish species that are expected to be impacted the most by construction of Alternative 2 are bottom-feeding species, or benthic species, such as Atlantic croaker. Demersal and benthic species found in bottom habitat will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates in the Lower Bay and Long Island Sound Regions. Moderate to Moderate-High impacts are expected, depending upon seasonal abundances and the extent of the measure. Impacts are expected to be localized and species will return when construction is completed.

Construction activities would include bottom habitat disturbance and the potential loss of forage species, such as Atlantic menhaden, silversides, killifish, and anchovies, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.
Construction of the sea walls is expected to have Low to Moderate impact on fish species, depending on the extent of the measure. Seawalls will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls planned in the Hackensack/Passaic and Upper Bay/Arthur Kill, under Alternative 2. There is one exception, Levees, which are set back from the shoreline and not expected to impact fish.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, and other invertebrates.

Low to moderate impacts to fish are expected from operations and maintenance of the storm surge barriers in the Lower Bay and Long Island Sound Regions, depending on the extent of the measure. Impact producing factors during operations and maintenance are similar to those described for construction: physical habitat disturbance, prey species displacement, and noise.

The overall mitigated impact to fish under Alternative 2 is Low to Moderate Impact. No impacts are expected in the Mid-Hudson and Capital District because no in-water measures are proposed there under Alternative 2.

Alternative 3A

Alternative 3A is anticipated to have the following impacts to fish associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Fish

ALT 3A Fish Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3+	2+	2	3+	3+	3+
O&M Assumptions	1	1	1	2	2	1	2	2	2
Mitigated Rating	*1*	*1*	*2*	*3*	*2*	*2*	*2*	*3*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to fish under Alternative 3A range from No to Moderate impacts. The construction of the storm surge barrier and tide gates in Jamaica Bay, the Raritan, Upper Bay/Arthur Kill, and Long Island Sound Regions are expected to have Moderate impacts on fish species, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and noise. One storm surge barrier is planned in the Lower Bay Region, however, the measure is located in a small part of the Region and impacts are expected to be localized; therefore, the impact rating is Low. Construction noise may cause short-term impacts to the presence of fish species, but fish are expected to return to the area once construction is completed. Physical habitat disturbance associated with the in-water measures is expected to primarily impact demersal and benthic fish species, however, most fish are expected to avoid active in-water work zones and move to appropriate nearby habitat, then return when construction is completed.

Fish species that are expected to be impacted the most by construction of Alternative 3A are bottom-feeding species, or benthic species, such as Atlantic croaker. Demersal and benthic species found in bottom habitat will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates in Jamaica Bay, the Upper Bay/Arthur Kill, Raritan, and Long Island Sound Regions. Impacts are expected to be localized and species will return when construction is completed.

Construction activities would include bottom habitat disturbance and the potential loss of forage species, such as Atlantic menhaden, silversides, killifish, and anchovies, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

Construction of the sea walls and elevated promenade measures in Long Island Sound and Jamaica Bay is expected to have Moderate impacts on fish species, depending on the extent of the measure. Seawalls and elevated promenade will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls planned in the Hackensack/Passaic, Upper Bay/Arthur Kill, Lower Hudson/East River, and Lower Bay planned under Alternative 3A. There is one exception, Levees, which are set back from the shoreline and not expected to impact fish.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, and other invertebrates.

Low impacts to fish are expected from operations and maintenance of the storm surge barriers and low impacts are expected from Shore-Based Measures that are located along the shoreline, such as elevated promenade and seawalls. Impact producing factors during operations and maintenance are similar to those described for construction: physical habitat disturbance, prey species displacement, and noise.

The overall mitigated impact to fish under Alternative 3A is Low to Moderate Impact. No impacts are expected in the Mid-Hudson and Capital District because no in-water measures are proposed there under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts to fish associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Fish

ALT 4 Fish Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3	2	1	3+	1	2+	3+
O&M Assumptions	1	1	2	1	1	1	1	2	2
Mitigated Rating	*1*	*1*	*3*	*2*	*1*	*2*	*1*	*2*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to fish under Alternative 4 range from No to Moderate impacts. The construction of the storm surge barrier and tide gates in Jamaica Bay and the Hackensack/Passaic Regions are expected to have Moderate impacts on fish species, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and noise. One storm surge barrier is planned in the Long Island Sound Region, however, the measure is located in a small part of the Region and impacts are expected to be localized; therefore, the impact rating is Low. Construction noise may cause short-term impacts to the presence of fish species, but fish are expected to return to the area once construction is completed. Physical habitat disturbance associated with the in-water measures is expected to primarily impact demersal and benthic fish species, however, most fish are expected to avoid active in-water work zones and move to appropriate nearby habitat, then return when construction is completed.

Fish species that are expected to be impacted the most by construction of Alternative 4 are bottom-feeding species, or benthic species, such as Atlantic croaker that utilize bottom habitat which will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates. Impacts are expected to be localized and species will return when construction is completed.

Construction activities would include bottom habitat disturbance and the potential loss of forage species, such as Atlantic menhaden, silversides, killifish, and anchovies, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

Construction of the sea walls and elevated promenade in the Long Island Sound, Jamaica Bay, Lower Hudson/East River, and Upper Bay/Arthur Kill Regions is expected to have Low to Moderate impacts on fish species, depending on the extent of the measure. Seawalls and elevated promenade will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls planned under Alternative 4. There is one exception, Levees, which are set back from the shoreline and not expected to impact fish.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, and other invertebrates.

Low impacts to fish are expected from operations and maintenance of the storm surge barriers and some of the Shore-Based Measures that are located along the shoreline, such as elevated promenade and seawalls. Impact producing factors during operations and maintenance are similar to those described for construction: physical habitat disturbance, prey species displacement, and noise.

The overall mitigated impact to fish under Alternative 4 is Low to Moderate Impact. No impacts are expected in the Lower Bay, Raritan, Mid-Hudson and Capital District because no in-water measures are proposed there under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts to fish associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Fish

ALT 5 Fish Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	2	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts

Construction impacts to fish under Alternative 5 range from No to Low impacts. The construction of the floodwalls and elevated promenade in the Lower Hudson/East River Regions are expected to have low impacts on fish species, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and noise. The levees planned in the Hackensack/Passaic and Upper Bay/Arthur Kill are not expected to impact fish because they are set back from the shoreline. Construction noise may cause short-term impacts to the presence of fish species, but fish are expected to return to the area once construction is completed.

Fish species that are expected to be impacted the most by construction of Alternative 5 are bottom-feeding species, or benthic species, such as Atlantic croaker. Construction activities would include bottom habitat disturbance and the potential loss of forage species, such as Atlantic menhaden, silversides, killifish, and anchovies, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

Low impacts to fish are expected from operations and maintenance of the elevated promenade and floodwalls. Impact producing factors during operations and maintenance are similar to those described for construction: physical habitat disturbance, prey species displacement, and noise.

The overall mitigated impact to fish under Alternative 5 is No to Low Impact. No impacts are expected in the Lower Bay, Raritan, Jamaica Bay, Long Island Sound, Mid-Hudson and Capital District because no in-water measures are proposed there under Alternative 5.

Migratory Fish

Impacts to migratory fish are anticipated during construction and operations and maintenance activities depending on the measure and existing conditions. The following are impact-producing factors to migratory fish: physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, dredging, barriers (e.g. dams), and noise. Below is a summary of the potential impacts to non- EFH-designated migratory fish. Migratory EFH-designated species are discussed in a subsequent Section of this Chapter.

Migratory finfish that are found within the Study Area include American eel, striped bass, river herring (alewife and blueback herring), and sea lamprey (uncommon). American eel, a catadromous species of finfish, utilizes the mouth of the Hudson River to access upriver freshwater habitat (ASMFC 2009). Catadromous species of fish spawn in the marine environment, then travel upstream to freshwater habitat as juveniles, where individuals mature and live as adults before returning to sea for spawning (ASMFC 2009). Striped bass is an anadromous species and mature individuals utilize the Hudson River to reach upriver spawning habitat in the spring, while juveniles travel downriver during summer and fall to reach coastal waters to live as adults (ASMFC 2009). Similarly, river herring make migrations up and down the Hudson to spawn, and juveniles utilize the system to grow and mature before making their way to coastal habitat.

Construction Impact Summary

Migratory finfish could experience short-term temporary impacts during construction of in-water structures. Temporary direct impacts include potential alteration of migration during construction associated with noise, vibration, and physical disturbance. Migratory species will actively avoid most in-water work areas opting for another appropriate habitat nearby. This avoidance behavior would occur only in those areas where construction is underway.

Operations and Maintenance Impact Summary

Storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure. This assumption will be updated as the barrier closure details are refined. During operations of in-water structures, migratory finfish may be impeded during barrier closure. Direct impacts and potential mortality may occur depending on the duration of the closure of flood structures during extreme events. Fish are expected to swim away from the barrier while it is closing, but there is potential for individuals to be injured or killed as the structures close. Migratory finfish are anticipated to avoid the area during operation, potentially causing a long-term permanent impact to migratory patterns. Under these assumptions, impacts are anticipated to be temporary and expected to be Low. Modeling of the potential impacts to migratory patterns from storm surge barriers and other structures may occur during the Tier 2 EIS(s).

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Migratory Finfish

TSP Migratory Finfish Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	2
O&M Assumptions	1	1	1	2	1	1	1	1	2
Mitigated Rating	*1*	*1*	1	2	*1*	1	*1*	*1*	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts associated with the TSP on migratory finfish are expected to range from No Impact to Low impact. The Regions expected to receive the greatest impact under the TSP are the Jamaica Bay Region and the Upper/Bay Arthur Kill Region because of in-water construction of the storm-surge barrier and tide gates which have a low impact rating to migratory finfish. One storm surge barrier is also planned in the Long Island Sound Region, however, the barrier is located within a small creek (Flushing Creek) so impacts are not expected to be significant.

Migratory species that are expected to be impacted the most by construction of the TSP are American eel, striped bass, river herring (blueback herring and alewife), and sea lamprey. Migratory finfish could experience short-term, temporary impacts during construction of in-water structures including alteration of migration pathways during construction associated with noise, vibration, and bottom habitat disturbance in the immediate vicinity of the placement of new structures. Migratory species are expected to avoid construction zones and seek other nearby habitat. Significant indirect impacts to migratory species, such as prey species displacement, are not expected during construction of the storm surge barriers because migratory finfish will actively move to appropriate nearby foraging habitat.

Construction of most Shore-Based Measures under the TSP are expected to have low impacts to migratory fish. Construction of seawalls, elevated promenade, and floodwalls in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Jamaica Bay will likely produce noise in shoreline habitat that may disturb migratory species that are nearby. Migratory species will actively avoid most in-water work areas and move to appropriate nearby habitat; therefore, impacts are expected to be Low. Levees, which are set back from the shoreline, are not expected to impact migratory fish. Shore-Based Measures are planned within the Long Island Sound Region, however, the measures are planned in a small area of the Region and impacts are not expected to be significant.

Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, operation and maintenance of the storm surge barriers is generally expected to have Low impacts to migratory finfish. Migratory species may be impacted by closure of the storm surge barriers if they do not avoid the area during operations; however, this will be temporary and therefore is not anticipated to cause long-term impacts. Operation of the storm surge barrier is expected to have Low impacts to American eel larvae, which would temporarily be restricted from migration by a barrier closure. Modeling of the potential impacts to migratory patterns as a result of storm surge barriers and other structures may occur during the Tier 2 EIS(s).

No impacts are expected to occur to migratory finfish in the Lower Bay, Raritan, Mid-Hudson, and Capital Regions under the TSP because no measures are planned there.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Migratory Finfish

ALT 2 Migratory Finfish Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	1	2	2
O&M Assumptions	1	1	1	1	2	1	1	2	2
Mitigated Rating	*1*	*1*	1	1	3	*1*	*1*	2	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts associated with Alternative 2 on migratory finfish are expected to range from No Impact to Moderate impact. The Lower Bay Region is expected to be impacted the most because of in-water construction of the storm-surge barrier and tide gates, which have a moderate impact to migratory finfish in the Region. The barrier planned in the Lower Bay will be extensive and is located in a major migratory pathway. Low impacts are expected to migratory fish that utilize the Jamaica Bay Region due to this barrier, which will be close by under Alternative 2. One storm surge barrier is planned in the Long Island Sound Region and impacts are expected to be Low.

Migratory species that are expected to be impacted the most during construction of Alternative 2 are American eel, striped bass, river herring (blueback herring and alewife), and sea lamprey. Migratory finfish could experience short-term, temporary impacts during construction of in-water structures including alteration of migration pathways during construction associated with noise, vibration, and bottom habitat disturbance in the immediate vicinity of the placement of new structures. Migratory species are expected to avoid construction zones and seek other nearby habitat. Significant indirect impacts to migratory species, such as prey species displacement, are not expected during construction of the storm surge barriers because migratory finfish will actively move to appropriate nearby foraging habitat.

Construction of most Shore-Based Measures under Alternative 2 is expected to have low impacts to migratory fish. Construction of seawalls, elevated promenade, and floodwalls in the Lower Bay, Jamaica Bay, Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound will likely produce noise in shoreline habitat that may disturb migratory species that are nearby. Migratory species will actively avoid most in-water work areas and move to appropriate nearby habitat; therefore, impacts are expected to be Low. Levees, which are set back from the shoreline, are not expected to impact migratory fish. Shore-Based Measures are planned within the Raritan Region under Alternative 2, however, the measures are planned in a small area of the Region and impacts are not expected to be significant.

Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, operation and maintenance of the storm surge barriers is generally expected to have Low impacts to migratory finfish. Migratory species may be impacted by closure of the storm surge barriers if they do not avoid the area during operations; however, this will be temporary and therefore is not anticipated to cause long-term impacts. Operation of the storm surge barrier is expected to have Low impacts to American eel larvae, which would temporarily be restricted from migration by a barrier closure. Modeling of the potential impacts to migratory patterns as a result of storm surge barriers and other structures may occur during the Tier 2 EIS(s).

No impacts are expected to occur to migratory finfish in the Mid-Hudson and Capital Regions under Alternative 2 because no measures are planned there.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Migratory Finfish

ALT 3A Migratory Finfish Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	2	2	2	2	2
O&M Assumptions	1	1	1	2	1	1	2	2	2
Mitigated Rating	*1*	*1*	1	*2*	1	1	*2*	2	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts associated with Alternative 3A on migratory finfish are expected to range from No Impact to Low impact. The Lower Bay, Jamaica Bay, the Long Island Sound, Upper Bay/Arthur Kill, and Raritan Regions are expected to be impacted the most because of in-water construction of the storm-surge barrier and tide gates, which have a low impact to migratory finfish in the Region.

Migratory species that are expected to be impacted the most during construction of Alternative 3A are American eel, striped bass, river herring (blueback herring and alewife), and sea lamprey. Migratory finfish could experience short-term, temporary impacts during construction of in-water structures including alteration of migration pathways during construction associated with noise, vibration, and bottom habitat disturbance in the immediate vicinity of the placement of new structures. Migratory species are expected to avoid construction zones and seek other nearby habitat. Significant indirect impacts to migratory species, such as prey species displacement, are not expected during construction of the storm surge barriers because migratory finfish will actively move to appropriate nearby foraging habitat.

Construction of most Shore-Based Measures under Alternative 3A is expected to have low impacts to migratory fish. Construction of various measures such as seawalls, elevated promenade, and floodwalls in the Lower Bay, Jamaica Bay, Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound will likely produce noise in shoreline habitat that may disturb migratory species that are nearby. Migratory species will actively avoid most in-water work areas and move to appropriate nearby habitat; therefore, impacts are expected to be Low. Levees, which are set back from the shoreline, are not expected to impact migratory fish. Shore-Based Measures are planned within the Raritan Region under Alternative 3A, however, the measures are planned in a small area of the Region and impacts are not expected to be significant.

Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, operation and maintenance of the storm surge barriers is generally expected to have Low impacts to migratory finfish. Migratory species may be impacted by closure of the storm surge barriers if they do not avoid the area during operations; however, this will be temporary and therefore is not anticipated to cause long-term impacts. Operation of the storm surge barrier is expected to have Low impacts to American eel larvae, which would temporarily be restricted from migration by a barrier closure. Modeling of the potential impacts to migratory patterns as a result of storm surge barriers and other structures may occur during the Tier 2 EIS(s). Impacts to migratory finfish in the Lower Bay during operations and maintenance of the storm surge barrier are not anticipated to be significant because the barrier is located in a small part of the Region.

No impacts are expected to occur to migratory finfish in the Mid-Hudson and Capital Regions under Alternative 3A because no measures are planned there.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Migratory Finfish

ALT 4 Migratory Finfish Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	1	2	1	2	2
O&M Assumptions	1	1	1	1	1	2	1	1	2
Mitigated Rating	*1*	*1*	1	1	*1*	*2*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts associated with Alternative 4 on migratory finfish are expected to range from No Impact to Low impact. The Jamaica Bay Region and the Hackensack/Passaic Region are expected to be impacted the most because of in-water construction of the storm-surge barrier and tide gates, which have a low impact to migratory finfish in the Region. One storm surge barrier is planned in the Long Island Region under Alternative 4, however, the measure is planned in a small creek, so impacts to migratory finfish are not anticipated to be significant.

Migratory species that are expected to be impacted the most during construction of Alternative 4 are American eel, striped bass, river herring (blueback herring and alewife), and sea lamprey. Migratory finfish could experience short-term, temporary impacts during construction of in-water structures including alteration of migration pathways during construction associated with noise, vibration, and bottom habitat disturbance in the immediate vicinity of the placement of new structures. Migratory species are expected to avoid construction zones and seek other nearby habitat. Significant indirect impacts to migratory species, such as prey species displacement, are not expected during construction of the storm surge barriers because migratory finfish will actively move to appropriate nearby foraging habitat.

Construction of most Shore-Based Measures under Alternative 4 is expected to have low impacts to migratory fish. Construction of various measures such as seawalls, elevated promenade, and floodwalls Jamaica Bay, the Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound, and Lower Hudson/east River will likely produce noise in shoreline habitat that may disturb migratory species that are nearby. Migratory species will actively avoid most in-water work areas and move to appropriate nearby habitat; therefore, impacts are expected to be Low. Levees, which are set back from the shoreline, are not expected to impact migratory fish.

Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, operation and maintenance of the storm surge barriers is generally expected to have Low impacts to migratory finfish. Migratory species may be impacted by closure of the storm surge barriers if they do not avoid the area during operations; however, this will be temporary and therefore is not anticipated to cause long-term impacts. Operation of the storm surge barrier is expected to have Low impacts to American eel larvae, which would temporarily be restricted from migration by a barrier closure. Modeling of the potential impacts to migratory patterns as a result of storm surge barriers and other structures may occur during the Tier 2 EIS(s). However, impacts to migratory finfish in the Lower Bay during operations and maintenance of the storm surge barrier are not anticipated to be significant because the barrier is located in a small part of the Region.

No impacts are expected to occur to migratory finfish in the Lower Bay, Raritan, Mid-Hudson and Capital Regions under Alternative 4 because no measures are planned there.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Migratory Finfish

ALT 5 Migratory Finfish Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	1	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts

Construction impacts associated with Alternative 5 on migratory finfish are expected to range from No Impact to Low impact. The Lower Hudson-East River Region is expected to be impacted the most because of the construction of Shore-Based Measures, such as floodwalls and elevated promenade, which will have low impacts to migratory finfish in the Region. The levees planned in the Upper Bay/Arthur Kill and Hackensack/Passaic Region are not expected to produce significant impacts to migratory finfish because they are set back from the shoreline.

Migratory species that are expected to be impacted the most during construction of Alternative 5 are American eel, striped bass, river herring (blueback herring and alewife), and sea lamprey. Construction of Shore-Based Measures along shoreline habitat may disturb migratory species that are nearby. Migratory species will actively avoid work zones and move to other appropriate nearby habitat; therefore, impacts are expected to be Low.

No impacts are expected to occur to migratory finfish in the other Regions under Alternative 5 because no measures are planned there.

Terrestrial Vegetation

Impacts to terrestrial vegetation are anticipated for the Study Area during construction, and operations and maintenance activities depending on the measure and existing conditions. The following are impact producing factors to terrestrial vegetation: physical habitat disturbance, habitat conversion, and land use change.

Construction Impact Summary

Construction of Shore-Based Measures, including floodwalls, floodwalls with park, elevated promenades, seawalls, buried seawall/dunes, levees, and berms are expected to impact terrestrial vegetation. Preparation of the construction sites for most measures would require clearing and grading of vegetation that could result in temporary upland and wetland vegetation impacts. Excavation and fill activities for construction of buried seawall/dune feature may temporarily cause indirect impacts to dune vegetation, specifically. Temporary impacts could be managed through implementation of a site-specific Storm Water Pollution Prevention Plan (SWPPP) and construction Best Management Practice (BMPs). Any native terrestrial vegetation impacted by construction could be mitigated on-site and in-kind.

Permanent impacts would occur from conversion of vegetated habitats to foundations and structures where measures are installed. Excavation, fill and foundation installation activities associated with some measures, such as an elevated promenade and seawall, may cause long-term permanent impacts to upland and wetland habitats through vegetation removal and conversion to impervious surfaces. Permanent impacts to trees for foundation installation may also occur, however, most of the trees in this highly urbanized area will be avoided, unavoidable impacts may be mitigated, and trees may be replaced. Operation and maintenance impacts with shore-based and in-water measures to terrestrial vegetation are expected to be Low.

Indirect impacts to terrestrial vegetation are not anticipated.

Operations and Maintenance Impact Summary

Beneficial effects of operations of both Shore-Based Measures and in-water measures during barrier closure during significant storm events include the managed risk to vegetation and substrates upon which they depend (such as dunes) from flooding and erosion damage associated with storm surge. Without the proposed project measures, the Study Area will continue to experience catastrophic damages and loss of valuable natural resources like those seen during Hurricane Sandy. Beneficial long-term impacts to wetland vegetation from wetland creation, may be anticipated. As the project measures become more defined during the Tier 2 evaluation, site-specific surveys may be completed to quantify the impacts to terrestrial vegetation. Areas for wetland creation and restoration, may also be identified in the development of the Tier 2 EIS.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to terrestrial vegetation associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Terrestrial Vegetation.

TSP Terrestrial Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to terrestrial vegetation under the TSP range from No Impact to Moderate impact. Moderate direct impacts are expected from construction of buried seawall and dune features which will impact terrestrial vegetation that inhabit dunes. These features are only planned for the Jamaica Bay Planning Region under the TSP. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to vegetation are expected to be Low. Impacts to vegetation would be associated with habitat disturbance and vegetation is expected to grow back when construction is complete.

Construction of the remaining Shore-Based Measures are anticipated to have a Low impact to terrestrial vegetation located in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Planning Regions. Floodwalls, elevated promenades, and levees are the most common features in the TSP. The placement of these features will occur in highly urbanized areas where forests, native vegetation and wetlands are uncommon. Trees associated with parks and other open spaces will be avoided or may be replaced in-kind, if impacted, as required by the park or local jurisdiction.

Operations and maintenance impacts associated with the TSP are expected to range from No impact to Low impact to vegetation in the Study Area within the Regions where measures are proposed.

The mitigated impact to terrestrial vegetation from implementation of the TSP is expected to range from No to Low impacts. Low impacts are still possible after avoidance, minimization, and mitigation by conversion of habitats to hard structures. However, implementation of the TSP will also provide a benefit to this resource, by managing the risk of flooding and erosion damage associated storm surge, RSLC, and coastal flooding.

No impacts to terrestrial vegetation are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts to terrestrial vegetation associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Terrestrial Vegetation.

ALT 2 Terrestrial Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	2	3	3
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to terrestrial vegetation under Alternative 2 range from No to Moderate impact. Impacts to terrestrial vegetation are expected to be Moderate within the Long Island Sound Planning Region from construction of levees, seawalls, floodwalls and berms. The extent of these structures is greatest within this Region under Alternative 2. Additionally, the existing landscape where Shore-Based Measures are planned is less urbanized than in other Regions, requiring a greater extent of conversion of vegetated areas to impervious surfaces or hard structure, at least temporarily.

Construction of the buried seawall and dune features are also expected to have a Moderate impact to terrestrial vegetation. These features are planned for the Jamaica Bay and Lower Bay Planning Regions under Alternative 2. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to vegetation are expected to be Low. Impacts to vegetation would be associated with habitat disturbance and vegetation is expected to grow back when construction is complete, therefore impacts are expected to be temporary.

Impacts to terrestrial vegetation from construction in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Raritan Region are expected to be Low. The impacts in these Regions are mostly associated with floodwalls, berms, and levees. The placement of these features is mostly in highly urbanized areas where forests, native vegetation and wetlands are uncommon. Trees associated with parks and other open spaces will be avoided or may be replaced in-kind if impacted, as required by the park or local jurisdiction.

Operations and maintenance associated with Alternative 2 are expected to have a Low impact on terrestrial vegetation in the Planning Region in regions where measures are proposed.

The mitigated rating to terrestrial vegetation from implementation of Alternative 2 is expected to range from No Impact to Low impact. Low impacts are also still possible from Shore-Based Measures after avoidance, minimization, and mitigation by conversion of habitats to hard structures. However, the implementation of Alternative 2 will provide a benefit to terrestrial vegetation, by managing the risk of flooding and erosion damage associated storm surges, RSLC, and coastal flooding.

No impacts are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts to terrestrial vegetation associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Terrestrial Vegetation.

ALT 3A Terrestrial Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	2	3	3
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to terrestrial vegetation under Alternative 3A range from No Impact to Moderate impact. Impacts to terrestrial vegetation are expected to be Moderate within the Long Island Sound and Lower Bay Planning Regions from construction of levees, seawalls, floodwalls, and berms. The existing landscape in these Regions is less urbanized than in other Regions where Shore-Based Measures are planned, requiring a greater extent of conversion of vegetated areas to impervious surfaces or hard structure, at least temporarily. Construction of buried seawall and dune features are expected to have a Moderate impact to terrestrial vegetation. These features are planned for the Jamaica Bay and Lower Bay Planning Regions under Alternative 3A. Road raising is also proposed along Broad Channel in Jamaica Bay and impacts to vegetation are expected to be Low. Impacts to vegetation would be associated with habitat disturbance and vegetation is expected to grow back when construction is complete.

Construction impacts in the Lower Hudson/East River, Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic, and Raritan Regions are expected to be Low. Impacts in these Regions are mostly associated with floodwalls, berms, and levees. The placement of these features is mostly in highly urbanized areas where forests, native vegetation and wetlands are uncommon. Trees associated with parks and other open spaces will be avoided or may be replaced in-kind if impacted, as required by the park or local jurisdiction.

Operations and maintenance associated with Alternative 3A are expected to have a Low impact on terrestrial vegetation in the Study Area in regions where measures are proposed.

The mitigated impact to terrestrial vegetation from implementation of Alternative 3A is expected to range from No to Low impact. Low impacts are also still possible from Shore-Based Measures after avoidance, minimization and mitigation by conversion of habitats to hard structures. However, the implementation of Alternative 3A will provide a benefit to terrestrial vegetation, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are expected in the Capital District and Mid-Hudson Planning Regions because no structural measures are proposed there under Alternative 3A.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts to terrestrial vegetation associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Terrestrial Vegetation.

ALT 4 Terrestrial Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to terrestrial vegetation under Alternative 4 range from No to Moderate impact. Construction of buried seawall and dune features are expected to have a Moderate impact to terrestrial vegetation that inhabit dunes. These features are only planned for the Jamaica Bay Planning Regions under Alternative 4. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to terrestrial vegetation are expected to be Low. Impacts to vegetation would be associated with habitat disturbance and vegetation is expected to grow back when construction is complete.

Construction of the remaining Shore-Based Measures are anticipated to have a Low impact to vegetation in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Planning Regions. Floodwalls, elevated promenades, and levees are most common shore-based features in Alternative 4. The placement of these features is mostly in highly urbanized areas where forests, native vegetation and wetlands are uncommon. Trees associated with parks and other open spaces will be avoided or may be replaced in-kind if impacted, as required by the park or local jurisdiction.

Operations and maintenance associated with Alternative 4 are expected to have a Low impact on terrestrial vegetation in the Study Area Regions where measures are proposed.

The mitigated impact to terrestrial vegetation from implementation of Alternative 4 is expected to range from No to Low impacts. Low impacts are still possible after avoidance, minimization and mitigation by conversion of habitats to hard structures. However, implementation of Alternative 4 will provide a benefit this resource, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are expected to terrestrial vegetation in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structural measures are proposed there under Alternative 4.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts to terrestrial vegetation associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Terrestrial Vegetation.

ALT 5 Terrestrial Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	2	2	1	2	1	1	1
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

The construction of the Shore-Based Measures included in Alternative 5 are anticipated to range from No to Low impact to terrestrial vegetation in the Lower Hudson/East River, Upper Bay/Arthur Kill and Hackensack/Passaic Planning Regions. Floodwalls and levees are most common shore-based features in Alternative 5. The placement of these features is generally mostly in highly urbanized areas where forests, native vegetation and wetlands are uncommon. Trees associated with parks and other open spaces will be avoided or may be replaced in-kind, as required by the park or local jurisdiction.

Operations and maintenance associated with Alternative 5 are expected to have a Low impact on terrestrial vegetation in the Study Area in regions where measures are proposed.

The mitigated impact terrestrial vegetation from implementation of Alternative 5 is expected to range from No to Low impacts. Low impacts are still possible after avoidance, minimization and mitigation by conversion of habitats to hard structures in the Study Areas where the structures are proposed. However, implementation of Alternative 5 will provide a benefit this resource, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are expected in the Capital District, Mid-Hudson, Lower Bay, Raritan, Long Island Sound, and Jamaica Bay Planning Regions because no structural measures are proposed there under Alternative 5.

Submerged Aquatic Vegetation

SAV is important habitat for many benthic organisms and larval and juvenile fish. Habitat disturbance, resuspension of sediments, and changes in DO and salinity ranges due to prolonged flooding may result in impact to SAV. Impacts to SAV are anticipated to be low in the Study Area with NYNJHAT project implementation during construction and operations and maintenance depending on the measure and existing conditions. The following are impact-producing factors to SAV: physical seabed disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion.

Construction Impact Summary

No impacts to SAV are anticipated from construction of levees because this measure is generally located away from coastline areas. Impacts to SAV might occur during construction of other shore-based located along shoreline habitat (elevated promenade, seawalls, floodwalls) and the in-water measures proposed in the Study Area, depending on the location and extent of the measures under each Alternative.

Impacts to SAV may occur in the vicinity of Gateway National Recreation Area at Sandy Hook, within the Lower Bay Region. NJDEP maintains an online database of historical mapped SAV in New Jersey (NJDEP 2022). SAV was mapped on the bay side of Sandy Hook, within the Gateway Recreation Area, to the north of Monmouth

Hills and to the southwest of Navesink Beach in 1979 (NJDEP 2022). SAV habitat was also documented in the Navesink and Shrewsbury Rivers in 1980, 1983, and 2015 (NJDEP 2022).

Shallow water habitats of the lower HR (including Haverstraw Bay), Mid-Hudson River, and Capital District also have mapped areas of SAV, however they are not near the proposed project measures. Because the footprint of the measures proposed in NYNJHAT Study Area not located in the mapped area of SAV, impacts from construction are expected to be Low or have no effect.

Within Jamaica Bay, SAV has been limited by anthropogenic activities, including dredging, infrastructure and residential development, and the spread of invasive species such as common reed (USACE 2020b). SAV is no longer present in the Region.

There is no documented SAV within the Hackensack/Passaic, Upper Bay/Arthur Kill, and Raritan Region (USACE 2020b and NJDEP 2022), and no SAV has been reported in the Long Island Sound Region.

Operations and Maintenance Impact Summary

Indirect impacts to SAV during operations and maintenance could occur following the closure of tide gates and storm surge barriers due to changes to flow velocities, scour, sedimentation patterns, and water quality. Impacts could be short-term or long-term depending on duration of barrier closures. Additional impacts to SAV may be further evaluated during the Tier 2 EIS(s).

TSP (Alternative 3B)

No impacts to SAV are anticipated with construction and operation and maintenance of the TSP as the footprint of the TSP is not near mapped SAV within the Study Area.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on SAV

TSP Submerged Aquatic Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

No impacts to SAV are anticipated with construction and operations and maintenance of the TSP. The footprint of the TSP is not located near mapped SAV in the Study Area. Potential benefits to SAV within the Jamaica Bay Region may be anticipated with operations and maintenance of the storm surge barriers.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts to SAV associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 to SAV

ALT 2 Submerged Aquatic Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	2	1	1	1	1
O&M Assumptions	1+	1+	1+	1	2+	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to SAV range from No to Low impact. Construction of the buried seawall and dune features, floodwalls, and berms may have a Low impact to SAV related to suspended sediments during construction in the Lower Bay, where SAV habitat is mapped. No other Planning Regions will have impacts to SAV from Construction of Alternative 2.

Operations and maintenance associated with Alternative 2 are expected to have a Low impact on SAV in the Lower Bay. There is mapped SAV on the bay side of Sandy Hook which may be indirectly impacted by closure of the storm surge barrier from Sandy Hook to Rockaway Bay.

The mitigated rating to SAV implementation of Alternative 2 is expected to have a Low impact. Low impacts to SAV are possible with avoidance, minimization and mitigation included, from operation of the storm surge barrier in the Lower Bay.

Low impacts to SAV are possible with avoidance, minimization and mitigation included, from operation of the storm surge barrier in the Lower Bay.

No impacts to SAV are anticipated in any of the other Planning Regions because the proposed measures are not located in the vicinity of mapped SAV.

Alternative 2 is anticipated to have a potential beneficial effect to SAV by managing the risk of not only coastal zones, but also areas upriver within the Hudson River from the devastating effects of storm surges. A benefit to SAV located within the Lower Hudson, Mid-Hudson, and Capital District Region is anticipated during operations and maintenance of Alternative 2, which will help reduce shoreline erosion in the more southerly Regions that may contribute to sediment transport and turbidity upriver during major storm events.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts to SAV associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on SAV.

ALT 3A Submerged Aquatic Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	2	1	1	1	1
O&M Assumptions	1+	1+	1+	1	2+	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to SAV under Alternative 3A range from No Impact to Low impact. Construction of the storm surge barrier and seawalls in the Lower Bay may have a Low impact to SAV related to suspended sediments during construction in the Lower Bay, where SAV habitat is mapped. No other Planning Regions will have impacts to SAV from Construction of Alternative 3A.

Operations and maintenance associated with Alternative 3A are expected to have a Low impact on SAV in the Lower Bay. There is mapped SAV on the bay side of Sandy Hook which may be indirectly impacted by closure of the storm surge barrier from Sandy Hook to Rockaway Bay.

The mitigated impact to SAV from implementation of Alternative 3A is expected to range from No to Low impact. Low impacts to SAV are possible with avoidance, minimization and mitigation included, from operation of the storm surge barrier in the Lower Bay.

No impacts to SAV are expected in any of the other Planning Regions because the measures are not planned in the vicinity of mapped SAV habitat.

Alternative 3A is anticipated to have beneficial effects to SAV by managing risk to not only coastal zones, but also areas upriver within the Hudson River from the devastating effects of storm surges. A benefit to SAV located within the Lower Hudson, Mid-Hudson, and Capital District Region is expected during operations and maintenance of Alternative 3A, which will help reduce shoreline erosion in the more southerly Regions that may contribute to sediment transport and turbidity upriver during major storm events.

ALTERNATIVE 4

No impacts to SAV are expected with construction or operation and maintenance of the Alternative 4, as the structural measures are not located near the mapped SAV in the project area.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on SAV

ALT 4 Submerged Aquatic Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1

Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

ALTERNATIVE 5

No impacts to SAV are anticipated from construction or operation and maintenance of the Alternative 5 as the structural measures in Alternative 5 are not located near the mapped SAV in the project area.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on SAV

ALT 5 Submerged Aquatic Vegetation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Invasive and Aquatic Nuisance Species

Terrestrial invasive nuisance species are indicative of disturbed environments and are therefore prolific in the Planning Region due to its highly urbanized landscape. Land disturbance associated with construction and land conversion may create potential for the spread of already established invasive plants. However, certain structural measures (e.g. floodwalls with park) and NNBFs may provide a benefit, as wetland restoration or creation for this project will involve planting of native vegetation. Compliance monitoring would likely be required under Federal and State wetland permitting and would identify changes in dominant species from native to invasives. This would specifically address successful establishment of native plantings and control of invasive species.

Construction Impact Summary

Equipment (boats, barges, etc.) used to construct in-water features could be vectors for transporting aquatic nuisance species. Land based equipment could also transport invasive plants, seeds, roots, and terrestrial invasive species such as the spotted lanternfly. Through the use of project specific BMPs, any potential impacts could be avoided and minimized, therefore no direct or indirect impacts would be anticipated.

Operations and Maintenance Impact Summary

No impacts are anticipated from operation and maintenance of shore-based or in-water measures.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to invasive and aquatic nuisance species associated with the construction footprint and operations and maintenances assumptions:

The TSP, Alternative 3B, is anticipated to have the following impacts to invasive and aquatic nuisance species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Invasive and Aquatic Nuisance Species

TSP Invasive & Aquatic Nuisance Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to invasive and aquatic nuisance species under the TSP range from No Impact to Low impact. Low direct impacts are anticipated from construction of any in-water or Shore-Based Measures and are expected in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound and Jamaica Bay Regions. No operations and maintenance impacts are expected. The overall mitigated rating is No impact in any Planning Region due to the anticipated use of project specific BMPs. Implementation of the TSP is expected to provide a benefit by managing the risk of coastal flooding that could encourage the spread of invasive species and additional related disturbances that would occur under the No Action Alternative.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts to invasive and aquatic nuisance species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Invasive and Aquatic Nuisance Species.

ALT 2 Invasive & Aquatic Nuisance Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	2	2	1	2	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to invasive and aquatic nuisance species under Alternative 2 range from No Impact to Low impact. Low direct impacts are anticipated from construction of any in-water or Shore-Based Measures and are expected in the Lower Hudson/East River, Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic, Long Island Sound and Jamaica Bay Regions. No operations and maintenance impacts are expected. The mitigated rating is No impact in any Planning Region due to the anticipated use of project specific BMPs. Implementation of Alternative 2 would be anticipated to provide a benefit by managing the risk of coastal flooding that could encourage the spread of invasive species and additional related disturbances that would occur under the No Action Alternative.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts to invasive and aquatic nuisance species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3A on Invasive and Aquatic Nuisance Species

ALT 3A Invasive & Aquatic Nuisance Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	2	2	1	2	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to invasive and aquatic nuisance species under Alternative 3A range from No Impact to Low impact. Low direct impacts are expected from construction of any in-water or Shore-Based Measures and are expected in the Lower Hudson/East River, Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic, Long Island Sound and Jamaica Bay Regions. No operations and maintenance impacts are expected. The mitigated rating is No impact in any Planning Region due to the anticipated use of project specific BMPs. Implementation of Alternative 3A would be anticipated to provide a benefit by manging the risk of coastal flooding that could encourage the spread of invasive species and additional related disturbances that would occur under the No Action Alternative.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts to invasive and aquatic nuisance species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 4 on Invasive and Aquatic Nuisance Species

ALT 4 Invasive & Aquatic Nuisance Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to invasive and aquatic nuisance species under Alternative 4 range from No Impact to Low impact. Low direct impacts are expected from construction of any in-water or Shore-Based Measures and are expected in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound and Jamaica Bay Regions. No operations and maintenance impacts are expected. The mitigated rating is No impact in any Planning Region due to the anticipated use of project specific BMPs. Implementation of Alternative 4 would be anticipated to provide a benefit by managing the risk of coastal flooding that could encourage the spread of invasive species and additional related disturbances that would occur under the No Action Alternative.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts to invasive and aquatic nuisance species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 5 on Invasive and Aquatic Nuisance Species

ALT 5 Invasive & Aquatic Nuisance Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to invasive and aquatic nuisance species under Alternative 5 range from No Impact to Low impact. Low direct impacts are expected from construction of any in-water or Shore-Based Measures and are expected in the Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Regions. No operations and maintenance impacts are expected. The overall mitigated rating is No impact in any Planning Region due to the anticipated use of project specific BMPs. Implementation of Alternative 5 would be anticipated to provide a benefit by managing the risk of coastal flooding that could encourage the spread of invasive species and additional related disturbances that would occur under the No Action Alternative.

6.1.3 Special Status Species

The following sections discuss the potential environmental effects to special status species, including threatened and endangered species (terrestrial and aquatic), MBTA species and bald eagles, EFH and EFH-designated species, MMPA species, and sea turtles. In Chapter 4, these resource categories are combined into one category, and their scores averaged together, to compare Alternative plans environmental acceptability.

Threatened and Endangered Species (Terrestrial)

Various aspects of the study have the potential to impact threatened and endangered species. Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. “Take”, as previously mentioned in the Existing Conditions Chapter, is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. The following are impact producing factors to terrestrial threatened and endangered species: physical seabed/land disturbance, habitat conversion, noise, air emissions, visible structures, and land use change.

Direct impacts could result in take of ESA species. Potential direct impacts to USFWS regulated species within the Planning Region include changes to and/or removal of habitat, localized changes to topography, the temporary and localized impacts from other construction activities (i.e., land or water disturbance, noise, and vibrations).

Indirect impacts are defined as those impacts that indirectly affect the well-being of a particular species. These impacts include activities that cause the loss of forage species. The primary indirect impact to ESA -listed species with implementation of the TSP is the conversion of coastal habitats to flood protection structures. Several of the ESA -listed species that may occur in the Study Area either nest, inhabit, or feed in areas that may be indirectly impacted by the TSP. Refer to Appendix A1 for additional information.

Construction Impact Summary (Mammals)

Construction impacts may be associated with the NYNJHAT Study to the listed bat species. Bat habitat is generally in forested areas or in caves, while most of the shore-based project measures are in urbanized areas without forests. With the exception of the Mid-Hudson Region and parts of the Capital District Region, the Study Area is highly urbanized and bat species are not expected to be a common occurrence.

Minor short-term impacts to bats from potential tree clearing and vegetation removal during construction site preparation activities could occur. Potential for impact to bats would be associated with direct removal of roosts or hibernacula for placement of the Shore-Based Measures, such as levees, seawalls, or floodwalls. Trees that provide habitat for bats may be removed to install the linear seawalls, levees, or floodwalls. As the projects become more defined, site-specific surveys for hibernacula and nesting locations in the vicinity of onshore project measures may be conducted to evaluate impacts during the Tier 2 EIS (s).

Indirect impacts to bats from potential vegetation removal, earth moving and during construction site preparation activities is possible. Soil displacement and vegetation removal may temporarily disturb insects and foraging habitat preferred by bats, but prey organisms are anticipated to move to other habitat nearby. Furthermore, insect populations should not be significantly impacted by soil displacement and vegetation removal; therefore, bats are not likely to be adversely affected.

Temporary short-term impacts associated with noise may occur during construction to bats roosting or hibernating in the vicinity of the construction but are not expected to be extensive. Bat species are anticipated to move away from active construction areas and use adjacent suitable habitat until construction is complete.

Construction Impact Summary (Birds)

Construction impacts to the listed bird species may be associated with the NYNJHAT Study implementation. Temporary short-term impacts associated with habitat disturbance and noise are expected during construction.

Beach-nesting birds may be disrupted when project measures such as buried seawalls with beach/dune are constructed. Construction activities would take place outside of beach-nesting seasons to the extent practicable and any beach-nesting birds present are anticipated to use adjacent suitable habitat. Suitable nesting habitat may be identified in later stages of planning and if identified these areas could be avoided to the maximum extent practicable.

Permanent impacts to birds from habitat alteration could occur where measure foundations and structures are installed, converting upland or beach habitat to hard structures. Impacts are expected during construction of composite seawalls with beach/dune. Sediment removal, fill and installation of stone will be required to construct the support structure that will be covered in sand to create a beach/dune feature. This has the potential to permanently impact beach nesting and breading birds such as roseate tern and piping plover. Other Shore-Based Measures, seawalls, floodwalls, berms, levees are expected to have only minor impact on threatened and endangered birds overall. Birds are anticipated to move away from the area of construction activities to suitable available habitat adjacent to the project sites. No direct impacts to bird species are anticipated for storm surge barrier and tide gate measures, as these will be constructed offshore and not within bird habitat.

The primary indirect impact to ESA -listed bird species from the NYNJHAT Study is the effect of construction activities on forage species for birds and insects in the action area. Construction activities would include bottom habitat disturbance and the potential loss of forage organisms, benthic and tidal invertebrates and fish, in the immediate vicinity of the placement of new structures. Based on previous studies, the re-establishment of benthic communities varies between six months to a year after the project's completion depending on substrate type (USACE 2007; Wilber and Clarke 2007). Thus, no long-term indirect impacts are expected on benthic communities, the fish that feed on them, or the ESA -listed birds in the Study Area as a result of construction. Additionally, the overall area that would be impacted includes a small percentage of the habitat that is available and bird species will be able to forage in adjacent areas.

Similarly, construction of in-water structures may indirectly affect pelagic birds like the red knot by disturbing benthic habitat, invertebrates and potentially the fish on which they feed. However, as described above, the area of impact is relatively small, and birds can forage in adjacent areas that will not be affected. The construction of the in-water structures is not expected to have an indirect effect on other USFWS ESA-listed species.

Construction Impact Summary (Insects)

Candidate threatened and endangered insects may experience low direct construction related impacts from equipment or during sand or soil displacement activities. However, because they are physically able to fly away from the construction zones, direct impacts are expected to be low. Monarch butterflies are most likely to be found areas with meadow, flowering plants and milkweed. Direct effects to monarch butterfly can also occur from conversion of meadow or beach dune habitat to permanent foundation structure. Yellow banded bumble bees live in a diverse range of habitats from open parkland, wildflower meadows to mixed woodlands, usually nesting underground in pre-existing cavities such as abandoned rodent burrows and rotten logs. Direct impacts are related to conversion of habitat to foundation structure.

Although it is possible to have direct impacts to monarch butterflies and yellow-banded bumble bee in any of the Planning Regions, they are most likely to occur in the Jamaica Bay Region, where the measures are being proposed in less developed areas with a higher likelihood of emergent flowing plants. Both species are most likely to be found in areas with meadows, flowering plants, and milkweed.

However, beneficial long-term impacts to monarch butterflies and the yellow-banded bumble bee from habitat creation, particularly for the buried seawall/dune measure, within the Jamaica Bay Planning Region, include an expanded shoreline and dune area for foraging and a coastal habitat buffer from future large storm events.

As the projects become more defined, desktop surveys for potential habitat for the candidate insects or site-specific surveys may be conducted to evaluate impacts during the Tier 2 EIS(s).

Construction Impact Summary (Plants)

Low impacts to the federally listed plant, Seabeach amaranth are possible due to construction of Shore-Based Measures with the NYNJHAT Study such as composite seawall/dune measures. Construction of these features will involve sediment displacement, installation of the composite seawall and placement of sand in potential habitat for this species, as well as movement of heavy equipment in potential habitat or locations of existing plants. Direct placement of sand on plants or seeds could kill plants and smother seeds and plants could be run over or pulled out of the ground during digging or sand relocation. However, targeted species surveys will be conducted to identify plants and suitable habitat so they can be avoided during construction. Time of year restrictions may also be implemented to avoid the growing season and times when impacts are expected to be highest. The impacts are anticipated to be short-term and temporary and provide a long-term beneficial impact by enhancing the dunes for protection from future large storm events.

Indirect impacts to the seabeach amaranth may occur from changes in dune and beach topography or slope related to construction or effects due to changes in hydrology. Potential indirect impacts to coastal habitats, including habitat for seabeach amaranth, through scouring or sedimentation from changes in hydrology may be further assessed in subsequent phases of the Study.

Operations and Maintenance Impact Summary

Operation of tide gates or storm surge barriers are expected to have minimal impacts to USFWS ESA species with implementation of the NYNJHAT Study. Storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure. This assumption will be updated as the barrier closure details are refined. Mammals, insects, and flower plants are not expected to be impacted by operation of the in-water measures in any of the Planning Regions because the measures should not affect their habitat.

Maintenance impacts to USFWS ESA listed species includes similar impacts discussed above during construction including maintenance dredging, or construction activities to repair damaged features. When the tide gates and storm surge barriers are in the open position, no impacts would occur to threatened and endangered species. Temporary impacts during barrier closure include changes to water quality, such as increases in turbidity and sediment suspension, or minor restriction of birds that prey on benthic or tidal fish species.

As noted above, mobile ESA species are anticipated to move away from maintenance operations in search of more suitable habitat. Operation and maintenance associated with the buried seawalls/dunes are expected to be minimal. Many of the ESA listed species in the Study Area inhabit these dune areas and are not likely to experience impacts after construction. Any operation and maintenance that would be necessary in areas where non-mobile species exist, like seabeach amaranth, would likely require species surveys, therefore a direct impact from operations and maintenance would not occur.

Indirect impacts of the NYNJHAT Study during barrier closure include temporary changes to hydrology and water quality, such as increases in turbidity and sediment suspension. Increased noise and vibration would be temporary and limited to the duration of barrier closure and opening operation. Neither of these indirect operational impacts are expected to affect USFWS ESA-listed species identified as potentially occurring in the action area.

Beneficial indirect impacts could occur through protection of dune and terrestrial habitats and therefore prey species for bats, birds, insects, and the seabeach amaranth during barrier closure from flooding and subsequent erosion during large storm events. Any wetland creation and restoration that may be implemented through mitigation may have long term beneficial impacts through the creation or enhancement of feeding habitat.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to terrestrial threatened and endangered species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Terrestrial Threatened and Endangered Species

TSP Terrestrial Threatened and Endangered Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to terrestrial threatened and endangered species under the TSP range from No Impact to Moderate impact, with the Jamaica Bay Region expected to have the highest impacts. The Jamaica Bay Region is the only Planning Region that contains the composite seawall/dune measures included in the TSP. Moderate direct impacts could occur to the listed bird species, as their habitats and nests could occur in the vicinity of the proposed composite seawall/dune measures. The bat species may have Moderate impacts due to conversion of habitats to berms and other Shore-Based Measures in the Jamaica Bay Region. The seabeach amaranth and insect species could also be impacted in the Jamaica Bay Region by the proposed composite seawall/dune measures, but impacts are expected to be Low. However, as described above avoidance and minimization measure, such as time of year restrictions and species and nest surveys may be conducted prior to construction to reduce impacts to these species. Road raising is also proposed along Broad Channel in Jamaica Bay and impacts to terrestrial threated and endangered species are expected to be Low. Impacts producing factors include habitat disturbance and noise during construction, however, road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be Low.

Construction of other Shore-Based Measures are anticipated to have a Low impact on terrestrial threatened and endangered species in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Planning Regions. Floodwalls, elevated promenades, and levees are most common features in these Planning Regions under the TSP. The listed bat species and candidate insect species are likely are present in these Regions, however the impact to each species is expected to be Low because few bats are presumed to inhabit the highly urbanized areas where the Shore-Based Measures are planned. Bats are also expected to avoid the construction zones. Similarly, construction impacts to bird species from those measures will be Low, as the areas where these measures a proposed are more urbanized and contain less suitable habitats and because the ESA listed bird species are expected to avoid the construction zones.

Construction impacts to insects are possible in all Planning Regions where Shore-Based Measures are planned due to potential conversion of land, but impacts are expected to be Low, as most areas are highly urbanized and don’t contain desirable habitat.

The Planning Regions where in-water structures are planned, Jamaica Bay and Upper Bay/Arthur Kill, may have Low to Moderate temporary indirect effect on the listed birds. Because the bird species will most likely be in the Jamaica Bay Planning Region and could be nesting there, the indirect impact in this Region is highest of all Study Area Planning Regions. Similarly, the bird species could be temporarily impacted by Shore-Based Measures within the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Regions, because of reduced foraging efficiency related to indirect construction impacts, such as increased turbidity. However, as described above, all three bird species are expected to forage in other locations, away from the construction and the potentially disturbed forage communities will be stabilized soon after the completion of construction. Therefore, these temporary indirect impacts are expected to be Low.

Operations and maintenance impacts associated with the TSP are expected to range from No Impact to Low impact to terrestrial threatened and endangered species in the Study Area Regions where measures are proposed. No impacts are expected to terrestrial threatened and endangered species with implementation of avoidance, minimization, and mitigation measures.

The TSP will also provide a benefit to these species, by managing the risk of coastal flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to terrestrial threatened and endangered species are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts to terrestrial threatened and endangered species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Terrestrial Threatened and Endangered Species

ALT 2 Terrestrial Threatened and Endangered Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	3	2	2	3	3
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to terrestrial threatened and endangered species under Alternative 2 range from No Impact to Moderate impact. Impacts to terrestrial threatened and endangered species are expected to be Moderate within the Long Island Sound Planning Region from construction of levees, seawalls, floodwalls, and berms. The extent of these structures is greatest in this Region under Alternative 2. Additionally, the existing landscape where Shore-Based Measures are planned is less urbanized than in other Regions, requiring a greater extent of conversion of vegetated areas to impervious surfaces or hard structure, at least temporarily.

Construction of buried seawall and dune features are also expected to have a Moderate impact to the listed bird species, as their habitats and nests could occur in the vicinity of the proposed composite seawall/dune measures. These features are planned for the Jamaica Bay and Lower Bay Planning Regions under Alternative 2. The bat species may have also Moderate impacts due to conversion of habitats to berms and other Shore-Based Measures in the Jamaica Bay Region. The seabeach amaranth and insect species could also be impacted in the Jamaica Bay Region by the proposed composite seawall/dune measures, but impacts are expected to be Low. Road raising is also proposed along Broad Channel in Jamaica Bay and impacts to terrestrial threatened and endangered species are expected to be Low. Impacts producing factors include habitat disturbance and noise during construction, however, road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be Low.

Impacts from construction in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Raritan Regions to terrestrial threatened and endangered species are expected to be Low. The listed bat species and candidate insect species are likely present in these Regions, however the impact to each species is expected to be Low because few bats are presumed to inhabit the highly urbanized areas where Shore-Based Measures are planned and because the bats are expected to avoid the construction zones. Similarly, construction impacts to the bird species from those measures will be Low, as the areas where these measures a proposed are more urbanized and contain less suitable habitats and because the ESA listed bird species are expected to avoid the construction zones.

The Planning Regions where in-water structures are planned under Alternative 2 are, Jamaica Bay and Upper Bay/Arthur Kill, may have a Low to Moderate temporary indirect effect on the listed birds. Because the bird species will most likely be in the Jamaica Bay Planning Region and could be nesting there, the indirect impact in this Region is highest of all Study Area Study Areas. Similarly, the bird species could be temporarily impacted by Shore-Based Measures within the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Regions, because of reduced foraging efficiency related to indirect construction impacts, such as increased turbidity. However, as described above all bird species can forage in other areas, away from the construction and the potentially disturbed forage communities will be stabilized soon after the completion of construction. Therefore, these temporary indirect impacts are expected to be Low.

Operations and maintenance associated with Alternative 2 are expected to have a Low impact on terrestrial threatened and endangered species in the Study Area in regions where measures are proposed. No impacts are anticipated to terrestrial threatened and endangered species with implementation of avoidance, minimization, and mitigation measures.

Alternative 2 will also provide a benefit to these species, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts to terrestrial threatened and endangered species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Terrestrial Threatened and Endangered Species.

ALT 3A Terrestrial Threatened and Endangered Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	2	2	2	2	3
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to terrestrial threatened and endangered species under Alternative 3A range from Moderate to No impact, with the Jamaica Bay Region expected to have the highest impacts. Moderate impacts could occur to the listed bird species, as their habitats and nests could occur in the vicinity of the proposed composite seawall/dune measures in the Jamaica Bay Region. The bat species may have also Moderate impacts due to conversion of habitats to berms and other Shore-Based Measures in the Jamaica Bay Region. The seabeach amaranth and insect species could also be impacted in the Jamaica Bay Region by the proposed composite seawall/dune measures, but impacts are expected to be Low. This measure is also included in the Lower Bay Region, but the listed bird species and seabeach amaranth aren't expected to occur there, so impacts should be Low in this Region. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to terrestrial threatened and endangered species are expected to be Low. Impacts producing factors include habitat disturbance and noise during construction, however, road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be Low.

Construction of other Shore-Based Measures are anticipated to have a Low impact on terrestrial threatened and endangered species in the Lower Hudson/East River, Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic, Raritan and Long Island Sound Planning Regions. Floodwalls, elevated promenades, and levees are most common features in these Planning Regions under Alternative 3A. The listed bat species are likely are present in these Regions, however the impact to each species is expected to be Low because few bats are presumed to inhabit the urbanized areas where Shore-Based Measures are planned and because the bat are expected to avoid the construction zones. Similarly, construction impacts to the bird species from those measures will be Low, as the areas where these measures a proposed are more urbanized and contain less suitable habitats for these species and because the ESA listed bird species are expected to avoid the construction zones.
Construction impacts to candidate insects are possible in all Planning Regions where Shore-Based Measures are planned due to potential conversion of land, but impacts are expected to be Low, as most areas are urbanized.

The Planning Regions where in-water structures are planned, Jamaica Bay, Upper Bay/Arthur Kill, Lower Bay, Raritan, and Long Island Sound may have a Moderate to Low temporary indirect effect on the listed birds. In-water impacts are expected to be Moderate in the Jamaica Bay Planning Region because the bird species could be nesting there. Impact related to construction of in-water features are expected to be Low in all other Regions. Similarly, threatened and endangered bird species may be temporarily impacted by construction of Shore-Based Measures because of reduced foraging efficiency related to indirect construction impacts, such as increased turbidity. However, as described above all bird species can forage in other areas, away from the construction and the potentially disturbed forage communities will be stabilized soon after the completion of construction. Therefore, these temporary indirect impacts are expected to be Low.

Operations and maintenance impacts associated with Alternative 3A are expected to range from No to Low impact to terrestrial threatened and endangered species in the Planning Region. No impacts are anticipated to terrestrial threatened and endangered species with implementation of avoidance, minimization and mitigation measures.

Alternative 3A will also provide a benefit to these species, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to terrestrial threatened and endangered species are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Terrestrial Threatened and Endangered Species

ALT 4 Terrestrial Threatened and Endangered Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to terrestrial threatened and endangered species under Alternative 4 range from No to Moderate impact, with the Jamaica Bay Region expected to have the highest impacts. The Jamaica Bay Region is the only Planning Region that contains the composite seawall/dune measures included in Alternative 4. Moderate impacts could occur to the listed bird species and seabeach amaranth, as their habitats and nests could occur in the vicinity of the proposed composite seawall/dune measures. The bat species may have also Moderate impacts due to conversion of habitats to berms and other Shore-Based Measures in the Jamaica Bay Region. The seabeach amaranth could also be impacted in the Jamaica Bay Region by the proposed composite seawall/dune measures, but impacts are expected to be Low. The candidate insect species could also be impacted in the Jamaica Bay Region by the proposed composite seawall/dune measures, but impacts are expected to be Low. However, avoidance and minimization measures, such as time of year restrictions and species and nest surveys may be conducted prior to construction to reduce impacts to these species. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to terrestrial threatened and endangered species are expected to be Low. Impacts producing factors include habitat disturbance and noise during construction, however, road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be Low.

Construction of other Shore-Based Measures under Alternative 4 are anticipated to have a Low impact on terrestrial threatened and endangered species in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Planning Regions. Floodwalls, elevated promenades, and levees are most common features in these Planning Regions under the Alternative 4. The listed bat species are present in these Regions, however the impact to each species is expected to be Low because few bats are presumed to inhabit the highly urbanized areas where Shore-Based Measures are planned and because the bats are expected to avoid the construction zones. Similarly, construction impacts to the bird species from those measures are anticipated to be Low, as the areas where these measures a proposed are more urbanized and contain less suitable habitats and because the ESA listed bird species are expected to avoid the construction zones.

Construction impacts to insect species are possible in all Planning Regions where Shore-Based Measures are planned due to potential conversion of land, but impacts are expected to be Low, as most areas are highly urbanized.

Constriction of the storm surge barrier in the Jamaica Bay Planning Region may have a Moderate temporary indirect effect on the listed birds because birds may be nesting there and may experience a reduced foraging efficiency related to indirect construction impacts, such as increased turbidity. Similarly, bird species could be temporarily impacted by Shore-Based Measures within the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound Regions due to reduced foraging efficiency. However, as described above all bird species can forage in other areas, away from the construction and the potentially disturbed forage communities will be stabilized soon after the completion of construction. Therefore, these temporary indirect impacts are expected to be Low.

Operations and maintenance impacts associated with Alternative 4 are expected to range from No to Low impact to terrestrial threatened and endangered species in the Study Area. No impacts are expected to terrestrial threatened and endangered species with implementation of avoidance, minimization, and mitigation measures.

Alternative 4 will also provide a benefit to these species, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to terrestrial threatened and endangered species are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under Alternative 4.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Terrestrial Threatened and Endangered Species

ALT 5 Terrestrial Threatened and Endangered Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	2	2	1	2	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Only Shore-Based Measures are included Alternative 5. The construction of these measures included in are anticipated to have Low impacts terrestrial threatened and endangered species in the Lower Hudson/East River, Upper Bay/Arthur Kill and Hackensack/Passaic Planning Regions. Floodwalls and levees are most common shore-based features in Alternative 5. The placement of these features is generally in highly urbanized areas where terrestrial threatened and endangered species are not expected to occur, especially those species that are present in dune habitats such as the listed birds and seabeach amaranth. The bat species are present in these Regions, however the impact to each species is expected to be Low because few bats are presumed to inhabit the highly urbanized areas where Shore-Based Measures are planned and because the bats are expected to avoid the construction zones.

Construction impacts to the candidate insect species are possible in all Planning Regions where Shore-Based Measures are planned due to potential conversion of land, but impacts are expected to be Low, as most areas are highly urbanized.

Operations and maintenance impacts associated with Alternative 5 are expected be Low in regions where measures are proposed. No impacts are expected to terrestrial threatened and endangered species after implementation of avoidance, minimization, and mitigation measures.

Alternative 5 will also provide a benefit to these species, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to terrestrial threatened and endangered species are expected in the Capital District, Mid-Hudson, Lower Bay, Raritan, Long Island and Jamaica Bay Planning Regions because no structures are proposed there under Alternative 5.

Threatened and Endangered Species (Aquatic)

Direct impacts could result in a “take” of aquatic ESA species through the implementation of various aspects of the NYNJHAT Study. These impacts include direct impact to construction equipment, physical alterations and/or removal of habitat, localized changes in water column depth, bathymetry, hydrodynamics, and sedimentation rates, the temporary and localized impacts from other construction activities (i.e., water disturbance, noise, and vibrations), and short-term changes to water quality conditions typically associated with in-water construction, including the suspension and deposition of sediments in the water column. Sea turtles and marine mammals are discussed as separate resources in this Chapter.

Construction Impact Summary

Aquatic threatened and endangered species are expected to experience short-term temporary impacts from habitat disturbance with construction of NYNJHAT Study measures. Temporary impacts from construction of in-water measures, include displacement of marine fauna associated with noise, vibration, and physical disturbance. Potential direct impacts during construction include physical contact with construction equipment such as vessel strikes, dredge buckets, hydraulic cutter heads, or impacts due to construction activities such as entrainment, exposure to underwater noise, and exposure to water discharges. As noted in NMFS 2017, sturgeon are anticipated to avoid areas of seabed disturbance, particularly during periods of elevated underwater noise and vibration.

During construction, changes in turbidity levels will be localized and temporary. In areas where the sediment is predominately sand, temporary impacts would be minimized as sand settles out of the water column quickly. Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). High Total Suspended Solids (TSS) levels can cause a reduction in Dissolved Oxygen (DO) levels. Sturgeon may become stressed when dissolved oxygen falls below certain levels. Jenkins et al. (1993) observed that younger shortnose sturgeon experienced high levels of mortality at low dissolved oxygen levels while older individuals tolerated those reduced levels for short periods of time. Tolerances may decline if chronic exposure to low dissolved oxygen levels occurs. Johnson (2018) recommends that sturgeon should not be exposed to TSS levels of 1,000 mg/L above ambient for longer than 14 days at a time to avoid behavioral and physiological effects. While the increase in suspended sediments may cause Atlantic sturgeon to alter their normal movements, these minor movements will be too small to be meaningfully measured or detected. TSS is most likely to affect sturgeon if a plume causes a barrier to normal behaviors. However, mobile aquatic threatened and endangered species are anticipated to move from the areas of in-water construction to more suitable habitat.

With implementation of site-specific SWPPP, SPCC and BMPs, suspension of sediments is anticipated to be negligible and would be anticipated to cause short-term temporary impacts to aquatic threatened and endangered species. BMPs including time of year restrictions and protected species observers on dredged, pile driving barges, and other construction platforms can help to mitigate and minimize impacts to ESA species during dredging operations.

Sturgeon are susceptible to impacts through water withdrawals in the form of entrainment in pumps or hydraulic cutter heads. However, early life stage sturgeon such as eggs, larvae, and juveniles are not anticipated to occur in the action area, therefore no impact from water withdrawals is anticipated for early life stages. The Atlantic Sturgeon Status Review Team (ASSRT 2007) reports that dredging activities indirectly impact sturgeon by disrupting spawning migrations, it does not clearly state what the cause and rationale are for this threat. In the case of the Upper and Lower Bays, dredging activities have been ongoing for at least 100 years, and still the Hudson River population of Atlantic sturgeon is considered one of the healthiest populations in the U.S. (ASSRT 2007). Therefore, despite regular dredging activities, Atlantic sturgeon are still finding and utilizing pathways through the NY-NJ Harbor to reach spawning grounds in the Hudson River. This is likely because the waterways available for migration extending from the mouth of the Hudson River to the marine environment are sufficiently deep enough and wide enough to permit Atlantic sturgeon to avoid potential dredging-related disturbances, including active dredges.

Indirect impacts are defined as those impacts that indirectly affect the well-being of a particular species. These impacts include activities that cause the loss of forage species. The primary indirect impact to ESA -listed species from implementation of the NYNJHATS Study is the disturbance of benthic and epibenthic forage communities. Construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or bottom disturbance. Atlantic sturgeon are demersal, or benthic feeders and may therefore experience a change in feeding efficiency for some period during and immediately following construction activities.

Based on previous studies, the re-establishment of benthic communities varies between six months to a year after the project's completion depending on substrate type (USACE 2007a; Wilber and Clarke 2007). Thus, no long-term indirect impacts are expected on benthic communities as a result of construction and the overall area that would be impacted is a small percentage of the habitat that is available and fish species will be able to forage in adjacent areas.

Construction of in-water structures could cause changes to community composition and attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, and other invertebrates. The loss of this benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities. Biofouling of underwater structures could also occur, causing a long-term permanent impact.

Operations and Maintenance Impact Summary

Operation of tide gates or storm surge barriers would present a potential barrier to migration for Atlantic sturgeon from the Atlantic Ocean into the Hudson River or vice versa and may have a Moderate impact to aquatic ESA -listed species. Storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure. This assumption will be updated as the barrier closure details are refined. Under these closure assumptions, it is not anticipated that long-term barriers to migrations that could impact natural sturgeon movements in the estuary;

however temporary impacts are anticipated. Shortnose sturgeon do not typically migrate from their natal rivers and therefore gate closures would not be anticipated to impact their behavior. If a closure occurs while Atlantic sturgeon are trying to move into or from the NYNJ Harbor, those individuals would be anticipated to have adequate habitat for foraging and movement rather than becoming impounded in an inadequate habitat.

Maintenance impacts to ESA -listed species includes similar impacts discussed above during construction including maintenance dredging, construction activities to repair damaged features, and water discharges or withdrawals from project vessels. As noted above, ESA species would be anticipated to move away from maintenance operations in search of more suitable habitat.

Indirect impacts during barrier closure include temporary changes to hydrology and water quality, such as increases in turbidity and sediment suspension. Increased noise and vibration would be temporary and limited to the duration of barrier closure.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Aquatic Threatened and Endangered Species

TSP Aquatic Threatened and Endangered Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	3
O&M Assumptions	1	1	1	2	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*2*	*1*	1	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to aquatic ESA Species (Atlantic sturgeon and shortnose sturgeon) under the TSP range from No to Moderate impact. The Region with the greatest impact to sturgeon species under the TSP is the Jamaica Bay Region, due to construction of the storm surge barrier and tide gates which are in-water measures. Storm surge barriers are planned within the Upper Bay/Arthur Kill Region, however, sturgeon tend to prefer deeper waters and are not anticipated to be common in this Region. Similarly, the Long Island Sound Region also has a storm surge barrier planned under the TSP, however, the barrier is located in a small creek (Flushing Creek) and impacts to Atlantic surgeon and shortnose sturgeon are not expected to be significant because these fish are not anticipated to utilize the creek.

Moderate impacts could occur from vessel strikes to Atlantic sturgeon during the construction of in-water measures, such as storm surge barriers and tide gates. Vessel strikes could also occur during the construction Shore-Based Measures that are constructed along the water, such as elevated promenade and seawalls. Construction noise may impact sturgeon and these fish may display behavior avoidance and displacement in response to high levels of underwater noise. However, these species are expected to avoid active in-water construction zones in search of nearby suitable habitat and return to the area when construction is completed.

Indirect construction impacts include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures in aquatic habitat that may impact the feeding efficiency of sturgeon species for some period during and immediately following construction activities.

With the exception of the levees, which are set back from the shoreline and not expected to significantly impact the aquatic environment, the construction of Shore-Based Measures is expected to have Low impacts to sturgeon in the Project Area, depending on the extent of those measures planned in a particular Region. Most Shore-Based Measures will be constructed along shoreline habitat. Runoff is expected to generate some turbidity which can contribute to low DO levels. Sturgeon are not expected to occupy shoreline habitat and are anticipated to avoid construction zones, or swim through visible plume to seek more appropriate habitat; therefore, low impacts are expected.

Under operations and maintenance assumptions, the impact rating to sturgeon ranges from No to Low impact. Within the Jamaica Bay Region and the Upper Bay/Arthur Kill Region, low impacts are attributed to operations and maintenance of the storm surge barrier measures and Shore-Based Measures such as the elevated promenade and seawalls, which are located along the shoreline. One storm surge barrier is also planned in the Long Island Sound Region, however, operations and maintenance impacts to aquatic special status species are not expected to be significant because sturgeon are not expected to utilize Flushing Creek. Impact producing factors for sturgeon during operations and maintenance are similar to impacts described for construction, such as bottom habitat disturbances during maintenance damage repair, and water discharges or withdrawals from project vessels during repairs. Operations and maintenance impacts are not expected to be significant in the Hackensack/Passaic and Lower Hudson/East River Regions because measures are primarily shore-based and sturgeon are expected to avoid maintenance activities. No impacts are expected from levees, which are set back from the shoreline.

No impacts to aquatic threatened and endangered species are expected in the Lower Bay, Raritan, Mid-Hudson, and Capital District Regions under the TSP because no measures are planned there.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Aquatic Threatened and Endangered Species

ALT 2 Aquatic Threatened and Endangered Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	3	2	1	2	2
O&M Assumptions	1	1	1	1	2	1	1	2	1
Mitigated Rating	*1*	*1*	1	1	3	1	*1*	*2*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to aquatic ESA Species (Atlantic sturgeon and shortnose sturgeon) under Alternative 2 range from No to Moderate impact. The Region with the greatest impact to sturgeon under Alternative 2 is the Lower Bay Region because of construction of the storm surge barrier and tide gates. Construction of storm surge barriers is also planned within the Long Island Sound Region, however, the measures are not as extensive so impacts are expected to be Low. Moderate impacts could occur from vessel strikes to sturgeon during the construction of in-water measures. Construction noise may impact sturgeon, which may display behavior avoidance and displacement in response to high levels of underwater noise. However, these species are expected to avoid active in-water construction zones in search of nearby suitable habitat and return to the area when construction is completed.

Indirect construction impacts include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures in aquatic habitat that may impact the feeding efficiency of sturgeon species for some period during and immediately following construction activities.

Under operations and maintenance, the impact rating to sturgeon ranges from No to Low impact. Within the Long Island Sound Region and the Lower Bay Region, low impacts are attributed to operations and maintenance of the storm surge barrier measures in each Region. Impact producing factors for sturgeon during operations and maintenance are similar to impacts described for construction, such as bottom habitat disturbances during maintenance damage repair, and water discharges or withdrawals from project vessels during repairs. Operations and maintenance impacts are not expected to be significant in Jamaica Bay because measures are primarily shore-based and located on the seaward side of the barrier beach, where sturgeon otherwise have sufficient habitat. Operations and maintenance impacts are not expected to be significant in the Hackensack/Passaic, Upper Bay/Arthur Kill, and Lower Hudson/East River Regions because measures are primarily shore-based and only account for small areas of each Region. No impacts are expected from levees, which are set back from the shoreline.

No impacts to sturgeon are expected in the Raritan Region because the Shore-Based Measures are not located near the shoreline. No impacts to aquatic threatened and endangered species are expected in the Mid-Hudson and Capital District Regions under Alternative 2 because no measures are planned there.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Aquatic Threatened and Endangered Species

ALT 3A Aquatic Threatened and Endangered Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	2	2	2	3	3
O&M Assumptions	1	1	1	2	1	1	1	2	2
Mitigated Rating	*1*	*1*	1	*2*	*1*	*1*	*1*	*2*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to aquatic ESA Species (Atlantic sturgeon and shortnose sturgeon) under Alternative 3A range from No to Moderate impact. The Regions with the greatest impact to sturgeon under Alternative 3A are Jamaica Bay, the Long Island Sound, and the Upper Bay/Arthur Kill because of construction of the storm surge barrier and tide gates. Construction of storm surge barriers is also planned within the Raritan and Lower Bay, however, the measures are not as extensive and sturgeon are not anticipated to frequent those locations, so impacts are expected to be Low. Moderate impacts could occur from vessel strikes to sturgeon during the construction of in-water measures. Construction noise may impact sturgeon, which may display behavior avoidance and displacement in response to high levels of underwater noise. However, these species are expected to avoid active in-water construction zones in search of nearby suitable habitat and return to the area when construction is completed.

Indirect construction impacts include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures in aquatic habitat that may impact the feeding efficiency of sturgeon species for some period during and immediately following construction activities.

Under operations and maintenance, the impact rating to sturgeon ranges from No to Low impact. Within the Long Island Sound Region, Jamaica Bay, and the Lower Bay Region, low impacts are attributed to operations and maintenance of the storm surge barrier measures in each Region. Impact producing factors for sturgeon during operations and maintenance are similar to impacts described for construction, such as bottom habitat disturbances during maintenance damage repair, and water discharges or withdrawals from project vessels during repairs. Operations and maintenance impacts are not expected to be significant in the Lower Bay and Raritan because sturgeon are not anticipated to common in those areas. Operations and maintenance impacts are not expected to be significant in the Hackensack/Passaic and the Lower Hudson/East River Regions because measures are primarily shore-based and only account for small areas of each Region. No impacts are expected from levees, which are set back from the shoreline.

No impacts to sturgeon species are expected in the Mid-Hudson and Capital District Regions under Alternative 3A because no measures are planned there.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Aquatic Threatened and Endangered Species.

ALT 4 Aquatic Threatened and Endangered Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	3
O&M Assumptions	1	1	1	1	1	1	1	1	2
Mitigated Rating	*1*	*1*	1	1	*1*	1	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to aquatic ESA Species (Atlantic sturgeon and shortnose sturgeon) under Alternative 4 range from No to Moderate impact. The Region with the greatest impact to sturgeon under Alternative 4 is Jamaica Bay because of construction of the storm surge barrier and tide gates. The construction of storm surge barriers is also planned within the Hackensack/Passaic Region, however, sturgeon are not anticipated to be common when compared to the inlet of Jamaica Bay, due to habitat preferences. Sturgeon prefer mid-depth and deep water, therefore, impacts are expected to be Low. Similarly, the storm surge barrier in the Long Island Sound Region is located within a small creek where sturgeon are not expected to occur, so no impacts are expected. Moderate impacts to sturgeon could occur from vessel strikes during the construction of in-water measures. Construction noise may impact sturgeon, which may display behavior avoidance and displacement in response to high levels of underwater noise. However, these species are expected to avoid active in-water construction zones in search of nearby suitable habitat and return to the area when construction is completed.

Indirect construction impacts include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures in aquatic habitat that may impact the feeding efficiency of sturgeon species for some period during and immediately following construction activities.

Under operations and maintenance, the impact rating to sturgeon ranges from No to Low impact. Within the Jamaica Bay Region, low impacts are attributed to operations and maintenance of the storm surge barrier measures. Impact producing factors for sturgeon during operations and maintenance are similar to impacts described for construction, such as bottom habitat disturbances during maintenance damage repair, and water discharges or withdrawals from project vessels during repairs. Operations and maintenance impacts are not expected to be significant in the Hackensack/Passaic and Long Island Sound because sturgeon are not anticipated to be common where measures are planned in each Region. Within the Upper/Bay Arthur Kill and Lower Hudson/East River, the measures are primarily shore-based and not expected to impact sturgeon habitat. Sturgeon are expected to avoid maintenance activities in search of other suitable habitat.

No impacts to aquatic threatened and endangered species are expected in the Lower Bay, Raritan, Mid-Hudson and Capital District Regions under Alternative 4 because no measures are planned there.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Aquatic Threatened and Endangered Species.

ALT 5 Aquatic Threatened and Endangered Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	1	1	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to aquatic ESA Species (Atlantic sturgeon and shortnose sturgeon) under Alternative 5 range from No to Low impact. The Region with the greatest impact to sturgeon under Alternative 5 is the Lower Hudson/East River because of construction of Shore-Based Measures such as the elevated promenade and floodwalls which are located near shoreline habitat. Vessel traffic, noise and vibration and runoff could potentially impact sturgeon during construction; however, the probability is low. Construction noise may impact sturgeon, which may display behavior avoidance and displacement in response to high levels of underwater noise. However, these species are expected to avoid active in-water construction zones in search of nearby suitable habitat and return to the area when construction is completed. Levee construction within the Upper Bay/Arthur and Hackensack/Passaic is not anticipated to impact sturgeon because levees are located away from the shoreline.

Indirect construction impacts include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures in aquatic habitat that may impact the feeding efficiency of sturgeon species for some period during and immediately following construction activities.

Under operations and maintenance, no impacts are expected to sturgeon. All measures under Alternative 5 are shore-based and not anticipated to impact sturgeon habitat during operations and maintenance.

No impacts to aquatic threatened and endangered species are expected in the remaining Planning Regions because no measures are planned there.

Migratory Bird Treaty Act Species and the Bald and Golden Eagle Protection Act Species

Impacts to migratory birds are anticipated during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors to migratory birds: physical seabed disturbance, air emissions, habitat conversion, noise, visible structures, and land use changes.

Construction Impact Summary

Short-term impacts to migratory birds from habitat disturbance are anticipated during construction. Activity, lighting, and noise during construction of the Shore-Based Measures can temporarily affect migratory birds. Construction noise can hinder migratory birds' ability to call and communicate. Beach-nesting, shore birds and gulls can be displaced near tidal flats and beach areas during construction activities. Construction activities would take place outside of breeding seasons and any beach-nesting birds present are anticipated to use adjacent suitable habitat outside of the construction area. Minor, short-term direct impacts on migratory birds from potential tree clearing and vegetation removal during construction site preparation activities could occur.

Dredging, sand nourishment, excavation, and fill activities may temporarily cause indirect impacts to benthic feeding areas for migratory birds. Turbidity from dredging activities and sediment placement in the water column can decrease foraging rates and cause birds to relocate to adjacent habitats (Greene 2002). As such, migratory birds that rely on benthic areas for feeding are anticipated to utilize suitable adjacent habitat until construction is complete. Turbidity impacts would be localized and expected to cease once dredging and construction is complete. Colonial nesting sites and certain raptor nesting sites may be temporarily impacted during construction activities due to construction noise, vibration, and physical disturbances. Migratory bird species are anticipated to vacate the areas of project activities and utilize adjacent suitable habitat until construction operations are complete.

Permanent direct impacts to migratory birds from habitat alteration would occur where measure foundations are installed, converting upland, beach, or dune habitats to hard structured habitat. Migratory birds are anticipated to vacate the area of construction activities to suitable available habitat adjacent to the project sites. Long-term benefits to migratory shorebirds from habitat creation, particularly for the buried seawall/dune measure, include an expanded shoreline for foraging, nesting, and roosting and a coastal habitat buffer from future large storm events.

No impacts to migratory bird species are anticipated for storm surge barrier and tide gate measures, as these will be constructed offshore and not cause impacts to migratory birds or their habitat. The deployable flood barriers, levees, seawalls, floodwalls, floodwall with parks, wetland restoration, and stone toe-protection and rock sill structure measures will have a Low impact rating on migratory birds overall. The seawalls and buried seawall/dune measures are anticipated to have a Moderate impact on migratory birds, overall. As the measures become more defined, site-specific impacts to migratory birds may be evaluated during the Tier 2 EIS (s).

Operations and Maintenance Impact Summary

During operation of storm surge barriers and tide gate closures, no direct impacts to migratory birds are anticipated, as these measures are located offshore. Beneficial indirect impacts could occur through management of risk from flooding and subsequent erosion during large storm events of coastal and terrestrial habitats during barrier closure utilized by migratory birds. Temporary impacts to migratory birds are anticipated during potential maintenance of Shore-Based Measures due to the noise and presence of equipment. These impacts would be minor, short-term, and localized as migratory birds would be able to move to suitable adjacent habitat for the duration of maintenance activities.

Beneficial long-term impacts to migratory birds would be anticipated from wetland restoration mitigation that would provide more nesting and foraging habitat opportunities. Further, Shore-Based Measures such as buried seawall/dunes could potentially provide suitable nesting and foraging habitat that is at a managed risk from large storm events.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to MBTA and Bald and Golden Eagle Protection Act species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species

TSP Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species under the TSP range from No Impact to Moderate impact, with the Jamaica Bay Region expected to have the highest impacts. The Jamaica Bay Region is the only Planning Region that contains the composite seawall/dune measures included in the TSP. Moderate direct impacts could occur to the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species, as their habitats and nests could occur in the vicinity of the proposed composite seawall/dune measures. Construction activities would take place outside of breeding seasons and any beach-nesting birds present are anticipated to use adjacent suitable habitat outside of the construction area. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species are expected to be Low. Impacts producing factors include habitat disturbance and noise during construction, however, road raisings would be limited to existing road structures so habitat disturbance is expected to be minor.

Construction of seawalls and other Shore-Based Measures could have a Low impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species due to disturbance during construction that can temporarily affect migratory birds. Planning regions where Low impacts are expected are in Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Long Island Sound.

Construction of the storm surge barriers are expected to have No impact on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species.

Operations and maintenance impacts associated with the TSP are expected to range from No Impact to Low impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in the Study Area in Regions where Shore-Based Measures are proposed. No impacts are expected to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species after implementation of avoidance, minimization, and mitigation measures.

The TSP will also provide a benefit to these species, by reduc the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species

ALT 2 Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	3	2	2	3	3
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species under Alternative 2 range from No Impact to Moderate impact, with the Jamaica Bay, Lower Bay and Long Island Sound Regions expected to have the highest impacts. The Jamaica Bay and Lower Bay Regions contain composite seawall/dune measures included in Alternative 2. Moderate direct impacts could occur to the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species, as their habitats and nests could occur in the vicinity of the proposed composite seawall/dune measures. Construction activities would take place outside of breeding seasons and any beach-nesting birds present are anticipated to use adjacent suitable habitat outside of the construction area. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species are expected to be Low. Impacts producing factors include habitat disturbance and noise during construction, however, road raisings would be limited to existing road structure so habitat disturbance is expected to be minor.

Construction of seawalls in the Long Island Sound Region would also have a Moderate impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species. The extent of these structures is greatest in this Region under Alternative 2. Additionally, the existing landscape where the seawalls are planned is less urbanized than in other Regions, requiring a greater extent of conversion of vegetated areas to impervious surfaces or hard structure, at least temporarily.

Construction of the remaining Shore-Based Measures is expected to have a Low impact on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Raritan Regions.

Construction of the storm surge barriers are expected to have No impact on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species.

Operations and maintenance impacts associated with Alternative 2 are expected to range from No Impact to Low impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in the Study Area in Regions where Shore-Based Measures are proposed. No impacts are expected after implementation of avoidance, minimization, and mitigation measures.

Alternative 2 will also provide a benefit to these species, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species

ALT 3A Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	2	3	3
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species under Alternative 3A range from No to Moderate impact, with the Jamaica Bay and Lower Bay and Long Island Sound Regions expected to have the highest impacts. The Jamaica Bay and Lower Bay Regions contain composite seawall/dune measures, Moderate direct impacts could occur to the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species, as their habitats and nests could occur in the vicinity of the proposed composite seawall/dune measures. Construction activities would take place outside of breeding seasons and any beach-nesting birds present are anticipated to use adjacent suitable habitat outside of the construction area. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species are expected to be Low. Impacts producing factors include habitat disturbance and noise during construction, however, road raisings would be limited to existing road structure so habitat disturbance is expected to be minor.

Construction of seawalls in the Long Island Sound Region would also have a Moderate impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species. The extent of these structures is greatest in this Region under Alternative 2. Additionally, the existing landscape where the seawalls are planned is less urbanized than in other Regions, requiring a greater extent of conversion of vegetated areas to impervious surfaces or hard structure, at least temporarily.

Construction of the remaining Shore-Based Measures is expected to have a Low impact on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, and Raritan Regions.

Construction of the storm surge barriers are expected to have No impact on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species.

Operations and maintenance impacts associated with Alternative 3A are expected to range from No Impact to Low impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in the Study Area in Regions where Shore-Based Measures are proposed. No impacts are expected after implementation of avoidance, minimization, and mitigation measures.

Alternative 3A will also provide a benefit to these species, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species

ALT 4 Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species under Alternative 4 range from No to Moderate impact, with the Jamaica Regions expected to have the highest impact. The Jamaica Bay Region is the only Planning Region that contains the composite seawall/dune measures included in Alternative 4. Moderate direct impacts could occur to the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species, as their habitats and nests could occur in the vicinity of the proposed composite seawall/dune measures. Construction activities would take place outside of breeding seasons and any beach-nesting birds present are anticipated to use adjacent suitable habitat outside of the construction area.

Road raising is also planned along Broad Channel in Jamaica Bay and impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species are expected to be Low. Impacts producing factors include habitat disturbance and noise during construction, however, road raisings would be limited to existing road structure so habitat disturbance is expected to be minor.

Construction of seawalls and other Shore-Based Measures in the Long Island Sound Region would also have a Low impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species, as the extent of these structures is less than in other Alternative plans. Construction of the remaining Shore-Based Measures is expected to have a Low impact on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Regions under Alternative 4.

Construction of the storm surge barriers are expected to have No impact on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species.

Operations and maintenance impacts associated with Alternative 4 are expected to range from No Impact to Low impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in the Study Area in Regions where Shore-Based Measures are proposed. No impacts are expected after implementation of avoidance, minimization, and mitigation measures.

Alternative 4 will also provide a benefit to these species, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under Alternative 4.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species

ALT 5 Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	2	2	1	2	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species under Alternative 5 range from No to Low impact. Only Shore-Based Measures are included Alternative 5. The construction of these measures included in are anticipated to have Low impacts Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in the Lower Hudson/East River, Upper Bay/Arthur Kill and Hackensack/Passaic Planning Regions. Floodwalls and levees are most common shore-based features in Alternative 5.

Operations and maintenance impacts associated with Alternative 5 are expected to range from No Impact to Low impact to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species in the Study Area in Regions where Shore-Based Measures are proposed. No impacts are expected after implementation of avoidance, minimization, and mitigation measures.

Alternative 5 will also provide a benefit to these species, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act species are expected in the Capital District, Mid-Hudson, Lower Bay, Raritan, Long Island and Jamaica Bay Planning Regions because no structures are proposed there under Alternative 5.

Marine Mammal Protection Act Species

Impacts to marine mammals are anticipated to occur in the Study Area during construction, and operations and maintenance activities, depending on the measure and existing conditions; particularly for in-water measures. No impacts to marine mammals are anticipated from construction of the Shore-Based Measures. In-water construction activity impact-producing factors include: vessel strikes, physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and noise.

Construction Impact Summary

Direct temporary in-water impacts include noise exposure (permanent or temporary threshold shifts) from construction vessels and acoustic disturbances. Sound plays a critical role in the life of most marine mammals, and the impacts of noise are of increasing concern. Marine mammals exposed to high noise levels risk tissue damage, loss of hearing sensitivity, and are likely to engage in avoidance behavior to avoid continued exposure to the noise. Potential direct permanent impacts due to hearing loss could occur during construction activities. Variables that affect the amount of hearing loss include the level, duration, spectral content, and temporal pattern of exposure to an acoustic stimulus, as well as differences in the sensitivity of individuals and species. Several studies have found that high-intensity exposure from pile driving can cause direct physical injury to marine mammals in the form of permanent or temporary threshold shifts (Clark et al. 2009, Jensen et al. 2009, Nowacek et al. 2007). Dolphins and marine mammals rely on sound for communication, navigation, predator avoidance, and foraging, using both active echolocation and passive listening for detection of prey (Allen et al. 2001, Nowacek et al. 2007, Tyack 2008).

Noise reduction measures would be necessary where noise levels exceed desired thresholds. Once the project measures become more defined, sound propagation modeling for anticipated construction activities may be conducted as required for permitting and/or the Tier 2 EIS (s).

Marine mammals display behavior avoidance and displacement in response to high levels of underwater noise. This avoidance behavior or flight responses into deeper waters from acoustic disturbances can cause barotrauma to marine mammals. Due to increased underwater noise levels, marine mammals may be spatially displaced and move away from the construction area. Cetaceans are most likely to avoid the sound field produced by construction equipment use. Several investigations have demonstrated that harbor porpoises avoided the sound field produced by pile-driving during the construction phases of off-shore wind farms off Denmark (Teilmann et al. 2006; Tougaard et al. 2003a, b, 2005, 2009), Germany (Dähne et al. 2014), the Netherlands (Scheidat et al. 2011), Scotland (Bailey et al. 2010a), and the United Kingdom (Vallejo et al. 2017). In the majority of these cases, harbor porpoises occurred in the area surrounding the area of construction noise and returned to the area after pile-driving activities stopped (Vallejo et al. 2017). Behavioral disruption of harbor porpoise has been measured out to distances of at least 12.4 mi (20 km) from the piling site (Tougaard et al. 2009, Brandt et al. 2011, Dähne et al. 2013, Haelters et al. 2015), although Vallejo et al. (2017) reported that they remained less than 11.2 miles (18 km) from pile driving operations off the United Kingdom.

Limited information is available about dolphins' behavioral avoidance/displacement during in-water construction. Bailey et al. (2010b) argued that the pile-driving noise they studied would be audible to bottlenose dolphins up to 24.9 miles (40 km) from the source, although they did not discuss the probable responses of these dolphins to the sound at these distances. Behavioral monitoring during Navy recapitalization projects reported no reactions attributed to pile-driving noise (NMFS 2019). Protected species observers detected fewer surfacing bottlenose dolphins during piling activities that were part of a wharf renewal project in Fremantle Harbour (Western Australia) (Paiva et al. 2015). The authors were unable to determine whether decreased detections were due to decreased use of that habitat or in response to the piling. Graham et al. (2017) remarked on a lack of strong behavioral response by bottlenose dolphins to vibratory and impact pile-driving to harbor construction works in northeast Scotland. Overall abundance during piling was similar to baseline, though there was a small spatial and temporal scale disturbance to bottlenose dolphins as a result of impact piling activities. Repeated sightings of recognizable bottlenose dolphins confirmed that some individuals continued to use the impacted area throughout the construction period. While there is the potential for disturbance and displacement to affect individual behavior, bottlenose dolphins are well-known for their adaptability and ability to tolerate certain levels of disturbance (Shane et al. 1986).

Watkins (1986) reviewed observations of the behavioral responses of 122 minke whales (*Balaenoptera acutorostrata*), 2,259 fin whales (*Balaenoptera physalus*), 833 right whales (*Eubalaena glacialis*), and 603 humpback whales (*Megaptera novaeangliae*) to various sources of human disturbance, and concluded that fin, humpback, minke, and North Atlantic right whales ignored sounds that occurred at relatively low received levels, sounds whose energy was concentrated at frequencies below or above their hearing capacities, or were distant from them, even when those sounds had considerable energies at frequencies well within the whales' range of hearing. He argued that most negative reactions occurred within 328 feet (100 m) of a sound source or when sudden increases in received sound levels were judged to be in excess of 12 dB, relative to previous ambient sounds. Further, when subjected to playbacks of seismic survey noise, humpback whale behavioral responses included frequent alterations of course, with changes in the duration of their dives and the speed of their migrations (Cato et al. 2019). Based on these observations, Kraus et al. (2019) concluded that there is reason to believe that displacement of large whales away from the pile driving source sounds is likely.

Based on the data available, whales, dolphins, and porpoises that are near construction operations when they begin are likely to actively avoid or evade additional exposure. Marine mammals are anticipated to practice avoidance behavior in areas of construction activity and loud underwater sound fields. Avoidance behavior is expected to be a direct temporary impact and marine mammals are anticipated to return to the area once construction operations are complete.

Increased vessel traffic during construction may increase the risk of collisions with marine mammals. Cetaceans and pinnipeds are vulnerable to vessel strikes, which have caused injury and stranding of pinnipeds in the U.S. (Waring et al. 2006). The likelihood of a seal or other marine mammal being struck by a vessel will depend on vessel speed and the ability of individuals to avoid vessel collision. Because of the slower speeds of project installation vessels and tugboats that will likely be used during construction, direct minor impacts to no impacts to marine mammals are anticipated.

Indirect impacts from construction include temporary changes in the distribution, abundance, and availability of prey species. Harbor seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) target both benthic and epibenthic prey, and construction activities causing seabed disturbance that kills or displaces these species may prevent seals from accessing potential prey. Prey species impacts are anticipated to be short-term, localized, and are anticipated to return to the area following construction completion.

Operations and Maintenance Impact Summary

Low impacts to marine mammals are anticipated during operation of the storm surge barrier and tide gate closures. When the tide gates and storm surge barriers are in the open position, no impacts would occur to marine mammals. During storm surge barrier closure due to a large storm event, marine mammal movements may be hindered, and could potentially cause injury or mortality from direct strikes from structures. Additional impacts to marine mammals may occur if they were trapped during closure and experienced poor water quality. Further, impacts from noise disturbances and separation of social groups may occur. However, these impacts are anticipated to be temporary.

Indirect impacts on the distribution and abundance of prey items and the disruption of foraging could occur during closure of storm surge barriers.

One potential benefit to the storm surge barriers and tide gates is that the foundation and structure installations can produce the artificial "reef effect," attracting numerous species of shellfish and finfish that marine mammals prey upon. The disruption of prey items could be offset by the introduction of new, hard-bottom substrate that will support reef communities and either attract or have no effect on marine mammals.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Marine Mammal Protection Act Species.

TSP Marine Mammal Protection Act Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2+	1	1	1	*2*	3+
O&M Assumptions	1	1	1	1	1	1	1	1	*2*
Mitigated Rating	*1*	*1*	1	2	*1*	*1*	*1*	1	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

The Region with the greatest impact to MMPA Species under the TSP is Jamaica Bay. This Region is expected to be impacted the most because of the construction of the storm surge barrier and tide gates, which are in-water measures that produce physical seabed/land disturbance, sediment suspension, habitat conversion, and noise. Seals are expected to be impacted the most, since these MMPA Species are more common in the Jamaica Bay Region. Storm surge barriers are also planned within the Upper Bay/Arthur Kill Region, however, MMPA Species are not expected to be common within the Region; therefore, impacts are expected to be Low. Similarly, within the Long Island Sound Region, one storm surge barrier is planned to be constructed but the barrier is located at the mouth of a small tributary (Flushing Creek) where MMPA Species are not expected to be present. Low impacts are expected to MMPA Species from construction of the dunes along the beach in the Jamaica Bay Region.

Seals target both benthic and epibenthic prey, and construction activities causing seabed disturbance may displace or kill forage species, or prevent seals from accessing prey. Indirect impacts from construction include temporary changes in the distribution, abundance, and availability of prey species. The availability of prey may be impacted within and surrounding active construction areas, however, seals are expected to seek other foraging habitat. Low to Moderate impacts are expected, depending on the extent of the construction. The proposed dune measure in Jamaica Bay may impact seals that utilize the beach in the Region. Impacts are expected to be Low because individuals are anticipated to seek other nearby habitat until construction is complete. Cetaceans are most likely to avoid the sound field produced by construction equipment use and return to the area when construction is completed. Whales, dolphins, and porpoises primarily occur offshore and outside the Study Area, so impacts to these animals are not expected.

During operations and maintenance of the storm surge barrier, similar impact producing factors are anticipated as with construction, including habitat disturbance and noise. In contrast to construction, maintenance activities will not be as widespread, so Low impacts are expected. Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, low impacts are expected to MMPA species movements in relation to the barriers. Storm surge barriers are planned in the Upper Bay/Arthur Kill and Long Island Sound, however, MMPA species are not expected to be common where the barriers are located; therefore, no significant impacts are anticipated.

The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates which is a benefit for marine mammals. The direct loss of soft substrate benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities.

No impact to MMPA Species is expected in the remaining Planning Regions because either no construction is planned there under the TSP (Raritan, Lower Bay, Mid-Hudson, and Capital District), or the measures planned are shore-based and not anticipated to impact marine mammal habitat (Lower Hudson/East River, Lower Bay, and Hackensack/Passaic). Furthermore, MMPA Species are not expected to occur within the Capital District Region.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Marine Mammal Protection Act Species.

ALT 2 Marine Mammal Protection Act Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	3+	1	1	2+	2
O&M Assumptions	1	1	1	1	2	1	1	2	1
Mitigated Rating	*1*	*1*	*1*	1	3	*1*	*1*	2	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Under Alternative 2, the Region where MMPA Species are expected to be impacted the most is the Lower Bay. The Lower Bay is anticipated to have Moderate impacts on MMPA species because of construction of the storm surge barriers and tide gates. Impact producing factors include physical seabed/land disturbance, sediment suspension, habitat conversion, and noise. Seals are expected to be impacted the most, since these MMPA Species are more common in the Jamaica Bay Region. Low impacts are expected in the Jamaica Bay Region because although no in-water measures are planned, the Jamaica Bay inlet borders the Lower Bay Region where a substantial storm surge barrier is located. Construction of the barrier is expected to have some impact on MMPA Species that might utilize Jamaica Bay. In the Long Island Sound, the storm surge barrier is expected to have a Low impact on MMPA Species because fewer marine mammals are anticipated to utilize the area when compared to the Lower Bay Region. No impact to MMPA species is expected from construction and operations and maintenance of any Shore-Based Measures proposed in the Planning Region.

Seals target both benthic and epibenthic prey, and construction activities causing seabed disturbance may displace or kill forage species, or prevent seals from accessing prey. Indirect impacts from construction include temporary changes in the distribution, abundance, and availability of prey species. The availability of prey may be impacted within and surrounding active construction areas, however, seals are expected to seek other foraging habitat. Low to Moderate impacts are expected, depending on the extent of the construction. The proposed dune measure in Jamaica Bay may impact seals that utilize the beach in the Region. Impacts are expected to be Low because individuals are anticipated to seek other nearby habitat until construction is complete. Cetaceans are most likely to avoid the sound field produced by construction equipment use and return to the area when construction is completed. Whales, dolphins, and porpoises primarily occur offshore and outside the Study Area, so impacts to these animals are not expected.

During operations and maintenance of the storm surge barriers, similar impact producing factors are anticipated as with construction, including habitat disturbance, noise, sediment suspense, discharge/release and withdrawals. In contrast to construction, maintenance activities will not be as widespread, so Low impacts are expected. Under the closure assumption utilized in this Draft Integrated FR/Tier 1 EIS, low impacts are expected to MMPA species movements in relation to the barriers. Storm surge barriers are planned in the Upper Bay/Arthur Kill and Long Island Sound, however, MMPA species are not expected to be common where the barriers are located; therefore, significant impacts are not anticipated.

The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, and other invertebrates which is a benefit for marine mammals. The direct loss of soft substrate benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities.

No impact to MMPA species is expected in the other Planning Regions because either no in-water measures are planned (Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Raritan, Mid-Hudson), or marine mammals are not expected to occur (Capital District).

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Marine Mammal Protection Act Species.

ALT 3A Marine Mammal Protection Act Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2+	2+	1	2+	2+	3+
O&M Assumptions	1	1	1	2	1	1	*1*	2	2
Mitigated Rating	*1*	*1*	*1*	2	2	*1*	2	2	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

The Planning Region with the greatest impact to MMPA species under Alternative 3A is the Jamaica Bay Region. Jamaica Bay is expected to be impacted the most because of construction of the storm surge barrier and tide gates, which are in-water measures with a Moderate impact rating to the Region. Impact producing factors include physical seabed/land disturbance, sediment suspension, habitat conversion, and noise. Seals are expected to be impacted the most, since these MMPA Species are more common in the Jamaica Bay Region. The Raritan, Upper Bay/Arthur Kill, and Long Island Sound also have storm surge barriers planned under Alternative 3A, however, marine mammal presence is not anticipated to be common in these Regions. Within the Lower Bay, one storm surge barrier is planned in Sandy Hook, however, the barrier occupies a small area, so impacts are expected to be Low.

Seals target both benthic and epibenthic prey, and construction activities causing seabed disturbance may displace or kill forage species, or prevent seals from accessing prey. Indirect impacts from construction include temporary changes in the distribution, abundance, and availability of prey species. The availability of prey may be impacted within and surrounding active construction areas, however, seals are expected to seek other foraging habitat. Low to Moderate impacts are expected, depending on the extent of the construction. The proposed dune measure in Jamaica Bay may impact seals that utilize the beach in the Region. Impacts are expected to be Low because individuals are anticipated to seek other nearby habitat until construction is complete. Cetaceans are most likely to avoid the sound field produced by construction equipment use and return to the area when construction is completed. Whales, dolphins, and porpoises primarily occur offshore and outside the Study Area, so impacts to these animals are not expected.

During operations and maintenance of the storm surge barriers, similar impact producing factors are anticipated as with construction, including habitat disturbance, noise, sediment suspense, discharge/release and withdrawals. In contrast to construction, maintenance activities will not be widespread and ongoing, so Low impacts are expected. Under the closure assumption utilized in this Draft Integrated FR/Tier 1 EIS impacts to the movements of MMPA species are generally expected to be Low. Storm surge barriers are planned in the Raritan and Lower Bay, however, MMPA species are not expected to be common in the Raritan and the barrier occupies a small area in the Lower Bay; therefore, significant impacts are not anticipated.

The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, and other invertebrates which is a benefit for marine mammals. The direct loss of soft substrate benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities.

No impact to MMPA species is anticipated in the Lower Hudson/East River and Hackensack/Passaic because no in-water measures are planned there. No measures are planned in the Mid-Hudson and Capital District.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Marine Mammal Protection Act Species

ALT 4 Marine Mammal Protection Act Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	1	1	1	1	2+	3+
O&M Assumptions	1	1	1	1	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Alternative 4 is anticipated to have Moderate impacts to MMPA species in the Jamaica Bay Region due to construction of the storm surge barrier and tide gates, which are in-water measures. Impact producing factors include physical seabed/land disturbance, sediment suspension, habitat conversion, and noise. Seals are expected to be impacted the most, since these MMPA species are more common in the Jamaica Bay Region. Storm surge barriers are also planned in the Hackensack/Passaic and Long Island Sound Regions: impacts are expected to be Low in the Long Island Sound because MMPA species are not expected to be common in the area. No impacts are expected in the Hackensack/Passaic because the barriers are located upriver where MMPA species are not anticipated to occur.

Seals target both benthic and epibenthic prey, and construction activities causing seabed disturbance may displace or kill forage species, or prevent seals from accessing prey. Indirect impacts from construction include temporary changes in the distribution, abundance, and availability of prey species. The availability of prey may be impacted within and surrounding active construction areas, however, seals are expected to seek other foraging habitat. Low impacts are expected, depending on the extent of the construction. The proposed dune measure in Jamaica Bay may impact seals that utilize the beach in the Region. Impacts are expected to be Low because individuals are anticipated to seek other nearby habitat until construction is complete. Cetaceans are most likely to avoid the sound field produced by construction equipment use and return to the area when construction is completed. Whales, dolphins, and porpoises primarily occur offshore and outside the Study Area, so impacts to these animals are not expected.

During operations and maintenance of the storm surge barriers, similar impact producing factors are anticipated as with construction, including habitat disturbance, noise, sediment suspense, discharge/release and withdrawals. In contrast to construction, maintenance activities will not be widespread and ongoing, so Low impacts are expected. Under the closure assumption utilized in this Draft Integrated FR/Tier 1 EIS, impacts to the movement of MMPA Species are generally expected to be Low. Storm surge barriers are planned in the Hackensack/Passaic and Long Island Sound; however, impacts are not expected to be significant because the barriers are located upriver (Hackensack/Passaic) or within a small creek (Long Island Sound) where MMPA Species are not anticipated to be common.

The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates which is a benefit for marine mammals. The direct loss of soft substrate benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities.

No impact to MMPA Species is expected in the other Planning Regions because either the measures are shore-based (Lower Hudson/East River and the Upper Bay/Arthur Kill), or no construction is planned within the Region (Lower Bay, Raritan, Mid-Hudson, and Capital District). Furthermore, MMPA Species are not expected to occur within the Capital District Region.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Marine Mammal Protection Act Species.

ALT 5 Marine Mammal Protection Act Species Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1

O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Under Alternative 5, no impact to MMPA species would occur because either the measures planned are shore-based (Upper Bay/Arthur Kill, Lower Hudson/East River, and Hackensack/Passaic) or no measures are proposed (Raritan, Lower Bay, Jamaica Bay, Long Island Sound, Mid-Hudson, and Capital District).

Sea Turtles

Sea turtle nesting has been documented on the Rockaway Peninsula in 2018, however this is a rare occurrence and sea turtle nesting normally occurs in the southern states (NYSDEC 2005); therefore, impacts are limited to in-water activities. During in-water construction, impact producing factors include: physical seabed disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and noise and vibration.

Construction Impact Summary

No impacts to sea turtles are anticipated from construction of the Shore-Based Measures as there is no in-water work associated with them. Potential impacts would be anticipated for in-water measures including the storm surge barriers and tide gate measures. Direct temporary in-water impacts include noise and vibration exposure (permanent or temporary threshold shifts) from construction vessels and acoustic disturbances. Data on sea turtle hearing is limited. Lenhardt et al. (1996) used a behavioral "acoustic startle response" to measure the underwater hearing sensitivity of one juvenile Kemp's ridley and one juvenile loggerhead turtle to a 430 Hertz (Hz) tone. They concluded that the underwater hearing of both sea turtles was about 10 decibels (dB) less sensitive than their in-air hearing. More recently, Bartol et al. (1999) measured the auditory evoked potentials of 35 juvenile animals and concluded that their effective hearing range is 250-750 Hz with most sensitive hearing at 250 Hz. Although these data are based on a small number of individuals and, therefore, may not be representative of all sea turtle species and life stages, they suggest that sea turtles are likely to hear sounds produced by construction activities. Underwater detonations are known to kill or injure sea turtles (Klima et al. 1988; Gitschlag and Herczeg 1994; Viada et al. 2008); however, those impacts appear to result primarily from barotrauma associated with shock waves produced by underwater detonations. Underwater detonations are not proposed for this project and no impacts due to barotrauma are anticipated.

Noise reduction measures would be necessary where noise levels exceed desired thresholds. Once the project measures become more defined, sound propagation modeling for anticipated construction activities may be conducted as required for permitting and/or the Tier 2 EIS. Site-specific impacts as a result of construction underwater noise may be further evaluated during the Tier 2 EIS.

Sea turtles may display behavior avoidance and displacement in response to high levels of underwater noise and vibration. Due to increased underwater noise and vibration levels, sea turtles may be spatially displaced and move away from the construction area. Sea turtles are anticipated to return to the area following construction completion.

Data on the response of sea turtles to vessel noise and disturbance is very limited. Hazel et al. (2007) reported that sea turtles reacted to approaching vessels in several ways. Turtles lying on the seabed launched upwards at a shallow angle and began swimming when vessels approached. The majority of the turtles swam away from the vessel while some swam along the vessel's track. Others crossed in front of the vessel's track before swimming away. Sea turtle reaction time was greatly dependent on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels. All of these responses were short-term responses that did not seem to have adverse long-term consequences for the individual sea turtles.

Although sea turtles have been observed to avoid surface vessels, Hazel et al. (2007) argued that it was the vessel's movement, not the vessel's noise, which caused the avoidance behavior. Therefore, surface vessel noise is expected to cause minimal behavioral avoidance and displacement to sea turtles. If a sea turtle detects a surface vessel and avoids it, or has a temporary stress response from the noise disturbance, these responses are expected to be temporary and short-term while the vessel passes through the construction area.

Increased vessel traffic during construction may increase the risk of collisions with marine sea turtles. Sea turtles spend at least 20 to 30 percent of their time at the ocean surface (Lutcavage *et al*. 1997) during which they would be vulnerable to being struck by vessels or struck by vessel propellers. Sea turtles are able to avoid collisions with slow-moving (<5 knots) vessels. The most informative study of the relationship between ship speed and collision risk was conducted on green sea turtles (Hazel et al. 2007). In that study green turtles avoided approaching vessels at distances of 39 feet (12 m); the proportion of turtles that avoided those vessels decreased as vessel speeds increased. Turtles fled frequently in encounters with vessels moving at speeds of 2.2 knots (4 km/hr), infrequently in encounters with vessels moving at moderate speeds (5.9 knots or 11 km/hr), and rarely in encounters with a fast vessel (10.3 knots or 19 km/hr; Hazel et al. 2007). It's important to note that these speeds are based on the sea turtle behavior in relatively warm water; cold water temperatures would decrease their ability to avoid vessels moving at even slow speeds. The risk for sea turtle collision is low once mitigation measures are implemented.

The likelihood of a sea turtle being struck by a vessel during construction will depend on vessel speed, vessel size and type, and visibility (Southeast Fisheries Science Center 2018). Increased vessel traffic during construction will be short-term and localized, and anticipated to represent a negligible increase to the highly-trafficked NY-NJ Harbor area. Because of the slower speeds of project installation vessels and tugboats that will likely be used during construction, minor impacts to no impacts to sea turtles are anticipated.

Temporary changes in the distribution, abundance, and availability of prey species for sea turtles may occur as a result of construction activities. Prey species impacts are anticipated to be short-term, localized, and are anticipated to return to the area following construction completion.

Operations and Maintenance Impact Summary

storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure. This assumption will be updated as the barrier closure details are refined.

Direct impacts to sea turtles are anticipated during operation of the storm surge barrier and tide gate closures. When the tide gates and storm surge barriers are in the open position, no impacts would occur to sea turtles. During storm surge barrier closure due to a large storm event, sea turtle movements may be hindered, and could potentially cause injury or mortality from direct strikes from structures. Additional impacts to sea turtles may occur if they were trapped during closure and experienced poor water quality, or experience noise disturbances. Indirect impacts on the distribution and abundance of prey items, and disruptions to foraging could occur during closure of storm surge barriers.

One potential benefit to construction of the storm surge barriers and tide gates is that the foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, finfish, and sea turtles. The loss of benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities and either attract or have no effect on sea turtles.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Sea Turtles.

TSP Sea Turtle Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	*1*	2+
O&M Assumptions	1	1	1	1	1	1	1	1	*1*
Mitigated Rating	*1*	*1*	1	1	*1*	*1*	*1*	1	1

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

The Region with the greatest impact to sea turtles under the TSP is Jamaica Bay. This Region is expected to be impacted the most because of the construction of the storm surge barrier and tide gates, which are in-water measures that produce physical seabed/land disturbance, sediment suspension, habitat conversion, and noise. The storm surge barriers and tide gates have a Low impact rating on sea turtles in the Region. Impacts are expected to primarily be associated with benthic habitat disturbance that affects sea turtle forage availability. storm surge barriers are also planned within the Upper Bay/Arthur Kill Region, however, sea turtles are not expected to be common within the Region; therefore, no impacts are expected. Similarly, within the Long Island Sound Region, one storm surge barrier is planned to be constructed, but the barrier is located at the mouth of a small tributary (Flushing Creek) where sea turtles are not expected to be present. No impact to sea turtles is expected from construction and operations and maintenance of any Shore-Based Measures proposed in the Study Area.

Sea turtles may experience a reduction in feeding efficiency for some period during and immediately following construction activities that disturb benthic habitat. Indirect impacts associated with in-water construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or bottom disturbance. Sea turtles are expected to seek other locations to forage and return to the area when construction is completed. Most juvenile and adult sea turtles are expected to occur offshore and would not be impacted by construction.

During operations and maintenance of the storm surge barrier, similar impact producing factors are anticipated as with construction, including habitat disturbance, noise, sediment suspense, discharge/release and withdrawals. In contrast to the construction of the planned measures, maintenance activities will not be widespread and ongoing, so Low impacts are expected. Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS; impacts are anticipated to be temporary and are expected to be Low. Storm surge barriers are planned in the Upper Bay/Arthur Kill and Long Island Sound, however, sea turtles are not expected to be common where the barriers are located; therefore, significant impacts are not anticipated.

One potential benefit to construction of the storm surge barriers and tide gates is that the foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, finfish, which are a food source for sea turtles. The loss of benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities and either attract or have no effect on sea turtles.

No impact to sea turtles is expected in the remaining Planning Regions because either no construction is planned there under the TSP (Raritan, Lower Bay, Mid-Hudson, and Capital District), or the measures planned are shore-based and not anticipated to impact sea turtle habitat (Lower Hudson/East River, Lower Bay, and Hackensack/Passaic). Furthermore, sea turtles are not expected to occur within the Capital District Region.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Sea Turtles.

ALT 2 Sea Turtle Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	3+	1	1	1	1
O&M Assumptions	1	1	1	1	2	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	1	3	*1*	*1*	1	1

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Under Alternative 2, the Region where sea turtles are expected to be impacted the most is the Lower Bay. The Lower Bay is anticipated to have Moderate impacts on sea turtles because of construction of the storm surge barriers and tide gates. Impact producing factors include physical seabed/land disturbance, habitat conversion, and noise. In the Long Island Sound, the storm surge barrier is not anticipated to impact Sea turtles because they are not expected to be common in the Region. No impact to sea turtles is expected from construction and operations and maintenance of any Shore-Based Measures proposed in the Study Area.

Sea turtles may experience a reduction in feeding efficiency for some period during and immediately following construction activities that disturb benthic habitat. Indirect impacts associated with in-water construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or disturbance. Sea turtles are expected to seek other locations to forage and return to the area when construction is completed. Most juvenile and adult sea turtles are expected to occur offshore and would not be impacted by construction.

During operations and maintenance of the storm surge barriers, similar impact producing factors are anticipated as with construction, including habitat disturbance and noise. In contrast to construction, maintenance activities will not be widespread and ongoing; therefore, impacts are not anticipated to be significant. Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, impacts are anticipated to be temporary and are expected to be Low. Storm surge barriers are planned in the Long Island Sound, however, sea turtles are not anticipated to be common in the Region.

One potential benefit to construction of the storm surge barriers and tide gates is that the foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, finfish, which are a food source for sea turtles. The loss of benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities and either attract or have no effect on sea turtles.

No impact to sea turtles is expected in the other Planning Regions because either no in-water measures are planned (Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Raritan, Mid-Hudson), or sea turtles are not expected to occur (Capital District).

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Sea Turtles.

ALT 3A Sea Turtle Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	2+	1	1	1	2+
O&M Assumptions	1	1	1	1	1	1	*1*	1	*1*
Mitigated Rating	*1*	*1*	*1*	*1*	1	*1*	1	1	1

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

The Planning Region with the greatest impact to sea turtles under Alternative 3A is Jamaica Bay. This Region is expected to be impacted the most because of construction of the storm surge barrier and tide gates, which are in-water measures with a Low impact rating. Impact producing factors include physical seabed/land disturbance, habitat conversion, and noise and vibration. The Raritan, Upper Bay/Arthur Kill, and Long Island Sound also have storm surge barriers planned under Alternative 3A, however, sea turtles are not anticipated to frequent the Regions. Within the Lower Bay, one storm surge barrier is planned in Sandy Hook, however, the barrier is located in a part of the Region and impacts are expected to be Low.

Sea turtles may experience a reduction in feeding efficiency for some period during and immediately following construction activities that disturb benthic habitat. Indirect impacts associated with in-water construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or disturbance. Sea turtles are expected to seek other locations to forage and return to the area when construction is completed. Most juvenile and adult sea turtles are expected to occur offshore and would not be impacted by construction.

During operations and maintenance of the storm surge barriers, similar impact producing factors are anticipated as with construction, including habitat disturbance and noise. In contrast to construction, maintenance activities will not be widespread and ongoing, so No impacts are expected. Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, impacts to sea turtle movements are not expected to be significant. Storm surge barriers are planned in the Raritan and Lower Bay, however, sea turtles are not expected to frequent the Regions.

One potential benefit to construction of the storm surge barriers and tide gates is that the foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, finfish, which are a food source for sea turtles. The loss of benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities and either attract or have no effect on sea turtles.

No impact to sea turtles is anticipated in the Lower Hudson/East River and Hackensack/Passaic because no in-water measures are planned there under Alternative 3A. No measures are planned in the Mid-Hudson and Capital District.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Sea Turtles

ALT 4 Sea Turtle Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	1	1	1	1	1	2+
O&M Assumptions	1	1	1	1	1	1	1	1	*1*
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	1

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Alternative 4 is anticipated to have Low impacts to sea turtles in the Jamaica Bay Region due to construction of the storm surge barrier and tide gates, which are in-water measures. Impact producing factors include physical seabed/land disturbance, habitat conversion, and noise. Storm surge barriers are also planned in the Hackensack/Passaic and Long Island Sound Regions, however, impacts are not expected because sea turtles are not anticipated to frequent the Regions.

Sea turtles may experience a reduction in feeding efficiency for some period during and immediately following construction activities that disturb benthic habitat. Indirect impacts associated with in-water construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or disturbance. Sea turtles are expected to seek other locations to forage and return to the area when construction is completed. Most juvenile and adult sea turtles are expected to occur offshore and would not be impacted by construction.

During operations and maintenance of the storm surge barriers, similar impact producing factors are anticipated as with construction, including habitat disturbance and noise. In contrast to construction, maintenance activities will not be widespread and ongoing, so no impacts are expected. Under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, impacts to sea turtle movements would be temporary and are not expected to be significant. Storm surge barriers are planned in the Hackensack/Passaic and Long Island Sound, however, impacts are no expected to be significant because the barriers are located upriver (Hackensack/Passaic) or within a small creek (Long Island Sound) where sea turtles are not anticipated to be common.

One potential benefit to construction of the storm surge barriers and tide gates is that the foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, finfish, which are a food source for sea turtles. The loss of benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities and either attract or have no effect on sea turtles.

No impact to sea turtles is expected in the other Planning Regions because either the measures are shore-based (Lower Hudson/East River and the Upper Bay/Arthur Kill), or no construction is planned within the Region (Lower Bay, Raritan, Mid-Hudson, and Capital District). Furthermore, Sea turtles are not expected to occur within the Capital District Region.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Sea Turtles.

ALT 5 Sea Turtle Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Under the Alternative 5 scenario, no impact to sea turtles are anticipated to occur because either the measures planned are shore-based (Upper Bay/Arthur Kill, Lower Hudson/East River, and Hackensack/Passaic) or no measures are planned at all (Raritan, Lower Bay, Jamaica Bay, Long Island Sound, Mid-Hudson, and Capital District).

Essential Fish Habitat and Essential Fish Habitat-Designated Species

Impacts to EFH and EFH-designated species are anticipated during construction and operations and maintenance activities depending on the measure and existing conditions. Potential direct impacts associated with the NYNJHATS Study measures to EFH-designated species include changes to and/or removal of EFH; localized changes in water column depth, bathymetry, hydrodynamics, and sedimentation rates; temporary and localized impacts from water disturbance, noise, and vibrations; and short-term changes to water quality, such as turbidity, that are typically associated with in-water construction. In addition to EFH-designated species, this Section also discusses impacts to commercial and recreationally important fisheries that fall under EFH designation, which include summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, monkfish, scup, bluefish, pollock, bluefin tuna, skipjack tuna, longfin inshore squid, ocean quahog, and Atlantic sea scallop. Below is a summary of the potential impacts to EFH and EFH-designated species. The EFH assessment can be found in Appendix A3.

Construction Impact Summary

The potential direct impacts to EFH associated with construction of the NYNJHATS Study measures is limited primarily to demersal fish species, including black sea bass, Atlantic butterfish, winter flounder, windowpane flounder, summer flounder, clearnose skate, little skate, winter skate, and red hake. Short-term, localized, and temporary impacts to water quality would result in the exclusion of the fish species from the construction area due to increased turbidity, suspended solids, water disturbance, noise, and vibrations. Mobile EFH-designated species that use the Study Area are expected to avoid most active in-water work areas and move to appropriate nearby habitat.

Impacts to EFH and EFH-designated species due to changes in water quality associated with project in-water activities, such as the construction of storm surge barriers and tide gates, is limited to changes in turbidity levels and suspended sediments in the immediate construction area. Temporary impacts to water quality during construction could be moderate. However, potential increases in suspended sediment and turbidity can be minimized by using BMPs, such as using the specific equipment types required by the state- issued water quality certificate for each contract area.

Surveys have shown that the suspended sediment plumes associated with dredging follow a pattern of rapid gradient decay and settlement to background conditions within 200m of the dredge in the upper water column and within 600m in the lower water column (USACE 2015c). In areas where the sediment is predominantly sand, temporary impacts would be minimized as coarse grain sediments settle out of the water column quickly. As modeled in the Tappan Zee Bridge replacement (FHA 2012), sediment suspended as a result of pile driving was found to be much less than anticipated for dredging activities (5 to 10 mg/L within a few hundred feet of the construction activity). Sediment suspension caused by construction is expected to be within the natural range of conditions and would not result in long term impacts to water quality.

In addition to turbidity, other water quality parameters (dissolved oxygen, salinity, and temperature) in the Study Area are naturally variable and sometimes exceed the biological threshold of the typical fish species found in the Study Area. Project-related changes would not significantly change the natural variability in water quality parameters during construction and, therefore, would not have a long-term significant impact. Species that are found in the Study Area tend to be highly adaptable or are itinerant species that move through the area on a seasonal basis.

Direct permanent impacts from foundation installation and structure installation include the replacement of intertidal, subtidal, and estuarine habitat with hard-bottom habitat. These impacts are expected to occur during the construction of in-water measures such as the storm surge barriers and tide gates, which have the potential to produce significant impacts to EFH. However, the area that would be impacted is a small percentage of the overall habitat that is available to benthic communities. The introduction of new hard-bottom habitat may have the beneficial effect of localized increase in habitat and species diversity. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates. The loss of this benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities. Biofouling of underwater structures could also occur, causing a long-term permanent impact. For example, species such as black sea bass often associate with hard-bottom or structured habitats. The total area of habitat conversion from soft to hard-bottom habitat, as well as total benthic impact area, may be calculated in support of the Tier 2 EIS (s).

The primary indirect impact to EFH species from construction of the NYNJHAT Study measures is the effect of construction activities on benthic communities in the Study Area. Many of the demersal, or benthic feeders, may experience a reduction in feeding efficiency for some time during and immediately following construction. Construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or bottom disturbance. However, based on previous studies, the re-establishment of benthic communities varies between six months to a year after the project’s completion depending on substrate type (USACE 2007a; Wilber and Clarke 2007). Thus, no long-term indirect impacts are expected on benthic communities as a result of construction and the overall area that would be impacted is a small percentage of the habitat that is available and fish species will be able to forage in adjacent areas.

Construction of Shore-Based Measures including deployable flood barriers, seawall, buried seawall/dune, floodwall, floodwall with park, stone toe-protection, and rock sill structures may result in temporary impacts to the benthic environment, depending on proximity to the water. No impacts to the benthic community are anticipated from levee construction because this measure is typically located away from coastline areas.

Summer flounder Habitat Areas of Particular Concern (HAPC) is designated in the entire Study Area and is associated with areas of native SAV. There is mapped SAV within the Lower Bay Region and along the shoreline of the Lower Hudson, Mid-Hudson, and Capital District Regions. Construction impacts to SAV, and thus summer flounder HAPC, would primarily be associated with habitat disturbance and suspended sediments. Impacts would largely depend upon the extent of the measures planned in each Region. No measures under any of the Alternative plans are planned near mapped SAV in the Lower Hudson, Mid-Hudson, and Capital District Regions;

therefore, summer flounder HAPC is not expected to be significantly impacted in those Regions. Within the Lower Bay, there is SAV near Sandy Hook and in-water measures are planned in the Region under Alternative plans 2 and 3A. Impacts to summer flounder HAPC would include benthic habitat disturbance and the disruption of forage species, however, summer flounder are expected to find other nearby available habitat and return to the area when construction is complete.

Temporary in-water noise level impacts would occur during foundation installation, cofferdam construction, dredging, dewatering, and excavation and fill activities. Equipment used for construction includes tugs, barges, and dredges that create noise in the Study Area. Fish use sound to detect prey and predators and, sometimes, for communication (Fay and Popper 2000). There are a variety of potential effects from construction noise that decrease at greater distances from the source (Richardson et al. 1995). Effects can range from injury or mortality to behavioral changes and would need to be mitigated. For example, pile driving has the potential to produce elevated levels of underwater noise. Potential control measures for pile driving would include the use of a cushion block, a soft start ramping procedure, use of vibratory hammers, or bubble curtains. Additional site-specific underwater noise surveys or monitoring may need to be conducted based on final design and equipment used in order to assess potential noise impacts to sensitive fish within the Study Area. These along with site-specific BMPs to mitigate noise impacts during construction may be included in the Tier 2 EIS(s).

Permanent changes in water depth, bathymetry, and localized changes in hydrodynamics in dredged areas or in areas where new structures are constructed would result in long-term impacts.

Operations and Maintenance Impact Summary

During operation of in-water structures, migratory EFH species (e.g., Atlantic herring) may be impeded during barrier closure. Direct impacts and potential mortality may occur based on closure and duration of the closed flood structures during extreme events. Fish are expected to swim away from the barrier while it is closing but there is potential for individuals to be injured or killed as the structures close. Migratory EFH-designated species are anticipated to avoid the area during operation, potentially causing a long-term permanent impact to migratory patterns. Modeling of the potential impacts to migratory patterns as a result of storm surge barriers and other structures may occur during the Tier 2 EIS(s) assessment.

Indirect impacts to EFH during barrier closure include temporary changes to hydrology and water quality which can cause increases in turbidity and sediment suspension. Increased noise and vibration would be temporary and limited to the duration of barrier closure.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on essential fish habitat and essential fish habitat-designated Species

TSP EFH and EFH-Designated Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	3	3+	1	2	1	2+	3+

O&M Assumptions	1	1	2	2+	1	2	1	2+	2+
Mitigated Rating	*1*	*1*	*3*	*3*	*1*	*2*	*1*	*2*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts associated with the TSP on EFH are expected to range from No Impact to Moderate impact. The Regions expected to receive the greatest impact under the TSP are the Jamaica Bay Region, Upper/Bay Arthur Kill Region, and the Lower Hudson/East River Region. These Regions are expected to be impacted the most because of in-water construction of the storm-surge barrier and tide gates, which is expected to produce Moderate impacts to Fish and EFH in those Regions.

EFH-designated species that are expected to be impacted the most by construction of the TSP are Atlantic butterfish, Atlantic mackerel, black sea bass, winter flounder, summer flounder, windowpane flounder, clearnose skate, winter skate, little skate, scup, and red hake. These are primarily demersal species found in bottom-water and benthic habitat that will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates in the Upper Bay/Arthur Kill Region; Low to Moderate impacts are expected, depending upon seasonal abundances. These species are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return to the area after construction is completed.

Bluefish and Atlantic herring are migratory EFH-designated species with habitat listed within the Upper Bay/Arthur Kill, Jamaica Bay, Hackensack/Passaic, Long Island Sound and Lower Hudson/East River Regions. Migratory finfish could experience short-term, temporary impacts during construction of in-water structures including alteration of migration pathways during construction associated with noise, vibration, and physical disturbance. However, these fish are highly active and expected to avoid construction areas and seek other nearby habitat.

Monkfish is a commercially important EFH-designated species that could be impacted by construction within Jamaica Bay. EFH for monkfish eggs and larvae occurs in Jamaica Bay which could potentially be impacted by construction of the storm surge barrier and tide gate. However, impacts to eggs and larvae are expected to be localized and in-water construction activities account for only a small portion of the planned measures in the Jamaica Bay Region. Similarly, EFH for silver hake eggs and larvae occurs within Jamaica Bay, but impacts are expected to be localized.

Sand tiger shark and smoothhound shark complex (Atlantic stock) are EFH-designated species within the Jamaica Bay Planning Region, however, these species primarily occur off-shore along the Mid-Atlantic Bight and are not expected to be present in Jamaica Bay. Any individuals in the area are expected to avoid the construction zones.

Pollock and longfin inshore squid are commercially important EFH-designated species found in the Long Island Sound Region that will have Low impacts under the TSP. Longfin inshore squid is demersal, with egg, larvae, and juvenile life stages for EFH, and would experience Low impacts during the construction of the storm surge barrier and Shore-Based Measures planned there; however, the storm surge barrier is planned within a small area in this Region (Flushing Creek), so impacts are expected to be localized. Both species are not expected to be abundant in the Region, so impacts will range from No to Low impact.

Construction of the elevated promenade is expected to have Low to Moderate impact on EFH-designated species, depending on the extent of the measure. Low impacts are expected from most other Shore-Based Measures, which account for a significant proportion of the measures planned under the TSP. There is one exception, levees, which are set back from the shoreline and not expected to impact EFH. Construction of the elevated promenade in the Lower Hudson/East River will likely produce noise in shoreline habitat and create some sediment suspension that could disrupt EFH-designated species in the area.

Construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

Operations and maintenance of the in-water measures is expected to have No to Low impacts. Migratory EFH-designated species may be impacted by closure of the storm surge barriers, however, they are expected to avoid the barrier when closed and seek other appropriate habitat or migratory routes. Direct impacts and potential mortality may occur to demersal species, based on closure and duration of the closure of flood structures during extreme events. Fish are expected to swim away from the barrier while it is closing but there is potential for individuals to be injured or killed as the structures close. Modeling of the potential impacts to migratory patterns as a result of storm surge barriers and other structures may occur during the Tier 2 EIS (s).

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial “reef effect,” which is habitat for structure oriented EFH species and will attract species of algae, shellfish and other invertebrates, and fish.

No impacts are expected to occur to EFH in the Lower Bay, Raritan, Mid-Hudson, and Capital Regions because no construction is planned there.

Special Status EFH Fisheries

Special status EFH fisheries that are expected to be impacted by construction of the TSP are summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, monkfish, scup, bluefish, pollock, and longfin inshore squid. Impacts are expected to range from No to Moderate impact.

The construction of the storm surge barrier and tide gates in the Jamaica Bay and Upper Bay/Arthur Kill Regions are expected to have Moderate impacts on commercial and recreational fishing, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, vessel traffic, and noise. Fishing vessels that typically navigate through the Planning Region on the way to other fishing locations would need to travel around areas of active construction, which could result in longer traveling time and increased fuel costs. Construction noise may cause short-term impacts to the presence of fish species sought by commercial and recreational fishers, but fish are expected to return to the area once construction is completed. Physical habitat disturbance is expected to impact demersal and benthic species that are targeted by commercial and recreational fisherman; however, most fish are expected to avoid active in-water work zones and move to appropriate nearby habitat, then return to the area after construction is completed.

Two storm surge barriers, one at the south end of the Arthur Kill and one on the east end of the Kill Van Kull are anticipated to have Moderate impacts to fishing access to the river during construction and operation and maintenance. Similarly, the Jamaica Bay Region has a storm surge barrier planned across the main inlet. Within the Long Island Sound Region, a storm surge barrier is proposed at the mouth of Flushing Creek, a small tributary in the Region. Impacts to the creek are anticipated to be localized and minor, and the waterbody is not expected to be heavily utilized for fishing; therefore, low impacts to fishing are expected in the Long Island Sound Region under the TSP.

The construction of the elevated promenade is expected to have Low impacts on commercial and recreational EFH-designated species, depending on the extent of the measure. The elevated promenade measure will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls planned in the Hackensack/Passaic, which account for a significant proportion of the measures planned under the TSP. Levees are set back from the shoreline and not expected to impact special status EFH fisheries. Anglers are expected to utilize other fishing locations away from active construction.

Demersal and benthic special status EFH species found in bottom habitat, such as summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, and scup, will be temporarily disturbed during construction of the storm surge barriers and tide gates in Jamaica Bay and the Upper Bay/Arthur Kill Region;

Low to Moderate impacts are expected to the species, depending upon seasonal abundances and the extent of the measures. These impacts are expected to be localized and primarily result in species displacement, which will then return to the area when construction is complete. Fishers will have the opportunity to target these species in other locations, away from active construction. One storm surge barrier is planned within the Long Island Sound Region under the TSP, however, the barrier will be located in a small creek (Flushing Creek) so impacts will be localized and the creek is not anticipated to be heavily utilized for fishing.

Bluefish is a recreationally important and migratory EFH-designated species with habitat listed within the Upper Bay/Arthur Kill, Jamaica Bay, Hackensack/Passaic, Long Island Sound and Lower Hudson/East River Regions. These fish are highly active and expected to avoid areas of construction and seek other nearby habitat. Recreational fishers will have opportunities to target bluefish in other locations, away from construction.

Longfin inshore squid is a commercially important species with EFH designated for eggs in both Jamaica Bay and the Upper Bay/Arthur Kill Regions, and eggs, larvae, and juveniles in the Long Island Sound Region, where storm surge barriers are planned. The fishery is not anticipated to be significantly impacted by these measures because other habitat will be available for fishing and the species is not expected to be heavily fished in those Regions. Similarly, EFH for monkfish eggs and larvae is designated in Jamaica Bay, however other habitat will be available and the species is not anticipated to be targeted by anglers in the Region. Pollock has designated EFH in the Long Island Sound Region, however, the species is not anticipated to be common within the Region and fishing vessels are expected to pursue the species in other locations outside the Study Area.

Indirect impacts to special status EFH fisheries may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals that are preferred by recreational and commercially important fish. These impacts are anticipated to be low because fish are expected to move to other nearby foraging habitat and anglers will be able to fish from locations away from active construction.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, and other invertebrates and attract EFH structure-oriented species. In addition, during storm events when the structures are closed there will be benefits to EFH and EFH species by reducing potential water quality impacts.

The mitigated impact to commercial and recreational fishing is expected to range from Low to Moderate impact. No impacts are expected in the remaining Planning Regions because no measures are proposed there under the TSP.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Essential Fish Habitat and Essential Fish Habitat-Designated Species

ALT 2 EFH and EFH-Designated Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	4+	2	1	3+	3

O&M Assumptions	1	1	1	1	3+	2	1	2+	2+
Mitigated Rating	*1*	*1*	*2*	*2*	*3*	*2*	*1*	*3*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to EFH are expected to range from No to Moderate-High impact under Alternative 2. Impacts in the Lower Bay Region associated with the construction of the extensive storm surge barrier are expected to be Moderate-High. Although the storm surge barrier is not being constructed in Jamaica Bay, many of the fish species that utilize Jamaica Bay are expected to be impacted by construction of the barrier in the adjacent Lower Bay Region; therefore, moderate impacts are expected in Jamaica Bay. Moderate impacts are expected in the Long Island Sound and Jamaica Bay Regions because of in-water construction of the storm-surge barriers which will disrupt benthic habitat and migratory pathways. This measure accounts for a significant proportion of the planned measures under Alternative 2.

EFH-designated species that are expected to be impacted the most by construction of Alternative 2 are winter flounder, summer flounder, windowpane flounder, clearnose skate, winter skate, Atlantic butterfish, black sea bass, scup, and red hake. These are demersal species that rely heavily upon benthic habitat which will be temporarily altered and disrupted during construction of the storm surge barrier and tide gate. These species are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return after conditions improve following the construction.

Construction activities would include bottom habitat disturbance and indirect impacts from potential loss of forage organisms in the immediate vicinity of the placement of new structures or bottom disturbance. Based on previous studies, the re-establishment of benthic communities varies between six months to a year after the project's completion depending on substrate type (USACE 2007a; Wilber and Clarke 2007). Thus, no long-term indirect impacts are expected on benthic communities as a result of operation and maintenance and the overall area that would be impacted is a small percentage of the habitat that is available and fish species will be able to forage in adjacent areas. Moderate indirect impacts are expected in the Lower Bay Region.

Bluefish and Atlantic herring are migratory EFH-designated species that could experience short-term impacts during construction of in-water structures, such as alteration of migration pathways associated with noise, vibration, and physical disturbance. These impacts are primarily associated with construction of the storm surge barrier in the Lower Bay Region. Migratory EFH-designated species are expected to avoid in-water construction, including any noise generated by the shore-based construction measures. This avoidance behavior would occur only in those areas where construction is underway. Atlantic mackerel is another EFH-designated species within the Jamaica Bay Planning Region that is expected to avoid construction zones and return when construction is completed.

EFH for bluefin tuna and skipjack tuna is listed offshore in the Mid-Atlantic Bight, however these species are not common in the Lower Bay and therefore will not be impacted by construction.

EFH for silver hake larvae and monkfish eggs and larvae occurs within Jamaica Bay which could potentially be indirectly impacted by operations and maintenance of the in-water measures when benthic and bottom-water foraging habitat is disturbed. EFH for monkfish (eggs and larvae) and silver hake (larvae) are expected to be localized and most in-water activities occur outside of the Jamaica Bay Region.

Many EFH-designated species of shark are listed within the Lower Bay and Jamaica Bay Region, including the common thresher shark (*Alopias vulpinus*), dusky shark (*Carcharhinus obscurus*), sand tiger shark (*Carcharias taurus*), sandbar shark (*Carcharhinus plumbeus*), spiny dogfish (*Squalus acanthias*), white shark (*Carcharodon carcharias*), and the smoothhound shark complex (Atlantic stock). These species primarily occur offshore along the Mid-Atlantic Bight and are not expected to be present in Jamaica Bay, nor within the Lower Bay Region. Any individuals in the area are expected to avoid the construction zones.

Construction of the buried seawall/dune accounts for a significant proportion of the Shore-Based Measures planned under Alternative 2. This measure is expected to produce Low impacts on fish and EFH. Construction of all other Shore-Based Measures are expected to have Low impacts to EFH, except levees which are located away from the shoreline.

Impacts during operations and maintenance associated with Alternative 2 to fish and EFH is expected to range from No Impact to Moderate Impact. Operation and maintenance of the storm-surge barrier and tide gates is expected to cause Moderate impacts in the Lower Bay, Jamaica Bay, and Long Island Sound Regions. EFH-designated species that are expected to be impacted the most by operation and maintenance of Alternative 2 within the Lower Bay and Jamaica Bay Regions are demersal species that rely heavily upon benthic habitat which will be temporarily altered and disrupted during deployment of the storm surge barrier and tide gates, including any necessary maintenance. These species are expected to avoid active in-water work zones and move away from the barrier to seek appropriate nearby habitat when it is deployed. These fish will return to the area after the barrier is opened and maintenance is complete.

Some Shore-Based Measures such as the elevated promenade and seawall are expected to have Low impacts to EFH-designated species during operations and maintenance under Alternative 2, for similar reasons as those described for construction; other Shore-Based Measures will have no impacts.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates and attract EFH structure-oriented species. In addition, during storm events when the structures are closed there will be benefits to EFH and EFH species by reducing potential water quality impacts.

No impacts are expected to occur to EFH in the Mid-Hudson Region and Capital District under Alternative 2 because no construction is planned there.

Special Status Essential Fish Habitat Fisheries

Special status EFH fisheries that fall within the construction footprint of Alternative 2 are summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, monkfish, scup, bluefish, pollock, bluefin tuna, skipjack tuna, longfin inshore squid, ocean quahog, and Atlantic sea scallop. Impacts are expected to range from No to Moderate impacts.

The construction of the storm surge barrier and tide gates in the Lower Bay and Long Island Sound Regions are expected to have Moderate impacts on commercial and recreational fishing, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, vessel traffic, and noise. Impacts to fishing vessels are the same as those discussed above for the TSP and primarily involve navigation issues, increased travel time, increased fuel costs, and displacement of target species due to noise and habitat disturbance. Similarly, although a storm surge barrier is not planned in the Jamaica Bay Region, impacts to fishing in the Region are expected to be Moderate because of reduced access to the Region due to the barrier planned the Lower Bay Region.

The construction of the elevated promenade and Shore-Based Measures such as seawalls in the Long Island Sound Region are expected to have Low impacts on commercial and recreational EFH-designated species. These measures will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are also expected from most other Shore-Based Measures, such as berms and floodwalls planned in the Hackensack/Passaic and Upper Bay/Arthur Kill Regions. Levees are set back from the shoreline and not expected to impact special status EFH fisheries. Anglers are expected to utilize fishing locations away from all active construction zones.

Demersal and benthic special status EFH species found in bottom habitat, such as summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, and scup, will be temporarily disturbed during construction of the storm surge barriers and tide gates. Impacts to these special status EFH fisheries are the same as those discussed above for the TSP; however, a storm surge barrier is planned in the Lower Bay Region under Alternative 2 which may impact nearby SAV in Sandy Hook and thus summer flounder HAPC. These impacts would primarily be associated with habitat disturbance and suspended sediments, and summer flounder are expected to move to other nearby habitat until construction is completed.

Bluefish is a recreationally important and migratory EFH -designated species with habitat listed within the Lower Bay, Upper Bay/Arthur Kill, Jamaica Bay, Hackensack/Passaic, Long Island Sound and Lower Hudson/East River Regions. These fish are highly active and expected to avoid areas of construction and seek other nearby habitat. Recreational fishers will have opportunities to target bluefish in other locations, away from construction. Longfin inshore squid is a commercially important species with EFH designated in the Lower Bay, Jamaica Bay, the Upper Bay/Arthur Kill Regions, however the fishery is not anticipated to be significantly impacted by construction because other habitat will be available for the species outside the Study Area. Similarly, EFH for monkfish eggs and larvae is designated in Jamaica Bay; however, other habitat will be available and the species is not anticipated to be targeted by anglers in the Region. Pollock has designated EFH in the Long Island Sound Region, but the species is not anticipated to be common within the Region and fishing vessels are expected to pursue the species in other locations outside of the Study Area.

Fishing for bluefin tuna and skipjack tuna, two special status EFH fisheries, primarily takes place offshore and outside the Study Area, so impacts are expected to be Low, or not occur at all. Similarly, ocean quahog and Atlantic sea scallop primarily occur offshore and fisheries are not expected to impacted by Alternative 2.

Indirect impacts to special status EFH fisheries may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals that are preferred by recreational and commercially important fish. These impacts are anticipated to be low because fish are expected to move to other nearby foraging habitat and anglers will be able to fish from locations away from active construction.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, other invertebrates, and fish.

The mitigated impact to commercial and recreational fishing is expected to range from Low to Moderate impact. No impacts are expected in the remaining Planning Regions because either no measures are proposed there under the Alternative 2, or the measures are not extensive enough to produce impacts to special status EFH fisheries.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Essential Fish Habitat and Essential Fish Habitat-Designated Species

ALT 3A EFH and EFH-Designated Species Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	3+	2+	2	2+	3+	3+
O&M Assumptions	1	1	1	2+	2+	1	2	2+	2+
Mitigated Rating	*1*	*1*	*2*	*3*	*2*	*2*	*2*	*3*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Direct impacts of construction associated with Alternative 3A on fish and EFH are expected to range from No to Moderate impact. The Regions expected to be impacted the most under Alternative 3A are the Upper Bay/Arthur Kill, Jamaica Bay, and the Long Island Sound Regions. Impacts are expected to these Regions because of in-water construction of the storm-surge barrier measure which will disrupt benthic habitat and migratory pathways. Storm surge barriers are also planned in the Raritan and Lower Bay, however the measure is not as extensive in those Regions and impacts are expected to be Low.

EFH -designated species that are expected to be impacted the most by construction of in-water measures under Alternative 3A are winter flounder, summer flounder, windowpane flounder, clearnose skate, winter skate, Atlantic butterfish, black sea bass, scup, and red hake. These are demersal species that are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return after conditions improve following the construction.

Construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals. These impacts will primarily occur to demersal EFH -designated species.

Many EFH-designated species of shark are listed within the Jamaica Bay Region, including the common thresher shark (*Alopias vulpinus*), dusky shark (*Carcharhinus obscurus*), sand tiger shark (*Carcharias taurus*), sandbar shark (*Carcharhinus plumbeus*), spiny dogfish (*Squalus acanthias*), white shark (*Carcharodon carcharias*), and the smoothhound shark complex (Atlantic stock). These species primarily occur off-shore along the Mid-Atlantic Bight and are not expected to be present in Jamaica Bay, nor within the Lower Bay Region. Any individuals in the area are expected to avoid the construction zones.

EFH for bluefin tuna and skipjack tuna is listed off-shore in the Mid-Atlantic Bight, however these species are not common in the Lower Bay and therefore will not be impacted by construction.

Within Jamaica Bay, construction of the elevated promenade will take place along the shoreline and Moderate impacts to fish and EFH are expected from this measure. Low impacts are expected to EFH-designated species from the other Shore-Based Measures, except levees which are located away from the shoreline and not anticipated to impact fish. The Shore-Based Measures proposed within the Hackensack/Passaic and Lower Hudson/East River Regions under Alternative 3A are expected to have Low impacts to EFH.

Impacts from operation and maintenance associated with Alternative 3A to EFH is expected to range from No Impact to Low Impact. Low indirect impacts to EFH-designated species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals during operations and maintenance of the storm surge barriers. Migratory EFH-designated species are not expected to experience significant indirect impacts during operations and maintenance of in-water structures because they will actively move to appropriate nearby foraging habitat. Most Shore-Based Measures are not expected to impact EFH during operations and maintenance under Alternative 3A, except for the elevated promenade and seawalls which have Low impact ratings.

Few indirect impacts to EFH are anticipated from measures associated with Alternative 3A within the Lower Bay and Raritan Regions. Indirect impacts would primarily be associated with benthic habitat disturbances, however, the storm surge barriers planned in these Regions will only impact a small portion available EFH; therefore, indirect impacts are not expected to be significant.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates and attract EFH structure-oriented species. In addition, during storm events when the structures are closed there will be benefits to EFH and EFH species by reducing potential water quality impacts.

No impacts to EFH-designated species are expected within the Mid-Hudson Region and the Capital District Region because no construction is planned there under Alternative 3A.

Special Status Essential Fish Habitat Fisheries

Special status EFH Fisheries that fall within the construction footprint of Alternative 3A are summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, monkfish, scup, bluefish, pollock, bluefin tuna, skipjack tuna, longfin inshore squid, ocean quahog, and Atlantic sea scallop. Impacts are expected to range from No to Moderate impacts.
The construction of the storm surge barrier and tide gates in Jamaica Bay, the Long Island Sound, the Upper Bay/Arthur Kill, and the Raritan Regions are expected to have Moderate impacts on commercial and recreational fishing, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, vessel traffic, and noise. Impacts to fishing vessels are the same as those discussed above for the TSP and primarily involve impacts to navigation, increased travel time, increased fuel costs, and displacement of target species due to noise and habitat disturbance.

The construction of the elevated promenade and Shore-Based Measures such as seawalls in the Long Island Sound Region are expected to have Low impacts on commercial and recreational EFH-designated species. These measures will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are also expected from most other Shore-Based Measures, such as berms and floodwalls planned in the Hackensack/Passaic, Upper Bay/Arthur Kill, and Lower Hudson/East River Regions. Levees are set back from the shoreline and not expected to impact special status EFH fisheries. Anglers are expected to utilize fishing locations away from all active construction zones.

Demersal and benthic special status EFH fisheries species found in bottom habitat, such as summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, and scup, will be temporarily disturbed during construction of the storm surge barriers and tide gates. Impacts to these special status EFH fisheries are the same as those discussed above for Alternative 2. One storm surge barrier is planned in the Lower Bay Region under Alternative 3A, which may impact nearby SAV in Sandy Hook and thus summer flounder HAPC. These impacts would primarily be associated with habitat disturbance and suspended sediments, and summer flounder are expected to move to other nearby habitat until construction is completed.

Bluefish is a recreationally important and migratory EFH-designated species with habitat listed within the Lower Bay, Upper Bay/Arthur Kill, Jamaica Bay, Hackensack/Passaic, Long Island Sound and Lower Hudson/East River Regions. Recreational fishers will have opportunities to target these highly active fish in other locations, away from construction. Longfin inshore squid is a commercially important species with EFH-designated in the Lower Bay, Jamaica Bay, the Upper Bay/Arthur Kill Regions for early life-stages, however the fishery is not anticipated to be significantly impacted by construction because other habitat will be available to fish for the adult life stage outside the Study Area. Similarly, EFH for monkfish eggs and larvae is designated in Jamaica Bay, however the species is not anticipated to be targeted by anglers in the Region and other habitat will be available to fish for the species elsewhere. Pollock has designated EFH in the Long Island Sound Region, however, the species is not anticipated to be common within the Region and fishing vessels are expected to pursue the species in other locations outside the Study Area.

Fishing for bluefin tuna and skipjack tuna, two special status EFH fisheries, primarily takes place offshore and outside the Study Area, so impacts are expected to be Low, or not occur at all. Similarly, ocean quahog and Atlantic sea scallop primarily occur offshore and are not expected to impacted by Alternative 3A.
As discussed above for the other Alternative plans, indirect impacts to special status EFH fisheries may occur due to forage species displacement and foraging habitat disturbances, but impacts are anticipated to be low because fish are expected to move to other nearby habitat and anglers will be able to fish from locations away from active construction.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, other invertebrates, and fish.

The mitigated impact to commercial and recreational fishing is expected to range from Low to Moderate impact. No impacts are expected in the remaining Planning Regions because no measures are proposed there under the Alternative 3A.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Essential Fish Habitat and Essential Fish Habitat Designated Species

ALT 4 EFH and EFH-Designated Species Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	3+	2	1	2+	1	2+	3+
O&M Assumptions	1	1	2	1	1	1+	1	2+	2+
Mitigated Rating	*1*	*1*	*3*	*2*	*1*	*2*	*1*	*2*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts associated with Alternative 4 on EFH are expected to range from No Impact to Moderate impact. The Regions expected to be impacted the most under Alternative 4 are the Jamaica Bay and Lower Hudson/East River Regions from construction of storm-surge barriers, measure which will disrupt benthic habitat and migratory pathways. Storm surge barriers are also planned in the Long Island Sound Region, however the measure is located within a small creek (Flushing Creek) and impacts are expected to be Low.

Indirect impacts associated with construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or bottom disturbance, resulting in Low impacts. Migratory EFH-designated species are not expected to experience significant indirect impacts during construction of in-water structures because they will actively move to appropriate nearby foraging habitat.

EFH-designated species that are expected to be impacted the most by construction of Alternative 4 are winter flounder, summer flounder, windowpane flounder, clearnose skate, winter skate, Atlantic butterfish, black sea bass, scup, and red hake. These are demersal species that are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return after conditions improve following the construction.

Many EFH-designated species of shark are listed within the Jamaica Bay Region, including the common thresher shark (*Alopias vulpinus*), dusky shark (*Carcharhinus obscurus*), sand tiger shark (*Carcharias taurus*), sandbar shark (*Carcharhinus plumbeus*), spiny dogfish (*Squalus acanthias*), white shark (*Carcharodon carcharias*), and the smoothhound shark complex (Atlantic stock). These species primarily occur offshore along the Mid-Atlantic Bight and are not expected to be present in Jamaica Bay, nor within the Lower Bay Region. Any individuals in the area are expected to avoid the construction zones.

EFH for bluefin tuna and skipjack tuna is listed offshore in the Mid-Atlantic Bight, however these species are not common in the Lower Bay and therefore will not be impacted by construction.

Construction of the elevated promenade is expected to have a Moderate impact on EFH-designated species because it located along the shoreline. Construction of all other the Shore-Based Measures is expected to be Low. Migratory EFH-designated species will actively avoid most in-water work areas and move to appropriate nearby habitat and therefore impacts are expected to be Low. Levees, which are set back from the shoreline, are not expected to impact EFH.

Operation and maintenance of the in-water measures are expected to have No to Low impacts. Migratory EFH-designated species may be impacted to closure of the storm surge barrier, however, they are expected to seek other nearby habitat or migratory routes. Modeling of the potential impacts to migratory patterns as a result of storm surge barriers and other structures may occur during the Tier 2 EIS(s). The ocean quahog and longfin inshore squid important invertebrate species that could be impacted by operation and maintenance of the storm surge barrier and tide gate in the Jamaica Bay Region.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates and attract EFH structure oriented species. In addition, during storm events when the structures are closed there will be benefits to EFH and EFH species by reducing potential water quality impacts.

No impacts to EFH-designated species are expected from Alternative 4 within the Lower Bay, Raritan, Mid-Hudson Region, and the Capital District Regions because no construction is planned there under Alternative 4.

Special Status Essential Fish Habitat Fisheries

Special status EFH fisheries that fall within the construction footprint of Alternative 4 are summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, monkfish, scup, bluefish, pollock, and longfin inshore squid. Impacts are expected to range from No to Moderate impacts.

The construction of the storm surge barrier and tide gates in Jamaica Bay is expected to have Moderate impacts on commercial and recreational fishing in the Region, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, vessel traffic, and noise. Impacts to fishing vessels are the same as those discussed above for the TSP, which primarily involve impacts to navigation, increased travel time, increased fuel costs, and displacement of target species due to noise and habitat disturbance. One storm surge barrier is also planned in the Hackensack/Passaic Region which will produce Low impacts to fishing.

The construction of the elevated promenade and seawalls in Jamaica Bay, the Upper Bay/Arthur Kill, and the Lower Hudson/East River Region are expected to have Low impacts on commercial and recreational EFH-designated species. These measures will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls planned under Alternative 4. Levees are set back from the shoreline and not expected to impact special status EFH fisheries. Anglers are expected to utilize fishing locations away from all active construction zones.

Demersal and benthic special status EFH species found in bottom habitat, such as summer flounder, winter flounder, windowpane flounder, yellowtail flounder, black sea bass, and scup, will be temporarily disturbed during construction of the storm surge barriers and tide gates. Impacts to these special status EFH fisheries are the same as those discussed above for the TSP.

Bluefish is a recreationally important and migratory EFH-designated species with habitat listed within the Lower Bay, Upper Bay/Arthur Kill, Jamaica Bay, Hackensack/Passaic, Long Island Sound and Lower Hudson/East River Regions. Recreational fishers will have opportunities to target these highly active fish in other locations, away from construction. Longfin inshore squid is a commercially important species with EFH designated in the Lower Bay, Jamaica Bay, the Upper Bay/Arthur Kill Regions, however the fishery is not anticipated to be significantly impacted by construction because other habitat will be available to fish for the adult life stage of this species outside the Study Area. Similarly, EFH for monkfish eggs and larvae is designated in Jamaica Bay, however the species is not anticipated to be targeted by anglers in the Region and other habitat will be available to the species elsewhere. Pollock has designated EFH in the Long Island Sound Region, however, the species is not anticipated to be common within the Region and fishing vessels are expected to pursue the species in other locations outside the Study Area.

As discussed above for the other Alternative plans, indirect impacts to special status EFH fisheries may occur due to forage species displacement and foraging habitat disturbances, but impacts are anticipated to be low because fish are expected to move to other nearby habitat and anglers will be able to fish from locations away from active construction.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates and attract EFH structure-oriented species. In addition, during storm events when the structures are closed there will be benefits to EFH and EFH species by reducing potential water quality impacts.

The mitigated impact to commercial and recreational fishing is expected to range from Low to Moderate impact. No impacts are expected in the remaining Planning Regions because no measures are proposed there under the Alternative 4.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Essential Fish Habitat and Essential Fish Habitat-Designated Species

ALT 5 EFH and EFH Designated Species Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	2	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts

Construction impacts associated with Alternative 5 on EFH are expected to range from No Impact to Low impact. Low impacts are expected in the Lower Hudson/East River from construction of the elevated promenade, a shore-based measure, which will be constructed along the shoreline in the Lower Hudson. No impacts to EFH are expected from levees. No in-water measures are planned under Alternative 5.

Direct and indirect impacts to EFH species may occur within shoreline habitat during construction of elevated promenades. Migratory species are expected to avoid in-water construction, including any noise generated by the shore-based construction measures.

Impacts from operations and maintenance associated with Alternative 5 on EFH are expected to range from No Impact to Low Impact. The Lower Hudson/East River Region is the only Region expected to have a Low impact, due to maintenance of the elevated promenade, a shore-based measure planned along the shoreline. No operations and maintenance impacts are expected from the other Shore-Based Measures under Alternative 5. No in-water measures are planned under Alternative 5.

No impacts to fish and EFH-designated species are expected in the Lower Bay, Raritan, Long Island Sound, Jamaica Bay, Mid-Hudson Region, and the Capital District Regions because measures are not planned there under Alternative 5.

Special Status Essential Fish Habitat Fisheries

Special status EFH fisheries that fall within the construction footprint of Alternative 5 are summer flounder, winter flounder, windowpane flounder, bluefish, and longfin inshore squid. Impacts are expected to range from No to Low impacts.

Impacts to fishing vessels is expected to be low under Alternative 5 because all proposed measures are shore-based and impacts would be limited to boat launches in each Region. Shoreline construction may impact access to fishing locations, but fishers will be able to utilize other areas.

The construction of the elevated promenade in the Lower Hudson/East River Region is not extensive under Alternative 5 and the impact to special status EFH fisheries is expected to be Low. This measure will be located along the shoreline and construction activities are expected to disturb nearshore habitat. No impacts are expected from other Shore-Based Measures planned under Alternative 5, which are not as extensive as other Alternative plans. Anglers are expected to utilize fishing locations away from all active construction zones.

Bluefish is a recreationally important and migratory EFH-designated species that recreational fishers will have opportunities to target in other locations away from construction. Longfin inshore squid is a commercially important species with EFH designated for eggs in the Upper Bay/Arthur Kill, Hackensack/Passaic, and Lower Hudson/East River Regions, however the fishery is not anticipated to be significantly impacted by construction because other habitat will be available to fish for the adult life stage of this species outside the Study Area.

As discussed above for the other Alternative plans, indirect impacts to special status EFH fisheries may occur due to forage species displacement and foraging habitat disturbances, but impacts are anticipated to be low because fish are expected to move to other nearby habitat and anglers will be able to fish from locations away from active construction.

The mitigated impact to commercial and recreational fishing is expected to range from No to Low impact. No impacts are expected in the remaining Planning Regions because no measures are proposed there under the Alternative 5.

6.1.4 Special Status Areas

The following sections discuss the potential environmental effects to special status areas, including wetlands, floodplains, Wild and Scenic rivers, Designated Critical Habitat, Critical Environmental Areas, Marine Protected Areas, Coastal Zone Management Act areas, Coastal Barrier Resource System Areas, NPS land, and Wildlife Refuge land. In Chapter 4, these resource categories are combined into one collective Special Status Areas category for impact rating scoring purposes to compare Alternative plans for environmental acceptability.

Wetlands

Impacts to wetlands and water resources are anticipated during construction and operations and maintenance activities, depending on the measure and existing conditions. To determine site-specific impacts and potential mitigation requirements, site-specific wetland delineation surveys may be conducted for the development of the Tier 2 EIS and/or permit applications. Wetland delineation survey scope will be based on project location and design. The following are impact-producing factors to wetlands and water resources: physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, and land use and economic change. Below is a summary of the potential impacts to wetlands and water resources.

There are major wetland systems at Kingston Point, Duck Cove, Inbocht Bay, Burget Creek, Ramshorn Creek, Catskill Creek, Mill Creek, Hannacrois Creek, Rogers Island, North Bay, Moordener Kill, the south side of Normans Kill, Vosburgh Swamp, Coxsackie Island, Rattlesnake Island, Bronck Island, Mull Island, Houghtaling Island, Schodack Island and across Schodack Creek in Columbia County, the peninsula now made up of Shad and Schermerhorn Islands, the flats near Esopus Creek, and the Tivoli Bays and Stockport Flats components of the Hudson River National Estuarine Research Reserve (HRNERR) (NYSDEC 2009; USFWS 2018). There are also significant wetlands south of the City of Hudson, landward of the train tracks, as well as on the eastern bank of the Hudson River south of the Village of Athens, south of the Town of Stuyvesant between the Hudson River and the train tracks, south of the Town of Coeymans, and along the shoreline of Albany.

Construction Impact Summary

Temporary impacts to wetlands are anticipated to occur during the construction of Shore-Based Measures, including deployable flood barriers, elevated promenades, seawalls, buried seawall/dunes, levees, and floodwalls.

Preparation of the construction sites would require clearing and grading of vegetation that could result in temporary wetland habitat impacts. Any temporary impacts to vegetation are anticipated to be replaced on-site and in-kind. Dewatering activities may cause temporary direct impacts to wetland areas during construction, but dewatered areas will be returned to pre-existing conditions post construction. Potential dredging in wetlands and intertidal habitats would also cause temporary impacts during construction, and adjacent transition areas may also be temporarily affected by clearing and soil disturbance. Temporary impacts would be managed through implementation of a site-specific SWPPP and construction BMPs.

Excavation and fill activities associated with some measures, such as an elevated promenade and seawall, may permanently impact wetlands and their transition zones through removal of vegetation and filling. Foundation installation may cause long-term permanent impacts to wetland habitat through vegetation removal and conversion to impervious surfaces. The storm surge barriers and tide gates could cause permanent changes in hydrology which could lead to secondary impacts to wetlands through scouring or sedimentation.

To determine site-specific impacts and potential mitigation requirements, site-specific wetland delineation surveys may be conducted for the development of the Tier 2 EIS and/or permit applications. Wetland delineation survey scope would be based on project location and design.

Storm surge barriers and tide gates are barrier measures located within in-water habitat. Temporary in-water impacts include increased turbidity during construction activities and resuspension of sediments into the water column during foundation installation, dredging, dewatering, and excavation and fill activities. Temporary and localized impacts to water quality from vessel anchoring and dewatering activities may occur but are expected to return to pre-existing conditions rapidly following active construction in a given area. Spills or leaks of fuels, lubricants, and coolant from construction equipment could adversely impact water resources. A site specific SPCC would be developed and implemented to prevent spills and minimize the potential impacts for any inadvertent spills. With implementation of the SPCC and BMPs, impacts from spills or leaks are anticipated to be minor. Water quality is anticipated to return to baseline conditions after construction activities are completed.

Operations and Maintenance Impact Summary

No operation and maintenance impacts from levees or other Shore-Based Measures are anticipated. During operations and maintenance of the proposed in-water measures, potential impacts to wetlands and water resources may occur, but are anticipated to be low overall. When the barriers are in the open position, no impacts would occur to wetlands and water resources. When the barriers are in the closed position, minor temporary impacts to water resources are anticipated, such as short-term changes in hydrology, sediment resuspension and minor increases in turbidity during operation. However, an intended beneficial impact of closing the barriers during significant storm events, would be the management of risk to wetlands and water resources from flooding and erosion damage associated with storm surge. Without the proposed project measures, the Study Area will continue to experience catastrophic damages and loss of valuable natural resources like those seen during Hurricane Sandy.

Beneficial long-term impacts to wetlands from potential wetland creation and restoration that may be implemented through mitigation would be anticipated. Wetlands would provide improved water quality, flood control, and ecological benefits to wildlife and fisheries resources. As the project measures become more defined and site-specific surveys may be completed to determine areas of wetland creation and restoration, the impacts will be quantified during the Tier 2 EIS(s).

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to wetlands associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Wetlands

TSP Wetlands Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	3	1	3	1	2	4
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*2+*	*1+*	*1+*	*1*	*1+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wetlands under the TSP range from No impact to Moderate-High. Moderate-High impacts may occur from construction of buried seawall and dune features which will affect wetlands in the Jamaica Bay Planning Region under the TSP. Moderate impacts to estuarine and marine wetlands may also occur from construction of levees and berms in the Hackensack/Passaic Region and construction of floodwalls and revetments in the Upper Bay/Arthur Kill Region. Construction is also expected to impact wetlands in the Lower Hudson/East River and Long Island Regions from levees and other Shore-Based Measures, but impacts were rated as Low because the area of impact is expected to be less in these Regions, with fewer wetlands and fewer crossings.

Construction of the storm surge barrier and tide gates, in the Jamaica Bay and Upper Bay/Arthur Kill Regions are expected to have a Low impact on wetlands as most impacts will be in tidal waters.

Two storm surge barriers, one at the south end of the Arthur Kill and one on the east end of the Kill Van Kull are anticipated to have Low impacts to wetlands during construction and operation and maintenance. Similarly, the Jamaica Bay Region has a storm surge barrier planned across the main inlet. Within the Long Island Sound Region, a storm surge barrier is proposed at the mouth of Flushing Creek, a small tributary in the Region. Impacts to the creek are anticipated to be localized and minor.

Operation and maintenance of the in-water features and several of the Shore-Based Measures, such as the buried seawall/dune, floodwall and seawalls, may have a Low impact to wetlands.

Low impacts are anticipated to wetlands after avoidance, minimization, and mitigation is completed under the TSP. Implementation of the TSP will also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to wetlands are anticipated in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts to wetlands associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Wetlands

ALT 2 Wetlands Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3	3	4	3	3	4	4
O&M Assumptions	1	1	1	2	2	1	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wetlands under Alternative 2 range from No Impact to Moderate-High. Moderate-High impacts may occur from construction of buried seawall and dune features which will affect wetlands in the Jamaica Bay and Lower Bay Planning Regions under Alternative 2. Moderate-High impact may also occur to wetlands in the Long Island Sound Regions from construction of seawalls, levees, tide gates, and floodwalls, many of which are proposed to cross wetlands. Moderate impacts to estuarine and marine wetlands may also occur from construction of levees and berms in the Hackensack/Passaic Region and construction of floodwalls and revetments in the Upper Bay/Arthur Kill and Raritan Regions. Construction is also expected to impact wetlands in the Lower Hudson/East River Region from levees and other Shore-Based Measures, but impacts were rated as Low because the area of impact is expected to minimal in these Regions, with fewer wetlands and fewer crossings. To determine site-specific impacts and potential mitigation requirements, site-specific wetland delineation surveys may be conducted for the development of the Tier 2 EIS and/or permit applications.

Operation and maintenance of the in-water features and several of the Shore-Based Measures, such as the buried seawall/dune, floodwall and seawalls, may have a Low impact to wetlands under Alternative 2.

Low impacts are anticipated to wetlands after avoidance, minimization, and mitigation is completed under Alternative 2. Implementation of Alternative 2 will also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to wetlands are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Wetlands

ALT 3A Wetlands Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	3	3	3	4	4
O&M Assumptions	1	1	1	2	2	1	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*2+*	*2+*	*1+*	*1*	*1+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wetlands under Alternative 3A range from Moderate-High to No impact. Moderate-High impacts may occur from construction of buried seawall and dune features which will affect wetlands in the Jamaica Bay Planning Region under Alternative 3A. Moderate-High impact may also occur to wetlands in the Long Island Sound Region from construction of seawalls, levees, tide gates, and floodwalls, many of which are proposed to cross wetlands. Moderate impacts to estuarine and marine wetlands may also occur from construction of levees and berms in the Hackensack/Passaic Region, construction of floodwalls and revetments in the Upper Bay/Arthur Kill and Raritan Regions and construction of seawalls, floodwalls and levees in the Lower Bay Region. Construction is also expected to impact wetlands in the Lower Hudson/East River Region from levees and other Shore-Based Measures, but impacts were rated as Low because the area of impact is expected to minimal in these Regions, with fewer wetlands and fewer crossings. To determine site-specific impacts and potential mitigation requirements, site-specific wetland delineation surveys would be conducted for the development of the Tier 2 EIS and/or permit applications.

Operation and maintenance of the in-water features and several of the Shore-Based Measures, such as the buried seawall/dune, floodwall and seawalls, may have a Low impact to wetlands under Alternative 3A.

Low impacts are anticipated to wetlands after avoidance, minimization, and mitigation is completed under Alternative 3A. Implementation of Alternative 3A will also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts to wetlands are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Special Status Areas

ALT 4 Wetland Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	1	3	1	2	4
O&M Assumptions	1	1	1	1	1	2	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wetlands under Alternative 4 range from No to Moderate-High impact. Moderate-High impacts may occur from construction of buried seawall and dune features which will affect wetlands in the Jamaica Bay Planning Region under Alternative 4. Moderate impacts to estuarine and marine wetlands may also occur from construction of levees, floodwalls and seawalls in the Hackensack/Passaic and Upper Bay/Arthur Kill Regions. Construction is also expected to impact wetlands in the Lower Hudson/East River and Long Island Regions from levees and other Shore-Based Measures, but impacts were rated as Low because the area of impact is expected to be less in these Regions, with fewer wetlands and fewer crossings.

Operation and maintenance of the in-water features and several of the Shore-Based Measures, such as the buried seawall/dune, floodwall and seawalls, may have a Low impact to wetlands under Alternative 4.

Low impacts are anticipated to wetlands after avoidance, minimization, and mitigation is completed under Alternative 4. Implementation of Alternative 4 will also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to wetlands are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under Alternative 4.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts to wetlands associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Wetlands

ALT 5 Wetland Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	3	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to wetlands under Alternative 5 range from No to Moderate impact. Moderate impacts may occur from construction of levees which will affect wetlands and floodplains in the Hackensack/Passaic Planning Region under Alternative 5. Low impacts to wetlands are expected in the Lower Hudson/East River Region and Upper Bay/Arthur Kill as few wetlands occur in the proposed area of impact. However, impacts to wetlands are temporary and expected to provide a benefit by managing the risk of flooding and subsequent erosion during large storm events.

Operation and maintenance of are not expected to have an impact on wetlands under Alternative 5.

Low impacts are anticipated to wetlands after avoidance, minimization, and mitigation is completed under Alternative 5. Implementation of Alternative 5 will provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to wetlands are expected in the Capital District, Mid-Hudson, Lower Bay, Jamaica Bay, Long Island Sound and Raritan Planning Regions because no structures are proposed there under Alternative 5.

Floodplains

Impacts to floodplains are anticipated to for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors to floodplains: physical seabed/land disturbance, habitat conversion, and land use and economic change.

Construction Impact Summary

Temporary impacts to floodplains will result from the construction of the Shore-Based Measures. Preparation of the construction sites would require clearing and grading of vegetation that could result in temporary impacts within the floodplain. Any temporary impacts to vegetation may be anticipated to be replaced on-site and in-kind. Dewatering activities and associated increases in water may cause temporary direct impacts to floodplains during construction, but would not cause long-term permanent impacts as dewatered areas will be returned to pre-existing conditions post construction. Potential dredging in floodplains and intertidal habitats would also cause temporary impacts during construction, and floodplains may also be temporarily affected by clearing and soil disturbance. Temporary impacts to would be managed through implementation of a site-specific SWPPP and construction BMPs.

Excavation and fill activities associated with the measures may permanently impact floodplains through removal of vegetation and filling. Foundation installation may cause long-term permanent impacts to floodplains through vegetation removal and habitat conversion to impervious surfaces. During construction, the storm surge barriers and tide gates could cause permanent changes in hydrology, which could lead to secondary impacts to floodplains through scouring or sedimentation.

Mitigation for construction within floodplains may be required in regulated areas; therefore, site-specific mitigation plans would be developed to offset project related impacts to floodplains as part of the Tier 2 EIS.

Operations and Maintenance Impact Summary

During operations and maintenance of the proposed measures, potential impacts to floodplains from storm surge and tide gate measures are anticipated. When the barriers are in the open position, no impacts would occur to floodplains. When the barriers are in the closed position, which would be when storm surge was expected, floodplains behind the barrier would benefit from the protection measures. Other minor temporary impacts to floodplains are anticipated, such as short-term changes in hydrology, sediment resuspension and minor increases in turbidity during operation.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to floodplains associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Floodplains.

TSP Floodplain Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	1	3	1	2	4
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*2+*	*1+*	*1+*	*1*	*1+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to floodplains under the TSP range from No to Moderate-High impacts. Moderate-High impacts may occur from construction of buried seawall and dune features which will affect floodplains in the Jamaica Bay Planning Region under the TSP. Moderate impacts to floodplains are expected from construction of levees and berms in the Hackensack/Passaic Region and construction of floodwalls and revetments in the Upper Bay/Arthur Kill under the TSP. Low impacts are expected from construction of the TSP to floodplains in the Lower Hudson/East River and Long Island Sound Regions from levees and other Shore-Based Measures. Impacts are related to clearing and grading required for Shore-Based Measures and dredging for in-water measures. These impacts are expected to be temporary. Permanent impacts to floodplains are expected from conversion of land to impervious surfaces from the implementation of the Shore-Based Measures.

Operation and maintenance impacts are expected to be Low in all Regions where measures are planned. Maintenance of Shore-Based Measures may have a Low impact on floodplains from any clearing or grading. Operations and maintenance of the storm surge barriers may also have a Low impact on floodplains.

Low impacts are anticipated to floodplains after avoidance, minimization, and mitigation is completed under the TSP. Implementation of the TSP will also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to floodplains are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Floodplains.

ALT 2 Floodplain Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3	3	4	3	3	4	4
O&M Assumptions	1	1	1	2	2	1	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to floodplains under Alternative 2 range from No to Moderate-High impacts. Moderate-High impacts to floodplains are expected in the Jamaica Bay and Lower Bay Planning Regions under Alternative 2 from construction of the buried seawall/dune features. Moderate-High impact may also occur to floodplains in the Long Island Sound Region from construction of levees, seawalls, tide gates, and floodwalls. Moderate impacts to floodplains may occur from construction of levees and berms in the Hackensack/Passaic Region and construction of floodwalls and revetments in the Upper Bay/Arthur Kill and Raritan Regions. Construction is also expected to impact floodplains in the Lower Hudson/East River Region from levees and other Shore-Based Measures, but impacts were rated as Low because the area of impact is expected to minimal in these Regions. Impacts are related to clearing and grading required for Shore-Based Measures and dredging for in-water measures. These impacts are expected to be temporary. Permanent impacts to floodplains are expected from conversion of land to impervious surfaces from the implementation of the Shore-Based Measures.

Operation and maintenance of the in-water features and several of the Shore-Based Measures, such as the buried seawall/dune, floodwall and seawalls, may have a Low impact to floodplains under Alternative 2.

Low impacts are anticipated to floodplains after avoidance, minimization, and mitigation is completed under Alternative 2. Implementation of Alternative 2 will also provide a benefit to these resources, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to floodplains are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Floodplains.

ALT 3A Floodplain Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	3	3	3	4	4
O&M Assumptions	1	1	1	2	2	1	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*2+*	*2+*	*1+*	*1*	*1+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to floodplains under Alternative 3A range from No to Moderate-High impacts. Moderate-High impacts to floodplains are expected from construction of the buried seawall and dune features in the Jamaica Bay Planning Region under Alternative 3A. Moderate-High impact may also occur to floodplains in the Long Island Sound Region from construction of seawalls, levees, tide gates, and floodwalls, many of which are proposed to cross floodplains. Moderate impacts to floodplains may also occur from construction of levees and berms in the Hackensack/Passaic Region, construction of floodwalls and revetments in the Upper Bay/Arthur Kill and Raritan Regions and construction of seawalls, floodwalls and levees in the Lower Bay Region. Construction is also expected to impact floodplains in the Lower Hudson/East River Region from levees and other Shore-Based Measures, but impact were rated Low because the area of impact is expected to be minimal in these Regions. Impacts are related to clearing and grading required for Shore-Based Measures and dredging for in-water measures. These impacts are expected to be temporary. Permanent impacts to floodplains are expected from conversion of land to impervious surfaces from the implementation of the Shore-Based Measures. Regions that require less land conversion, such a Lower Hudson/East River received a lower impact score.

Operation and maintenance impacts to floodplains from the in-water features and several of the Shore-Based Measures, such as the buried seawall/dune, floodwall and seawalls, are expected to be Low in all Regions where measures are planned under Alternative 3A.

Low impacts are anticipated to floodplains after avoidance, minimization, and mitigation is completed under Alternative 3A. Implementation of Alternative 3A will also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to floodplains are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Floodplains.

ALT 4 Floodplain Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	1	3	1	2	4
O&M Assumptions	1	1	1	1	1	2	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to floodplains under Alternative 4 range from No to Moderate-High impacts. Moderate-High impacts to floodplains are expected from construction of buried seawall and dune features in the Jamaica Bay Region under Alternative 4. Moderate impacts to floodplains may also occur from construction of levees, floodwalls and seawalls in the Upper Bay/Arthur Kill and Hackensack/Passaic Regions. Construction is also expected to impact floodplains in the Lower Hudson/East River and Long Island Sound Regions from levees and other Shore-Based Measures, but impacts were rated as Low because the area of impact is expected to be less in these regions. Impacts are related to clearing and grading required for Shore-Based Measures and dredging for in-water measures. These impacts are expected to be temporary. Permanent impacts to floodplains are expected from conversion of land to impervious surfaces from the implementation of the Shore-Based Measures.

Operation and maintenance of the in-water features and several of the Shore-Based Measures, such as the buried seawall/dune, floodwall and seawalls, may have a Low impact to floodplains under Alternative 4.

Low impacts are anticipated to floodplains after avoidance, minimization, and mitigation is completed under Alternative 4. Implementation of Alternative 4 will also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to floodplains are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under Alternative 4.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Floodplains.

ALT 5 Floodplain Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	3	1	1	1

O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to floodplains under Alternative 5 range from No to Moderate impact. Moderate impacts may occur from construction of levees which will affect floodplains in the Hackensack/Passaic Planning Region under Alternative 5. Low impacts to floodplains are expected in the Lower Hudson/East River Region and Upper Bay/Arthur Kill as few floodplains occur in the proposed area of impact. However, impacts to floodplains are temporary and expected to provide a benefit by managing the risk of flooding and subsequent erosion during large storm events.

Operation and maintenance of are not expected to have an impact on floodplains under Alternative 5. Low impacts are anticipated to floodplains after avoidance, minimization, and mitigation is completed under Alternative 5. Implementation of Alternative 5 will provide a benefit this resource, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to floodplains are expected in the Capital District, Mid-Hudson, Lower Bay, Jamaica Bay, Long Island Sound and Raritan Planning Regions because no structures are proposed there under Alternative 5.

Wild and Scenic Rivers

No impacts are anticipated to Wild and Scenic Rivers as those designated areas do not occur within the NYNJHAT Study Area. Therefore, all Alternatives reflect a “1” or No Impact rating:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Wild and Scenic Rivers.

ALT 3B (TSP), 2, 3A, 4, and 5 Wild and Scenic Rivers Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

Designated Critical Habitat

There is ESA-designated Critical Habitat for Atlantic sturgeon in the NYNJHAT Study Area in the Hudson River extending from the Battery in NY and Jersey City and continuing upriver to Troy at the northern end of the Study Area. Impact producing factors to designated Critical Habitat are physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals and habitat conversion. For more information on Atlantic sturgeon critical habitat, refer to Appendix A2.

Construction Impact Summary

Atlantic sturgeon Critical Habitat may be impacted by construction and associated changes in water quality due to turbidity or suspended sediments in the immediate construction area related to Shore-Based Measures such as floodwalls and seawalls. Turbidity levels are anticipated to return to baseline following construction completion and permanent impacts are not anticipated. Temporary impacts could be managed through implementation of a site-specific SWPPP and construction BMPs.

Operations and Maintenance Impact Summary

Closure of tidal gates or storm surge barriers may have temporary impacts on Atlantic sturgeon Critical Habitat, as unimpeded movement of adults to and from spawning sites is one of the physical requirements for this species' habitat. However, storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure. This should therefore not have a significant impact on movement of sturgeon.

Additionally, most of the construction associated with the NYNJHAT Study is limited to the very lower end of the Critical Habitat where fish may be swimming through to get to spawning sites farther upriver, construction impacts to the habitat in these areas are expected to be Low overall.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Designated Critical Habitat

TSP Designated Critical Habitat Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	2	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Critical Habitat for Atlantic sturgeon under the TSP range from No to Low impact. Low impacts are only expected in the Lower Hudson/East River Region. Impacts are possible from the in-water construction required for elevated promenades, seawalls and floodwalls that will occur in the Critical Habitat. Impacts will be related to changes in water quality in the vicinity of the construction. However, turbidity levels are anticipated to return to baseline following construction completion and permanent impacts are not anticipated. Temporary impacts could be managed through implementation of a site-specific SWPPP and construction BMPs.

Operations and maintenance may have Low impacts on Critical Habitat for Atlantic sturgeon if in-water work is required.

No impacts are expected to Critical Habitat in the Capital District, Mid-Hudson, and Raritan Planning Regions because no structures are proposed there under the TSP. No Critical Habitat is identified in the Lower Bay, Upper Bay/Arthur Kill, Hackensack/Passaic, Raritan, Long Island Sound and Jamaica Bay Regions; therefore, No impacts are anticipated.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Designated Critical Habitat

ALT 2 Designated Critical Habitat Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	2	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Critical Habitat for Atlantic sturgeon under Alternative 2 range from No to Low impact. Low impacts are only expected in the Lower Hudson/East River Region. Impacts are possible from the in-water construction required for floodwalls that will occur in the Critical Habitat. Impacts will be related to changes in water quality in the vicinity of the construction. However, turbidity levels are anticipated to return to baseline following construction completion and permanent impacts are not anticipated. Temporary impacts could be managed through implementation of a site-specific SWPPP and construction BMPs.

Operations and maintenance may have Low impacts on Critical Habitat for Atlantic sturgeon if in-water work is required.

No impacts are expected to Critical Habitat in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2. No Critical Habitat is identified in the Lower Bay, Upper Bay/Arthur Kill, Hackensack/Passaic, Raritan, Long Island Sound and Jamaica Bay Regions; therefore, no impacts are anticipated.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Designated Critical Habitat

ALT 3A Designated Critical Habitat Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	2	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Critical Habitat for Atlantic sturgeon under Alternative 3A range from No to Low impact. Low impacts are only expected in the Lower Hudson/East River Region. Impacts are possible from the in-water construction required for floodwalls that will occur in the Critical Habitat. Impacts will be related to changes in water quality in the vicinity of the construction. However, turbidity levels are anticipated to return to baseline following construction completion and permanent impacts are not anticipated. Temporary impacts could be managed through implementation of a site-specific SWPPP and construction BMPs.

Operations and maintenance may have Low impacts on Critical Habitat for Atlantic sturgeon if in-water work is required.

No impacts are expected to Critical Habitat in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A. No Critical Habitat is identified in the Lower Bay, Upper Bay/Arthur Kill, Hackensack/Passaic, Raritan, Long Island Sound and Jamaica Bay Regions; therefore, No impacts are anticipated.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Designated Critical Habitat

ALT 4 Designated Critical Habitat Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	2	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Critical Habitat for Atlantic sturgeon under the Alternative 4 from No to Low impact. Low impacts are only expected in the Lower Hudson/East River Region. Impacts are possible from the in-water construction required for elevated promenades, seawalls and floodwalls that will occur in the Critical Habitat. Impacts will be related to changes in water quality in the vicinity of the construction. However, turbidity levels are anticipated to return to baseline following construction completion and permanent impacts are not anticipated. Temporary impacts would be managed through implementation of a site-specific SWPPP and construction BMPs.

Operations and maintenance may have Low impacts on Critical Habitat for Atlantic sturgeon if in-water work is required.

No impacts are expected to Critical Habitat in the Capital District, Mid-Hudson, Lower Bay and Raritan Planning Regions because no structures are proposed there under Alternative 4. No Critical Habitat is identified in the Lower Bay, Upper Bay/Arthur Kill, Hackensack/Passaic, Raritan, Long Island Sound and Jamaica Bay Regions; therefore, no impacts are anticipated.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Designated Critical Habitat.

ALT 5 Designated Critical Habitat Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	2	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to Critical Habitat for Atlantic sturgeon under Alternative 5 range from No to Low impact. Low impacts are only expected in the Lower Hudson/East River Region. Impacts are possible from the in-water construction required for elevated promenades, seawalls and floodwalls that will occur in the Critical Habitat. Impacts will be related to changes in water quality in the vicinity of the construction. However, turbidity levels are anticipated to return to baseline following construction completion and permanent impacts are not anticipated. Temporary impacts could be managed through implementation of a site-specific SWPPP and construction BMPs.

Operations and maintenance may have Low impacts on Critical Habitat for Atlantic sturgeon if in-water work is required.

No impacts are expected to Critical Habitat in the Capital District, Mid-Hudson, Lower Bay, Jamaica Bay, Long Island Sound and Raritan Planning Regions because no structures are proposed there under Alternative 5. The Lower Bay, Upper Bay/Arthur Kill, Hackensack/Passaic, Raritan, Long Island Sound and Jamaica Bay Regions don’t contain any Critical Habitat so No impacts are expected.

Critical Environmental Areas (State)

Within the Lower Hudson/East River Planning Region, the east side of the Hudson River from Yonkers to the town of Peekskill is designated as a NY State Critical Environmental Area (CEA) for exceptional or unique character. The entirety of the Jamaica Bay Region is also designated as a CEA for protection of ecosystems and wildlife. The northern Long Island Sound in Westchester County is designated as a CEA for exceptional or unique character. One Special Groundwater Protection Area is located in Nassau County in the area of Lake Success.

In NJ, critical environmental sites are included in the NJ State Development and Redevelopment Plan. The critical environmental sites are used to help organize planning for new development or redevelopment and protect these resources from adverse impacts where possible.

Impact producing factors to CEAs include physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, air emissions, habitat conversion, noise, traffic, visible structures, and land use and economic change. Potential impacts and benefits to CEAs are discussed in further detail below.

Construction Impact Summary

Construction impacts from the buried seawall/dune measure that is proposed along the eastern shoreline of Sandy Hook to Long Branch, NJ under several Alternative plans. Sandy Hook is a barrier beach peninsula that is designated as a Gateway National Recreation Area and is administered by the NPS. A levee is proposed on the western portion of the Sandy Hook peninsula. There is one CEA located along the coastline from Highlands Beach south to Long Branch Beach that would have construction impacts from the buried seawall/dune. Impacts are also expected from the construction of all measures in the Jamaica Bay Region. The impacts are anticipated to be short-term and temporary and provide a long-term beneficial impact by enhancing the dunes for protection from future large storm events.

Operations and Maintenance Impact Summary

Operations and maintenance of the storm surge barriers has the potential to impact NY and NJ CEAs. When the barriers are in the open position, no impacts would occur to CEAs. When the barriers are in the closed position, which would be when storm surge was expected, CEAs behind the barrier would benefit from the protection measures.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Critical Environmental Areas.

TSP Critical Environmental Areas Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	1	1	1	1	1	3
O&M Assumptions	1	1	1	1	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*1+*	*1*	*1*	*1*	*1*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to CEAs under the TSP range from No to Moderate impacts. Moderate impacts may occur from construction of buried seawall and dune features, seawalls, levees, berms, floodwalls and bulkheads which will affect the Jamaica Bay CEA, in the Jamaica Bay Planning Region under the TSP. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to the CEA are expected to be Low. Road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be minor. Construction of the storm surge barrier in the Rockaway Inlet is also expected to impact the Jamaica Bay CEA.

Operations and maintenance are expected to have a Low impact on the Jamaica Bay CEA from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barrier.

The mitigated impact to CEAs ranges from No Impact to Low impacts. Low impacts are still possible after avoidance, minimization, and mitigation due to operation and maintenance of the storm surge barrier in Rockaway Inlet. Implementation of the TSP will also provide a benefit the Jamaica Bay CEA, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding. Additionally, even though measure footprints are not located within CEAs in the Upper Bay/Arthur Kill Region, features included in the TSP are expected to manage the risk of flooding to CEAs in this Region. No mitigated impacts are associated with any of the other Regions.

No impacts are to CEAs are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP. No impacts to CEAs are expected in the Upper Bay/Arthur Kill or Hackensack/Passaic Regions as no CEAs are located in those regions. The CEAs located in the Long Island Region will not be impacted by the TSP as it is located inland of the proposed measures.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Critical Environmental Areas.

ATL 2 Critical Environmental Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	3	1	1	1	3
O&M Assumptions	1	1	1+	1+	2	1+	1+	1	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1+*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to CEAs under Alternative 2 range from No to Moderate impacts. Moderate impacts may occur from construction of berms, floodwalls and bulkheads which will affect the Jamaica Bay CEA, in the Jamaica Bay Planning Region under Alternative 2. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to the CEA are expected to be Low. Road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be minor. Moderate impacts may also be expected in the Lower Bay Region with construction of the storm surge barrier in the outer harbor, which is also expected to impact the Jamaica Bay CEA.

Operation and maintenance impacts are expected to be Low in all Regions where measures are planned. Maintenance of Shore-Based Measures may have a Low impact on CEAs from any clearing or grading. Maintenance of in-water measures have the potential to impact CEAs from in-water work. The mitigated impact to CEAs ranges from No to Low impact. Low impacts are still possible after avoidance, minimization, and mitigation due to operation and maintenance of the storm surge barrier in the outer harbor. No mitigated impacts are associated with any of the other Regions. Implementation of Alternative 2 will also provide a benefit the Jamaica Bay CEA, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that are expected under the No Action Alternative. Additionally, even though measure footprints are not located within CEAs in the Upper Bay/Arthur Kill, Lower Hudson/East River, Hackensack Passaic and Raritan Regions, features included in Alternative 2 are expected to reduce the risk of flooding to CEAs in these Regions.

No impacts are to CEAs are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2. The CEAs located in the Long Island Region will not be impacted by Alternative 2 as it is located inland of the proposed measures.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Critical Environmental Areas.

ALT 3A Critical Environmental Areas Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	1	3	1	1	1	3
O&M Assumptions	1	1	1	1	2	1	1	1	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1+*	*1*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to critical environmental areas under Alternative 3A range from Moderate to No impact. Moderate impacts may occur from construction of berms, floodwalls and bulkheads which will affect the Jamaica Bay CEA, in the Jamaica Bay Planning Region under Alternative 3A. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to the CEA are expected to be Low. Road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be minor. Construction of the storm surge barrier in Rockaway Inlet is also expected to impact the Jamaica Bay CEA. Moderate impacts may also be expected in the Lower Bay Region from construction of the storm surge barrier on the bay side of Sand Hook and levees and seawalls that have the potential to impact CEA in the Atlantic Highlands.

Operations and maintenance are expected to have a Low impact on the Jamaica Bay and Atlantic Highlands CEAs from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barriers.

The mitigated impact to CEAs ranges from No to Low impact. Low impacts are still possible after avoidance, minimization, and mitigation due to operation and maintenance of the storm surge barrier in Rockaway Inlet. No mitigated impacts are associated with any of the other Regions. Implementation of Alternative 3A will also provide a benefit the Jamaica Bay CEA, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative. Additionally, even though measure footprints are not located within CEAs in the Upper Bay/Arthur Kill, Lower Hudson/East River, Hackensack Passaic and Raritan Regions, features included in the TSP are expected to manage the risk of flooding to CEAs in these Regions.

No impacts are to CEAs are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A. The CEAs located in the Long Island Region will not be impacted by Alternative 3A as it is located inland of the proposed measures.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Critical Environmental Areas.

ALT 4 Critical Environmental Areas Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	3
O&M Assumptions	1	1	1	1	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*1+*	*1*	*1+*	*1*	*1*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to CEAs under Alternative 4 range from No to Moderate impacts. Moderate impacts may occur from construction of buried seawall and dune features, seawalls, levees, berms, floodwalls and bulkheads which will affect the Jamaica Bay CEA, in the Jamaica Bay Planning Region under Alternative 4. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to the CEA are expected to be Low. Road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be minor. Construction of the storm surge barrier in the Rockaway Inlet is also expected to impact the Jamaica Bay CEA.

Operations and maintenance are expected to have a Low impact on the Jamaica Bay CEA from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barrier.

The mitigated impact to CEAs ranges from No impact to Low impacts. Low impacts are still possible after avoidance, minimization, and mitigation due to operation and maintenance of the storm surge barrier in Rockaway Inlet. Implementation of Alternative 4 will also provide a benefit the Jamaica Bay CEA, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding would occur with the No Action Alternative. Additionally, even though measure footprints are not located within CEAs in the Upper Bay/Arthur Kill and Hackensack/Passaic Regions features included in Alternative 4 are expected to reduce the risk of flooding to CEAs in this Region. No mitigated impacts are associated with any of the other Regions.

No impacts are to CEAs are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under Alternative 4. No impacts to CEAs are expected in the

Lower Hudson/East River as no CEAs are located in that Region. The CEAs located in the Long Island Region will not be impacted by the TSP as it is located inland of the proposed measures.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Critical Environmental Areas.

ALT 5 Critical Environmental Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

No construction or operations and maintenance impacts are expected to critical environmental areas under Alternative 5. Measures will not be constructed in CEAs nor will measures benefit CEAs.

Marine Protected Areas

Three Federally-designated marine protected areas (MPAs) have been established in the NY-NJ Harbor region in proximity to the project measures. One is the Gateway Recreation Area that includes areas on Jamaica Bay, Sandy Hook and Staten Island. This MPA is managed by the NPS and is conserved for natural heritage and cultural heritage and has Commercial and Recreational Fishing Restrictions. Another MPA is Cheesequake State Park in the Lower Bay Region. It is managed by NJDEP and is conserved for natural heritage and has Commercial and Recreational Fishing Restrictions. A third MPA is Liberty State Park in the Upper Bay/Arthur Kill Region. It is managed by NJDEP and is conserved for natural heritage and has Commercial and Recreational Fishing Restrictions.

Construction Impact Summary

Construction of the storm surge barriers and tide gates would occur within protected lands. Impact producing factors include physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, air emissions, habitat conversion, noise, traffic, visible structures, and land use and economic change. Barrier construction would permanently remove benthic habitat and replace it with hard-bottom and structural habitat. Any displaced species are expected to return to the area when construction is completed. These impacts would not affect the MPA designations.

Operations and Maintenance Impact Summary

Operations and maintenance of the storm surge barriers has the potential to impact MPAs. When the barriers are in the open position, no impacts would occur to MPAs. Direct and indirect impacts during barrier closure include temporary changes to hydrology and water quality, such as increases in turbidity and sediment suspension. Increased noise and vibration would be temporary and limited to the duration of barrier closure. These impacts would be temporary and would not be anticipated to affect the MPA designations. When the barriers are in the closed position, which would be when storm surge was expected, MPAs behind the barrier would benefit from the measures. Operation of the barriers is expected to provide a long-term beneficial impact by protecting from future large storm events.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts to MPAs associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Marine Protected Areas.

TSP Marine Protected Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	1	1	1	3
O&M Assumptions	1	1	1	2+	1	1	1	1	2+
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to MPAs under the TSP range from No to Moderate impacts. Moderate construction impacts are expected in the Gateway Recreational Area in Jamaica Bay. Low construction impacts are expected in Liberty State Park from the Shore-Based Measures planned in the Upper Bay/Arthur Kill Region. Impacts would be temporary during active construction. Site-specific BMPs to mitigate impacts during construction may be included in the Tier 2 EIS.

Operations and maintenance are expected to have a Low impact on MPAs from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barrier in the Jamaica Bay Region. Operations and maintenance are expected to have a Low impact on the Liberty State Park MPA from maintenance required for the levee in this area.

The mitigated impact to MPAs ranges from No impact to Low impact. Low impacts are still possible after avoidance, minimization, and mitigation due to operation and maintenance of the storm surge barrier in Rockaway Inlet. No mitigated impacts are associated with any of the other Regions. Implementation of the TSP is anticipated to also provide a benefit to the Gateway Recreational Area in Jamaica Bay, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative. Operations of the measures is also expected to benefit Liberty State Park by offering protection from future storm events.

No impacts are to MPAs are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP. No impacts to MPAs are expected in the Hackensack/Passaic and Long Island Regions as no MPAs are located in those regions.

ALTERNATIVE 2

Alternative 2, is anticipated to have the following impacts to MPAs associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Marine Protected Areas.

ALT 2 Marine Protected Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	3	1	1	1	3
O&M Assumptions	1	1	1	1+	2+	1	1	1	2+
Mitigated Rating	*1*	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to MPAs under Alternative range from No to Moderate impacts. Moderate construction impacts are expected in the Gateway Recreational Area in Jamaica Bay and Lower Bay Planning Regions. Impacts would be temporary during active construction. Site-specific BMPs to mitigate impacts during construction may be included in the Tier 2 EIS.

Operations and maintenance are expected to have a Low impact on MPAs from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barrier in the Jamaica Bay and Lower Bay Region.

The mitigated impact to MPAs ranges from No impact to Low impacts. Low impacts are still possible after avoidance, minimization, and mitigation due to operation of the storm surge barrier in the outer harbor. No mitigated impacts are associated with any of the other Regions.

Implementation of Alternative 2 is anticipated to also provide a benefit to the Gateway Recreational Area in Jamaica Bay and Sandy Hook, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative. The Liberty State Park and Cheesequake State Park MPAs are anticipated to also be at a managed risk of flooding and erosion damage with operation of the storm surge barrier in the outer harbor.

No impacts are expected to MPAs in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2. The Lower Hudson/East River, Hackensack/Passaic, Raritan, and Long Island Sound Regions don’t contain any MPAs so No impacts are expected.

ALTERNATIVE 3A

Alternative 3A, is anticipated to have the following impacts to MPAs associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Marine Protected Areas.

ALT 3A Marine Protected Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	3	1	1	1	3
O&M Assumptions	1	1	1	1+	2+	1	1	1	2+
Mitigated Rating	*1*	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to MPAs under Alternative range from No to Moderate impacts. Moderate construction impacts are expected in the Gateway Recreational Area in Jamaica Bay and Lower Bay Planning Regions. Impacts would be temporary during active construction. Site-specific BMPs to mitigate impacts during construction may be included in the Tier 2 EIS.

Operations and maintenance are expected to have a Low impact on MPAs from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barrier in the Jamaica Bay and Lower Bay Region.

The mitigated impact to MPAs ranges from No impact to Low impacts. Low impacts are still possible after avoidance, minimization, and mitigation due to operation and maintenance of the storm surge barrier in the outer harbor. No mitigated impacts are associated with any of the other Regions.

Implementation of Alternative 3A will also provide a benefit to the Gateway Recreational Area in Jamaica Bay and Sandy Hook, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative. The Liberty State Park MPA will also be at a reduced the risk of flooding and erosion damage with operation of the storm surge barrier in the lower bay.

ALTERNATIVE 4

Alternative 4, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Marine Protected Areas.

ALT 4 Marine Protected Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	1	1	1	3
O&M Assumptions	1	1	1	2+	1	1	1	1	2+
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to MPAs under Alternative 4 range from No to Moderate impacts. Moderate construction impacts are expected from the storm surge barrier measures in the Gateway Recreational Area in Jamaica Bay. Impacts would be temporary during active construction. Low construction impacts are expected in Liberty State Park from the Shore-Based Measures planned in the Upper Bay/Arthur Kill Region. Site-specific BMPs to mitigate impacts during construction may be included in the Tier 2 EIS.

Operations and maintenance are expected to have a Low impact on MPAs from any maintenance required for Shore-Based Measures and from operation of the storm surge barrier in the Jamaica Bay Region. Operations and maintenance are expected to have a Low impact on the Liberty State Park MPA from maintenance required for the levee in this area.

The mitigated impact to MPAs ranges from No impact to Low impacts. Low impacts are still possible after avoidance, minimization, and mitigation due to operation and maintenance of the storm surge barrier in Rockaway Inlet. No mitigated impacts are associated with any of the other Regions. Implementation of the TSP is anticipated also provide a benefit to the Gateway Recreational Area in Jamaica Bay, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative. Operations of the measures are also expected to benefit Liberty State Park by offering protection from future storm events.

No impacts are to MPAs are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP. No impacts to MPAs are expected in the Hackensack/Passaic and Long Island Regions as no MPAs are located in those regions.

ALTERNATIVE 5

Alternative 5, is anticipated to have the following impacts to MPAs associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Marine Protected Areas.

ALT 5 Marine Protected Areas Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	2	1	1	1	1	1
O&M Assumptions	1	1	1	2+	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to MPAs under Alternative 5 range from No to Low impacts. Low construction impacts are expected in Liberty State Park in the Upper Bay/Arthur Kill Region. Impacts would be temporary during active construction. Site-specific BMPs to mitigate impacts during construction may be included in the Tier 2 EIS.

Operations and maintenance are expected to have a Low impact on the Liberty State Park MPA from maintenance required for the levee in this area. Operations of the measures are expected to benefit Liberty State Park by offering protection from future storm events.

No mitigated impact is expected to the MPAs under Alternative 5.

No impacts are to MPAs are expected in the Capital District, Mid-Hudson, Lower Bay, Jamaica Bay, Long Island Sound and Raritan Planning Regions because no structures are proposed there under Alternative 5. No impacts to MPAs are expected in the Hackensack/Passaic or Lower Hudson/East River Regions because no MPAs are located near the Alternative 5 measure footprints.

Coastal Zone Management Act Areas

NOAA maintains federally mapped CZMA boundaries, NYSDOS Office of Planning and Management maintains New York State mapped CZMA boundaries present within New York State, and NJDEP maintains mapped CZMA boundaries. The NY State Coastal Management Program (CMP), a division of NYSDOS, establishes the boundaries of the Coastal Area under the National Coastal Zone Management Program (CZMP). The coastal zone boundary encompasses land and water where there could be significant impact on coastal waters. Most measures would impact the New York CMP.

New Jersey CZMA includes land regulated under the following regulations, the Coastal Area Facility Review Act (CAFRA), the Waterfront Development Law, the Hackensack Meadowlands Reclamation and Development Act, and the Wetlands Act of 1970. New Jersey's coastal zone encompasses tidal and non-tidal waters, waterfronts, and on land areas, including the Hudson River from the interstate border with New York and related tidal waters, south to the Raritan Bay. This area also encompasses the Coastal Facility Review Act (CAFRA) zone and tidally influenced municipalities regulated under the Waterfront Development Law. CAFRA areas are located from Highlands Beach south to Long Branch Beach, NYA review of each of the policies for NY State, NY City and NJ are included in Appendix A4.

Construction Impact Summary

Construction impacts to the NY CMP would occur for all measures, as the majority of the action area in NY is within CZMA areas. However, once constructed, measures would provide a managed risk to NY's coastal boundaries during large storm events. NY State Significant Coastal Fish and Wildlife Habitats (SCFWH) are identified under NY's CMP and include Jamaica Bay, Breezy Point Tip, the Hudson River on the western side of Manhattan, and several other habitats within Long Island Sound. Project measures are expected to enhance SCFWH, but impacts are expected during construction. Impact producing factors include physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, air emissions, habitat conversion, noise, traffic, visible structures, and land use and economic change.

Buried seawall/dune measure would be constructed through the CAFRA zone as well as berms, seawalls, floodwalls, revetments with floodwalls and levees, depending on the Alternative, and impacts are anticipated. Nearly all of the features proposed in NJ are within lands regulated under CZMA, this includes lands within the Hackensack Meadowlands region, tidal waters and Upland Waterfront Development Areas.

Operations and Maintenance Impact Summary

Impacts may occur during maintenance of Shore-Based Measures that may prevent access to coastal areas where Shore-Based Measures are installed. However, these impacts are expected to be temporary and maintenance is not expected to occur often.

Operations and maintenance of the storm surge barriers has the potential to impact CZMA areas. When the barriers are in the open position, no impacts would occur to CZMA areas. When the barriers are in the closed position, which would be when storm surge was expected, CZMA areas behind the barrier would benefit from the protection measures. Direct and indirect impacts during barrier closure include temporary changes to hydrology and water quality, such as increases in turbidity and sediment suspension. Increased noise and vibration may also occur, but would be temporary and limited to the duration of barrier closure.

The NYNJHAT Study measures are expected to enhance the shoreline and provide a reduced risk from future large storm events, which aligns with the intent of this policy.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Coastal Zone Management Act Areas.

TSP Coastal Zone Management Act Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3	3	1	2	1	2	3
O&M Assumptions	1	1	2+	2+	1	2+	1	2+	2+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to CZMA areas under the TSP range from No to Moderate impacts. Moderate impacts to CZMA areas are expected in the Jamaica Bay Region from construction of all Shore-Based Measures proposed there under the TSP. Similarly, Moderate impacts to CZMA areas from all Shore-Based Measures proposed there are expected in the Upper Bay/Arthur Kill and Lower Hudson/East River Regions as these resources are extensive in these Regions. Low impacts are expected from construction of the TSP to CZMA areas in the Long Island Sound and Hackensack/Passaic Regions from levees, floodwalls and other Shore-Based Measures. However, impacts to CZMA areas are temporary and expected to provide a benefit by managing the risk of flooding and subsequent erosion during large storm events.

Operations and maintenance are expected to have a Low impact on CZMA areas from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barrier in the Jamaica Bay Region.

No mitigated impacts are expected to CZMA areas. Implementation of the TSP is anticipated to also provide a benefit to Study Area CZMA areas, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to CZMA area are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP.

ALTERNATIVE 2

Alternative 2, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Coastal Zone Management Act Areas

ALT 2 Coastal Zone Management Act Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	2	3	3
O&M Assumptions	1	1	2+	2+	2+	2+	2+	2+	2+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to CZMA areas under Alternative 2 range from No to Moderate impacts. Moderate impacts CZMA areas are expected in the Jamaica Bay and Lower Bay Regions from construction of all Shore-Based Measures proposed there, including the buried seawall/dune feature under Alternative 2. Similarly, Moderate CZMA areas from all Shore-Based Measures proposed are expected in the Long Island Sound Region. Low impacts are also expected to New York and New Jersey CZMA areas from construction of Shore-Based Measures in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic and Raritan Regions. However, impacts to these areas are temporary and expected to provide a benefit by managing the risk of flooding and subsequent erosion during large storm events.

Operations and maintenance are expected to have a Low impact on CZMA areas from any maintenance required for Shore-Based Measures and from operation of the storm surge barrier in the Jamaica Bay Region.

No mitigated impacts are expected to CZMA areas. Implementation of Alternative 2 is anticipated to also provide a benefit to Study Area CZMA areas, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to CZMA areas are expected in the Capital District, and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2.

ALTERNATIVE 3A

Alternative 3A, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3A on Coastal Zone Management Act Areas

ALT 3A Coastal Zone Management Act Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	3	3	3
O&M Assumptions	1	1	2+	2+	2+	2+	2+	2+	2+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to CZMA areas under Alternative 3A range from No to Moderate impacts. Moderate impacts to CZMA areas are expected in the Jamaica Bay, Long Island Sound, Raritan and Lower Bay Regions from construction of all Shore-Based Measures proposed there, including the buried seawall/dune feature under Alternative 3A. Moderate impacts are also expected from construction of the storm surge barriers in these regions. Low impacts to CZMA areas from all Shore-Based Measures proposed are expected in the Upper Bay/Arthur Kill, Hackensack/Passaic and Lower Hudson/East River Regions. However, impacts to CZMA areas are temporary and expected to provide a benefit by managing the risk of flooding and subsequent erosion during large storm events.

Operations and maintenance are expected to have a Low impact on CZMA areas from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barrier in the Jamaica Bay, Raritan and Lower Bay Regions.

No mitigated impacts are expected to CZMA areas. Implementation of Alternative 3A is anticipated to also provide a benefit to Study Area CZMA areas, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to CZMA areas are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A.

ALTERNATIVE 4

Alternative 4, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 4 on Coastal Zone Management Act Areas.

ALT 4 Coastal Zone Management Act Areas Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	3	3	1	3	1	2	3
O&M Assumptions	1	1	2+	2+	1	2+	1	2+	2+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to CZMA areas under Alternative 4 range from No to Moderate impacts. Moderate impacts to CZMA areas are expected in the Jamaica Bay Region from construction of all Shore-Based Measures proposed there under Alternative 4. Similarly, Moderate impacts to CZMA areas from all Shore-Based Measures proposed there are expected in the Upper Bay/Arthur Kill, Hackensack/Passaic Region and Lower Hudson/East River Regions as these resources are extensive in these Regions. Low impacts are expected from construction of Alternative 4 to CZMA areas in the Long Island Sound Regions from levees and other Shore-Based Measures. However, impacts to these CMZA areas are temporary and expected to provide a benefit by managing the risk of flooding and subsequent erosion during large storm events.

Operations and maintenance are expected to have a Low impact on CZMA areas from any maintenance required for Shore-Based Measures and from operation and maintenance of the storm surge barrier in the Jamaica Bay and Long Island Sound Regions.

No mitigated impacts are expected to CZMA areas. Implementation of Alternative 4 is anticipated to also provide a benefit to Study Area CZMA areas, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to land use are expected in the Lower Bay, Mid-Hudson, Raritan and Capital District Regions because no structures are proposed there under Alternative 4.

ALTERNATIVE 5

Alternative 5, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 5 on Coastal Zone Management Act Areas.

ALT 5 Coastal Zone Management Act Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3	2	1	3	1	1	1
O&M Assumptions	1	1	2+	2+	1	2+	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to CZMA areas under Alternative 5 range from No to Moderate impacts. Moderate impacts may occur to CZMA areas in the Lower Hudson/East River and Hackensack/Passaic Regions from construction of floodwalls, levees, elevated promenades and deployable flood barriers. There are also Low impacts expected in the Upper Bay/Arthur Kill Region to NJ tidal waters and upland CZMA areas from construction of the levees proposed in Jersey City under Alternative 5.

Operations and maintenance are expected to have a Low impact on CZMA areas from any maintenance required for Shore-Based Measures in the Lower Hudson/East River, Upper Bay/Arthur Kill and Hackensack/Passaic Regions. However, no mitigated impacts are expected to CZMA areas. Implementation of Alternative 5 are anticipated to also provide a benefit to Study Area CZMA areas, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No impacts are to CZMA areas are expected in the Capital District, Mid-Hudson, Lower Bay, Jamaica Bay, Long Island Sound and Raritan Planning Regions because no structures are proposed there under Alternative

Coastal Barrier Resources Act Areas

The Coastal Barrier Resource System (CBRS) is mapped along the Sandy Hook peninsula and the entirety of Jamaica Bay. These areas are protected under the CBRA and development is generally restricted. No adverse impacts are expected therefore there are no impact producing factors to CBRS areas. For more information on CBRS, refer to Appendix A7.

Construction Impact Summary

No adverse impacts associated with construction are anticipated to the CBRA Otherwise Protected Area by the project. However, note that although no impacts are anticipated to the CBRA designated Otherwise Protected Area, this does not indicate there are no impacts to other resources that may be present within the Otherwise Protected Area, which are assessed in more detail in other sections of this report and associated appendices (e.g., NPS Land, wetlands, threatened and endangered species, etc.). Construction of the barriers within Jamaica Bay and the Sandy Hook-Breezy Point barrier would be anticipated to provide beneficial impacts to coastlines by preventing erosion and flooding during large storm events.

Operations and Maintenance Impact Summary

No adverse impacts are associated with operations and maintenance to the CBRA Otherwise Protected Area by the project. Beneficial effects from some Alternative plans would be anticipated to align with the intent of the CBRA, which encourages the conservation of storm-prone areas and reduce loss of natural resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Coastal Barrier Resource System Areas.

TSP Coastal Barrier Resource System Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction is not expected to impact to the CBRS under the TSP. Operation and maintenance of Shore-Based Measures are not expected to impact the CBRS. Operation of the storm surge barrier is expected to benefit the CBRS in the Jamaica Bay Planning Region. No adverse impacts to CBRS are expected during operation and maintenance of storm surge barrier. Beneficial effects of the TSP are anticipated to align with the intent of the CBRA, which encourages the conservation of storm-prone areas and reduce loss of natural resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year. Anticipated benefits include managed damages caused by coastal storms and managed storm damage risks to the Otherwise Protected Areas of Gateway National Recreation Area (NY-60P).

ALTERNATIVE 2

Alternative 2, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Coastal Barrier Resource System Areas.

ALT 2 Coastal Barrier Resource System Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1+	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	*1*	*1+*	*1*	*1*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction is not expected to impact to the CBRS under Alternative 2. Operation and maintenance of Shore-Based Measures are not expected to impact the CBRS. Operation of the storm surge barrier in the outer harbor is expected to benefit the CBRS in the Jamaica Bay and Lower Bay Planning Regions. No adverse impacts to CBRS are expected during operation and maintenance of storm surge barrier. Beneficial effects of Alternative 2 are anticipated to align with the intent of the CBRA, which encourages the conservation of storm-prone areas and manage loss of natural resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year. Anticipated benefits include reduced damages caused by coastal storms and managed storm damage risks to the Otherwise Protected Areas of Gateway National Recreation Area (NY-60P).

ALTERNATIVE 3A

Alternative 3A, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3A on Coastal Barrier Resource System Areas.

ALT 3A Coastal Barrier Resource System Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1+	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	*1*	*1+*	*1*	*1*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction is not expected to impact to the CBRS under Alternative 3A. Operation and maintenance of Shore-Based Measures are not expected to impact the CBRS. Operation of the storm surge barriers in Jamaica Bay and on the bay side of Sandy Hook are expected to benefit the CBRS in the Jamaica Bay and Lower Bay Planning Regions. No adverse impacts to CBRS are expected during operation and maintenance of storm surge barrier. Beneficial effects of Alternative 3A are anticipated to align with the intent of the CBRA, which encourages the conservation of storm-prone areas and manage loss of natural resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year. Anticipated benefits include reduced damages caused by coastal storms and managed storm damage risks to the Otherwise Protected Areas of Gateway National Recreation Area (NY-60P).

ALTERNATIVE 4

Alternative 4, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 4 on Coastal Barrier Resource System Areas.

ALT 4 Coastal Barrier Resource System Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction is not expected to impact to the CBRS under Alternative 4. Operation and maintenance of Shore-Based Measures are not expected to impact the CBRS. Operation of the storm surge barriers in Jamaica Bay are expected to benefit the CBRS in the Jamaica Bay Planning Region. No adverse impacts to CBRS are expected during operation and maintenance of storm surge barrier. Beneficial effects of Alternative 4 are anticipated to align with the intent of the CBRA, which encourages the conservation of storm-prone areas and manage loss of natural resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year. Anticipated benefits include reduced damages caused by coastal storms and managed storm damage risks to the Otherwise Protected Areas of Gateway National Recreation Area (NY-60P).

ALTERNATIVE 5

Alternative 5, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 5 on Coastal Barrier Resource System Areas.

ALT 5 Coastal Barrier Resource System Areas Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1

O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction and operation maintenance is not expected to impact to the CBRS under Alternative 5, as measures under this alternative are not located in the vicinity of the CBRS.

National Park Service Land

Several NPS properties and National Heritage Areas intersect with or lie within the viewshed of proposed project features. The largest of these by far is the Gateway National Recreation Area (GNRA) which is administered by the NPS and located within the NYNJHAT Study Area. Impacts to NPS lands are expected from construction of buried seawalls/dunes, reinforced dunes, storm surge barriers, levees, floodwalls, and bulkheads. Impact producing factors to NPS lands include physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, air emissions, habitat conversion, noise, traffic, visible structures, land use and economic change, impacts to historic properties and National Historic Landmarks, and visitor experience. The NPS provided comments on the conceptual alternatives following the release of the draft Interim Report in 2019 in which they analyzed the potential direct and indirect impacts from the proposed alternatives. In the letter NPS indicated that while they support USACE's goal of managing storm risk along nearly 1,000 miles of densely populated shoreline in New York and New Jersey they note that many of the plans could have permanent and significant impacts to park resources.

It must be noted that for any measure to be constructed within NPS Land, mutual acceptability between the Department of Interior and the Department of Army is required. The GATE enabling legislation (Public Law 92-592, 1972) states: "The authority of the Secretary of the Army to undertake or contribute to water resource developments, including shore erosion control, beach protection, and navigation improvements (including the deepening of the shipping channel from the Atlantic Ocean to the New York harbor) on land and/or waters within the recreation area shall be exercised in accordance with plans which are mutually acceptable to the Secretary of the Interior and the Secretary of the Army and which are consistent with both the purpose of this subchapter and the purpose of existing statutes dealing with water and related land resource development." A mutually acceptable plan must meet USACE project objectives, minimize impacts to NPS cultural, natural and recreational resources, and mitigate for all unavoidable impacts to NPS resources.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on National Park Service Land

TSP National Park Service Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	1	1	1	4
O&M Assumptions	1	1	1+	1	1	1	1	1	3+
Mitigated Rating	*1*	*1*	*1+*	*1*	*1*	*1*	*1*	*1*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to NPS land under the TSP range from No to Significant impacts. Moderate impacts may occur from construction of buried seawall and dune features, seawalls, levees, berms, floodwalls and bulkheads which will affect the GNRA, in the Jamaica Bay Planning Region under the TSP. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to National Park are expected to be Low. Road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be Low. Construction of shore-based measures in Lower Manhattan located in the vicinity of Battery Park and in Jersey City, NJ within Liberty State Park have the potential to impact the visitor experience in the short and long term as well as emergency access in the short term at the Ferry Terminal. Additionally, construction in the vicinity of the Castle Clinton Historic Site could result in harmful vibrations. BMPs and design refinements would be expected to reduce or eliminate most impacts to NPS resources located within the Upper Bay/Arthur Kill and Lower Hudson/East River Region, therefore a Low impact rating was given for these Regions. In GNRA's review of the alternative they indicated that the construction of Alternative 3B could have permanent and significant impacts to cultural, natural, and recreational resources, specifically the Jamaica Bay storm surge barrier therefore the impacts were considered Moderate to High for the Jamaica Bay Region. Park resources that could be impacted by these alternatives include:

- The Fort Tilden Historic District
- Jacob Riis Park Historic District
- Breezy Point Surf Club Historic District
- Silver Gull Beach Club Historic District
- USCG Station Far Rockaway Historic District
- Floyd Bennett Field Historic District
- Archeological resources
- The beach and dune systems at Breezy Point Tip, Plumb Beach, Fort Tilden, and Jacob Riis Park
- Natural areas at Breezy Point Tip, Fort Tilden, and the Jamaica Bay Wildlife Refuge
- Jamaica Bay waters, including inlets, submerged lands, and Dead Horse Bay
- Beach experience, including access to ocean surf
- Public access to bay and ocean shorelines
- Water-based activities such as surfing, boating, fishing, and swimming

Operations and maintenance of the storm surge barrier and the shore-based measures in the Rockaway Inlet is expected to have a Moderate impact on the GNRA in the Jamaica Bay Planning Region under the TSP.

The mitigated impact to NPS lands areas ranges from No Impact to Low Impacts. Low impacts are still possible after avoidance, minimization, and mitigation due to operation of the storm surge barrier in Rockaway Inlet. Implementation of the TSP will also provide a benefit the Gateway National Recreational Area, in the Jamaica Bay Planning Region, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur under the No Action Alternative. A beneficial impact to the Lower Hudson/East River Region may also be expected to the NPS lands located in Manhattan from the levees and other Shore-Based Measures proposed in this region.

No impacts to NPS lands are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP. No impacts are expected in the Long Island Sound or Hackensack/Passaic Regions as no NPS Lands would be affected by construction of the TSP.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on National Park Service Land

ATL 2 National Park Service Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	4	1	1	1	4
O&M Assumptions	1	1	1	1	3+	1	1	1	3+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1*	*1*	*1*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Direct and indirect construction/footprint impacts to NPS lands under Alternative 2 range from No to Moderate to High impacts. Moderate impacts to cultural, natural, and recreational resources may occur from construction of berms, floodwalls and bulkheads within the GNRA, in the Jamaica Bay and Lower Bay Planning Regions under Alternative 2. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to National Park are expected to be Low. Road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be Low. Moderate to High direct and indirect impacts are also expected to NPS land in the Lower Bay and Jamaica Bay Regions from construction and operation of the storm surge barrier in the outer harbor. In their analysis of this alternative NPS indicated that the impact from construction of the storm surge barrier/shore-based measure system would have permanent and Moderate to High impacts and that further analysis would be needed to assess the impacts of the Sandy Hook to Breezy Point Barrier on the GNRA given its size and projected 25-year construction duration (NPS 2019). Specific park resources that could be impacted by Alternative 2 include:

- The Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District
- The Sandy Hook Light National Historic Landmark
- The Spermaceti Cove Life Saving Station Number 2
- The Fort Tilden Historic District
- Jacob Riis Park Historic District
- Breezy Point Surf Club Historic District
- Silver Gull Beach Club Historic District
- Fort Wadsworth Historic District
- Archeological resources
- The beach and dune systems at Breezy Point Tip, Fort Tilden, Jacob Riis Park and Sandy Hook
- Natural areas at Breezy Point Tip, Fort Tilden, Hoffman and Swinburne Islands, and the Jamaica Bay Wildlife Refuge
- Jamaica Bay waters, including inlets, submerged lands, and Dead Horse Bay
- Sandy Hook maritime forest
- Beach experience, including access to ocean surf
- Public access to bay and ocean shorelines
- Water-based activities such as surfing, boating, fishing, and swimming

Operation and maintenance impacts are expected to be Moderate in all Regions where measures are planned on NPS land. Maintenance of Shore-Based Measures may have a Low impact on NPS land from any clearing or grading.

With the anticipation of design refinements to manage or eliminated certain impacts and incorporation of mitigation measures that will be developed in consultation with NPS impacts under Alternative 2 are expected to be reduced to Low. Implementation of Alternative 2 is anticipated to also provide a benefit the NPS land in the Jamaica Bay Unit by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that are expected under the No Action Alternative. Beneficial impacts are also expected to NPS sites in the Lower Hudson/East River Region, including Castle Clinton National Monument, as well as in the Upper Bay/Arthur Kill Region to the Statue of Liberty National Monument and Governors Island National Monument.

No impacts to NPS lands are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2. No impacts are expected in the Long Island Sound, Raritan or Hackensack/Passaic Regions as NPS lands would not be affected by construction or operation of Alternative 2 measures located in those regions.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on National Park Service Land

ALT 3A National Park Service Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	3	1	1	1	4
O&M Assumptions	1	1	1+	1+	2+	1	1	1	3+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1*	*1*	*1*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to NPS lands under Alternative 3A range from No to Significant impact. Moderate impacts may occur from construction of buried seawall and dune features, seawalls, levees, berms, floodwalls and bulkheads which will affect the GNRA in the Jamaica Bay Planning Region under Alternative 3A. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to NPS resources is expected to be Low. Road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be Low. Construction of the storm surge barrier in Rockaway Inlet is also expected to have a significant impact on the GNRA in the Jamaica Bay Planning Region. Moderate impacts may also be expected in the Lower Bay Region from construction of the storm surge barrier on the bay side of Sandy Hook and levees and seawalls that have the potential to impact the GNRA on Sandy Hook. In their analysis of this alternative NPS indicated that the impact from construction of the Verrazano Narrows and Jamaica Bay storm surge barrier/shore-based measure systems could have permanent and Moderate to High direct and indirect impacts and that further analysis is needed to assess the impacts of this alternative (NPS 2019). Park resources that could be impacted by this alternative include:

- The Fort Tilden Historic District
- Jacob Riis Park Historic District
- Breezy Point Surf Club Historic District
- Silver Gull Beach Club Historic District

- USCG Station Far Rockaway Historic District
- Floyd Bennett Field Historic District
- Fort Wadsworth Historic District
- Archeological resources
- The beach and dune systems at Breezy Point Tip, Plumb Beach, Fort Tilden, and Jacob Riis Park
- Natural areas at Breezy Point Tip, Fort Tilden, and Jamaica Bay Wildlife Refuge
- Jamaica Bay waters, including inlets, submerged lands, and Dead Horse Bay
- Beach experience, including access to ocean surf
- Public access to bay and ocean shorelines
- Water-based activities such as surfing, boating, fishing, and swimming

Operations and maintenance are expected to have a Low to Moderate impact on the GNRA, in the Jamaica Bay and Lower Bay Planning Regions any maintenance required for Shore-Based Measures and from operation of the storm surge barriers.

Design refinements and BMPs will be employed to reduce or eliminate certain impacts to park resources but Mitigation for impacts to NPS lands is anticipated under Alternative 3A. Implementation of Alternative 3A would be expected to also provide a benefit to the GNRA, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative. Beneficial impacts are also expected to NPS sites in the Lower Hudson/East River Region, including Castle Clinton National Monument, as well as in the Upper Bay/Arthur Kill Region to the Statue of Liberty National Monument and Governors Island National Monument.

No impacts to NPS lands are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A. No impacts are expected in the Long Island Sound, Raritan or Hackensack/Passaic Regions as NPS lands would not be affected by construction or operation of Alternative 3A.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on National Park Service Land.

ALT 4 National Park Service Land Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	4
O&M Assumptions	1	1	1	1+	1	1+	1	1	3+
Mitigated Rating	*1*	*1*	*1*	*1+*	*1*	*1+*	*1*	*1*	2+

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to NPS land under Alternative 4 range from No to Significant impacts. Moderate impacts may occur from construction of buried seawall and dune features, seawalls, levees, berms, floodwalls and bulkheads which will affect the Gateway National Recreational Area, in the Jamaica Bay Planning Region under

Alternative 4. Road raising is also planned along Broad Channel in Jamaica Bay and impacts to National Park are expected to be Low. Road raisings are expected to occur in areas surrounding existing road structure, so habitat disturbance is anticipated to be Low. Construction of shore-based measures in Lower Manhattan located in the vicinity of Battery Park and in Jersey City, NJ within Liberty State Park have the potential to impact the visitor experience in the short and long term as well as emergency access in the short term at the Ferry Terminal. Additionally, construction in the vicinity of the Castle Clinton Historic Site could result in harmful vibrations. BMPs and design refinements would be expected to reduce or eliminate most impacts to NPS resources located within the Upper Bay/Arthur Kill and Lower Hudson/East River Region, therefore a Low impact rating was given for these Regions. Construction of the storm surge barrier in the Rockaway Inlet is also expected to have Moderate to High direct and indirect impacts on the GNRA. In their analysis of this alternative NPS indicated that the impact from construction of the Jamaica Bay storm surge barrier/shore-based measure systems could have permanent and significant direct and indirect impacts and that further analysis is needed to assess the impacts of this alternative (NPS 2019). Park resources that could be impacted by this alternative include:

- The Fort Tilden Historic District
- Jacob Riis Park Historic District
- Breezy Point Surf Club Historic District
- Silver Gull Beach Club Historic District
- USCG Station Far Rockaway Historic District
- Floyd Bennett Field Historic District
- Fort Wadsworth Historic District
- Archeological resources
- The beach and dune systems at Breezy Point Tip, Plumb Beach, Fort Tilden, and Jacob Riis Park
- Natural areas at Breezy Point Tip, Fort Tilden, and Jamaica Bay Wildlife Refuge
- Jamaica Bay waters, including inlets, submerged lands, and Dead Horse Bay
- Beach experience, including access to ocean surf
- Public access to bay and ocean shorelines
- Water-based activities such as surfing, boating, fishing, and swimming

Operations and maintenance are expected to have a Moderate impact on the Gateway National Recreational Area, in the Jamaica Bay Planning Region under Alternative 4.

Design refinements and BMPs will be employed wherever possible to reduce or eliminate certain impacts to park resources but Mitigation for impacts to NPS lands is anticipated under Alternative 4. Implementation of Alternative 4 will also provide a benefit to the GNRA, in the Jamaica Bay Planning Region, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur under the No Action Alternative. A beneficial impact to the Lower Hudson/East River Region may also be expected to the NPS lands located in Manhattan from the levees and other Shore-Based Measures proposed in this region.

No impacts to NPS lands are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under Alternative 4. No impacts are expected in the Upper Bay/Arthur Kill, Long Island Sound or Hackensack/Passaic Regions as NPS lands would not be affected by construction or operation of Alternative 4.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on National Park Service Land

ALT 5 National Park Service Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1+	1	1	1	1	1	1
O&M Assumptions	1	1	1+	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

No construction or operations and maintenance impacts are expected to NPS lands under Alternative 5. Measures will not be constructed in NPS lands. A beneficial impact to the Lower Hudson/East River Region may be expected to the NPS lands located in Manhattan from the levees and other Shore-Based Measures proposed in this region by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur under the No Action Alternative.

Wildlife Refuge Land

The William T. Davis Wildlife Refuge is located in the Upper Bay/Arthur Kill Region (Staten Island) and includes a diverse landscape of salt meadow, low marsh, forested uplands, rock outcrops, a swamp forest, and small spring-fed ponds. These habitat types have attracted an abundance of birds, where over 117 bird species have been recorded (NYC Parks 2022). The Jamaica Bay Wildlife Refuge, established as part of the Gateway National Recreation Area, is located within the Jamaica Bay Region. No Wildlife Refuge Lands are identified within the Capital District Region, Mid-Hudson Region, Lower Hudson/East River Region, Hackensack/Passaic Region, Raritan Region, and Long Island Sound Region.

Impact producing factors to Wildlife Refuge Lands include physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, air emissions, habitat conversion, noise, traffic, visible structures, and land use and economic change. Potential impacts and benefits to Wildlife Refuge Lands are discussed in further detail below.

Construction Impact Summary

Construction impacts from the floodwalls that are proposed in the Upper Bay/Arthur Kill may impact the William T. Davis Wildlife Refuge. Many of these measures are proposed along the shoreline in each Region, so impacts are expected to be Low. Impacts to Wildlife Refuge Lands associated with construction of the measures include habitat conversion, noise, and temporary displacement of species that utilize the area. Any displaced species are expected to return to the area when construction is completed.

Operations and Maintenance Impact Summary

No impacts would occur to Wildlife Refuge Lands. When the barriers are in the closed position, which would be when storm surge was expected, Refuge Lands that are behind the barrier would benefit from the managed risk of coastal flooding.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Wildlife Refuge Lands.

TSP Wildlife Refuge Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	*1+*	*1*	*1*	*1*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to Wildlife Refuge Lands during construction of the TSP are expected to range from No to Low impact. The Region impacted the most will be the Upper Bay/Arthur Kill Region, which has floodwalls planned along the shoreline and near the William T. Davis Wildlife Refuge, on the west side of the Refuge. Impacts from construction include habitat conversion, noise, and temporary displacement of species that utilize the area. Any displaced species are expected to return to the area when construction is completed.

No impacts would occur to Wildlife Refuge Lands. When the barriers are in the closed position, which would be when storm surge was expected, Refuge Lands that are behind the barrier would benefit from the reduced risk of coastal flooding.

No mitigated impacts are associated the TSP. Implementation of the TSP would be anticipated to also provide a benefit, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No Impacts are expected to the other Regions under the TSP, either because Wildlife Refuge Lands do not occur within the Region, or measures are not planned in areas that would impact Wildlife Refuge Lands within the Region.

ALTERNATIVE 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Wildlife Refuge Lands.

ALT 2 Wildlife Refuge Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	1	1	1	1
O&M Assumptions	1	1	1	1	1+	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	*1+*	*1+*	*1*	*1*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to Wildlife Refuge Lands during construction of Alternative 2 are expected to range from No to Low impact. The Region impacted the most will be the Upper Bay/Arthur Kill Region, which has floodwalls planned along the shoreline and near the William T. Davis Wildlife Refuge, on the west side of the Refuge. Impacts from construction include habitat conversion, noise, and temporary displacement of species that utilize the area. Any displaced species are expected to return to the area when construction is completed.

No impacts would occur to Wildlife Refuge Lands. When the barriers are in the closed position, which would be when storm surge was expected, Refuge Lands that are behind the barrier would benefit from the managed risk of coastal flooding.

No mitigated impacts are associated Alternative 2. Implementation of Alternative 2 would be anticipated to also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.
No Impacts are expected to the other Regions under Alternative 2, either because Wildlife Refuge Lands do not occur within the Region, or measures are not planned in areas that would impact Wildlife Refuge Lands within the Region.

ALTERNATIVE 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Wildlife Refuge Lands

ALT 3A Wildlife Refuge Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	1	1	1	1
O&M Assumptions	1	1	1	1	1+	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	*1+*	*1+*	*1*	*1*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to Wildlife Refuge Lands during construction of Alternative 3A are expected to range from No to Low impact. The Regions impacted the most will be the Upper Bay/Arthur Kill Region and the Lower Bay, which have floodwalls and seawalls planned. Floodwalls are planned along the shoreline of the Upper Bay/Arthur Kill Region and on the west side of the William T. Davis Wildlife Refuge. Impacts from construction include habitat conversion, noise, and temporary displacement of species that utilize the area. Any displaced species are expected to return to the area when construction is completed.

No impacts would occur to Wildlife Refuge Lands. When the barriers are in the closed position, which would be when storm surge was expected, Refuge Lands that are behind the barrier would benefit from the reduced risk of coastal flooding.

No mitigated impacts are associated Alternative 3A. Implementation of Alternative 3A would be anticipated to also provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No Impacts are expected to the other Regions under Alternative 3A, either because Wildlife Refuge Lands do not occur within the Region, or measures are not planned in areas that would impact Wildlife Refuge Lands within the Region.

ALTERNATIVE 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Wildlife Refuge Lands.

ALT 4 Wildlife Refuge Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1+
Mitigated Rating	*1*	*1*	*1*	1+	*1*	*1*	*1*	*1*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to Wildlife Refuge Lands during construction of Alternative 4 are expected to range from No to Low impact. The Region impacted the most will be the Upper Bay/Arthur Kill Region, which has floodwalls planned along the shoreline and near the William T. Davis Wildlife Refuge, on the north side of the Refuge. Impacts from construction include habitat conversion, noise, and temporary displacement of species that utilize the area. Any displaced species are expected to return to the area when construction is completed.

No impacts would occur to Wildlife Refuge Lands. When the barriers are in the closed position, which would be when storm surge was expected, Refuge Lands that are behind the barrier would benefit from the managed risk of coastal flooding.

No mitigated impacts are associated Alternative 4. Implementation of Alternative 4 will also provide a benefit these resources, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding that would occur with the No Action Alternative.

No Impacts are expected to the other Regions under Alternative 4, either because Wildlife Refuge Lands do not occur within the Region, or measures are not planned in areas that would impact Wildlife Refuge Lands within the Region.

ALTERNATIVE 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Wildlife Refuge Lands.

ALT 5 - Wildlife Refuge Land Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

No Impacts are expected to Wildlife Refuge Lands in any Planning Region under Alternative 5, either because Wildlife Refuge Lands do not occur within the Region, or measures are not planned in areas that would impact Wildlife Refuge Lands within the Region.

6.1.5 Commercial and Recreational Fishing

Commercial and recreational fisheries are anticipated to be impacted during construction and operations and maintenance of the NYNJHAT Study measures. The following are impact- producing factors to commercial and recreational fishing: physical seabed disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, noise, vessel traffic, and land use and economic change. Below is a summary of the potential impacts to commercial and recreational fishing.

Many commercial and recreationally important species of fish and shellfish are found within the Study Area. These include largemouth bass (*Micropterus salmoides*), tautog (*Tautoga onitis*), weakfish (*Cynoscion regalis*), Atlantic croaker (*Micropogonias undulatus*), anchovy (*Anchoa spp.*), hard clam (*Mercenaria mercenaria*), soft shell clam (*Mya arenaria*), oyster (*Crassostrea virginica*), blue mussel (*Mytilus edulis*), and blue crab (*Callinectes sapidus*). Filter feeders such as blue mussel, hard clam, and oyster help maintain water quality that supports healthy ecosystems (Bain et al. 2007 and Waldman 2008). Blue mussels provide habitat for many species of fish and invertebrates by forming reef colonies that serve as substrate within bays and estuaries (Dewey 2000; Coen and Grizzle 2007; McDermott et. al. 2008). Largemouth bass, tautog, Atlantic croaker, and weakfish are among the many freshwater and brackish species that are recreationally targeted by anglers in the Study Area.

Atlantic menhaden (*Brevoortia tyrannus*), anchovies, silversides (*Menidia spp.*), and killifish (*Fundulus spp.*) are important forage species for commercially and recreationally sought-after fish in the Study Area. Prey species displacement is an indirect impact of both construction and operations and maintenance activities on fish in the Study Area.

Construction Impact Summary

Temporary short-term impacts are anticipated from the presence of construction equipment that could prohibit commercial and recreational fishing access within the Study Area. These impacts are expected to occur with the construction of the storm surge barrier and tide gates, which are in-water measures. Fishers that typically navigate through the Study Area on the way to other fishing locations would need to navigate around areas of active construction, resulting in short-term impacts to travel time and associated fuel expenses. Construction is temporary in nature and would not cause long-term access impacts to fishing locations.

Many of the fish in the Study Area are demersal, or benthic feeders, which may experience a reduction in feeding efficiency for some period of time during and immediately following construction. Construction activities would include bottom habitat disturbance and the potential loss of forage organisms in the immediate vicinity of the placement of new structures or bottom disturbance. Impacts may occur due to the effects of construction activities on benthic communities including forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals. Shellfish species that live on the substrate, such as bivalves, may experience mortality during benthic habitat disturbance. Mortality would be limited to individuals and is only expected within the construction footprint, so impacts will be localized.

Construction noise may cause short-term impacts to the presence of fish species sought by commercial and recreational fishers. These species are anticipated to return to the area once construction activities are completed.

While most juvenile and adult fish species will be able to actively avoid construction areas, direct permanent impacts to individuals of less mobile species may occur from contact with equipment and project vessels during construction. Mortality or injury to individuals of slow or immobile fish species, invertebrates, and demersal eggs could occur, but impacts would be localized and limited to individuals.

Operations and Maintenance Impact Summary

There would be no impacts to commercial and recreational fishing when the barriers are in the open position. Impacts to commercial and recreational fishing may be temporary when the barriers are closed during large storm events however, it is anticipated that commercial and recreational fishing may not be occurring. Barrier closure would hinder vessel traffic to and from fishing locations during potential routine maintenance if the barriers require closure outside of a large storm event. Storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure. Under these assumptions, once the barriers are re-opened, commercial and recreational fishing can continue, resulting in no long-term permanent impacts. Maintenance could be scheduled, and the schedule communicated to commercial and recreational fishing interests to the extent practicable.

Indirect impacts to fish and shellfish during barrier closure include temporary changes to hydrology and water quality which can cause increases in turbidity and sediment suspension. Increased noise and vibration would be temporary and limited to the duration of barrier closure. Indirect impacts such as prey species displacement may occur when benthic habitat becomes disturbed during barrier closure.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Commercial and Recreational Fishing.

TSP Commercial and Recreational Fishing Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3+	1	2	1	2+	3+
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*2*	*3*	*1*	*2*	*1*	*2*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to commercial and recreational fishing under the TSP range from No to Moderate impacts. The construction of the storm surge barrier and tide gates in the Jamaica Bay and Upper Bay/Arthur Kill Regions are expected to have Moderate impacts on commercial and recreational fishing, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, vessel traffic, and noise. Fishing vessels that typically navigate through the Study Area on the way to other fishing locations would need to travel around areas of active construction, which could result in longer traveling time and increased fuel costs. Construction noise may cause short-term impacts to the presence of fish species sought by commercial and recreational fishers, but fish are expected to return to the area once construction is completed. Physical habitat disturbance is expected to impact demersal and benthic species that are targeted by commercial and recreational fishermen; however, most fish are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return to the area after construction is completed.

Commercially important species that are expected to be impacted the most by construction of the TSP are benthic species such as blue mussel, hard clam, soft shell clam, and blue crab. Commercial and recreational oyster reefs are not currently present in the Study Area (NOAA 2018). Several oyster reefs have been installed throughout the NY-NJ Harbor as restoration habitat but are not commercially or recreationally fished (Baumann et al., 2021). Recreational species that are expected to be impacted include bottom-feeders such as tautog and Atlantic croaker. Demersal and benthic species found in bottom habitat will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates in Jamaica Bay and the Upper Bay/Arthur Kill Region; Low to Moderate impacts are expected, depending upon seasonal abundances and the extent of the measure. Impacts are expected to be localized and species will return or re-colonize (bivalves) when construction is complete. One storm surge barrier is planned within the Long Island Sound Region under the TSP, however, the barrier will be located in a small creek (Flushing Creek) so impacts are expected to be localized; therefore, Low impacts are expected.

Construction of the elevated promenade is expected to have Low impacts on commercial and recreational fish species, depending on the extent of the measure. The elevated promenade measure will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls planned in the Hackensack/Passaic, which account for a significant proportion of the measures planned under the TSP. There is one exception, Levees, which are set back from the shoreline and not expected to impact fish. Construction of the elevated promenade in Jamaica Bay and the Lower Hudson/East River will likely produce noise or disturbance to shoreline habitat that may impact fish and shellfish in the area.

Construction activities would include bottom habitat disturbance and the potential loss of forage organisms, such as silversides, killifish, and Atlantic menhaden, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates and fish. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates. This addition of fish habitat is expected to provide fishing opportunities which benefit anglers that utilize the area.

Two storm surge barriers, one at the south end of the Arthur Kill and one on the east end of the Kill Van Kull are anticipated to have Low impacts to fishing access to the river during construction and operation and maintenance. Similarly, the Jamaica Bay Region has a storm surge barrier planned across the main inlet. Within the Long Island Sound Region, a storm surge barrier is proposed at the mouth of Flushing Creek, a small tributary in the Region. Impacts to the creek are anticipated to be localized and minor, and the waterbody is not expected to be heavily utilized for fishing; therefore low impacts to fishing are expected in the Long Island Sound Region under the TSP.

Indirect impacts to fish and shellfish during barrier closure include temporary changes to hydrology and water quality which can cause increases in turbidity and sediment suspension. Increased noise and vibration would be temporary and limited to the duration of barrier closure. The storm surge barriers will also disturb benthic habitat during operations; however under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, impacts are anticipated to be localized and Low.

Barrier closure would hinder vessel traffic to and from fishing locations during potential routine maintenance. Once the barriers are re-opened, commercial and recreational fishing can continue, resulting in no long-term permanent impacts. Impacts to vessel passage are expected to be Low.

The mitigated impact to commercial and recreational fishing under the TSP ranges from Low to Moderate. Even with mitigation, impacts to commercial and recreational fishing are expected because of habitat disturbance associated with the storm surge barriers and the occasional restriction of fishing access within the Study Area. No impacts are expected in the remaining Planning Regions because no in-water measures are proposed there under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Commercial and Recreational Fishing.

ALT 2 Commercial and Recreational Fishing Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3+	2	1	3+	3
O&M Assumptions	1	1	2	2	3	2	2	2	2
Mitigated Rating	*1*	*1*	*2*	*2*	*3*	*2*	*2*	*3*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to commercial and recreational fishing under Alternative 2 range from No to Moderate impacts. The construction of the storm surge barrier and tide gates in the Lower Bay and Long Island Sound Regions are expected to have Moderate impacts on commercial and recreational fishing, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, vessel traffic, and noise. No storm surge barriers are planned within Jamaica Bay, however, fishing is expected to be moderately impacted by the extensive storm surge barrier planned in the adjacent Lower Bay Region. Fishing vessels that typically navigate through the Study Area on the way to other fishing locations would need to travel around areas of active construction, which could result in longer traveling time and increased fuel costs. Construction noise may cause short-term impacts to the presence of fish species sought by commercial and recreational fishers, but fish are expected to return to the area once construction is completed. Physical habitat disturbance is expected to impact demersal and benthic species that are targeted by commercial and recreational fishing vessels, however, most fish are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return to the area after construction is completed.

Commercially important species that are expected to be impacted the most by construction of Alternative 2 are benthic species such as blue mussel, hard clam, soft shell clam, and blue crab. Commercial and recreational oyster reefs are not currently present in the Study Area (NOAA 2018). Several oyster reefs have been installed throughout the NY-NJ Harbor to as restoration habitat but are not commercially or recreationally fished (Baumann et al., 2021). Recreational species that are expected to be impacted include bottom-feeders such as tautog and Atlantic croaker. Demersal and benthic species found in bottom habitat will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates in the Lower Bay and Long Island Sound Region; Low to Moderate impacts are expected, depending upon seasonal abundances and the extent of the measure. Impacts are expected to be localized and species will return or re-colonize (bivalves) when construction is complete.

Construction of the seawalls and elevated promenade is expected to have Low impact on commercial and recreational fish species, depending on the extent of the measure. These measures will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls. There is one exception, Levees, which are set back from the shoreline and not expected to impact fish.

Construction activities would include bottom habitat disturbance and the potential loss of forage organisms, such as silversides, killifish, and Atlantic menhaden, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates and fish. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates This addition of fish habitat is expected to provide fishing opportunities which benefit anglers that utilize the area.

The storm surge barriers planned in the Lower Bay and Long Island Sound will have Low impacts to fishing access in the Harbor and Lower Hudson River system during construction and operation and maintenance. The barriers will also disturb benthic habitat during operations; however, under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, impacts are anticipated to be Low in the Long Island Sound Region and moderate in the Lower Bay. Greater impacts are expected in the Lower Bay due to the extensive barrier that is planned under Alternative 2.

Barrier closure would hinder vessel traffic to and from fishing locations during potential routine maintenance. Once the barriers are re-opened, commercial and recreational fishing can continue, resulting in no long-term permanent impacts.

The mitigated impact to commercial and recreational fishing ranges from Low to Moderate impact as impacts to commercial and recreational fishing are expected because of habitat disturbance associated with the storm surge barrier measures and the occasional restriction of fishing access within the Study Area.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Commercial and Recreational Fishing.

ALT 3A Commercial and Recreational Fishing Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	3+	2+	2	3+	3+	3+
O&M Assumptions	1	1	1	2	2	1	2	2	2
Mitigated Rating	*1*	*1*	*2*	*3*	*2*	*2*	*2*	*3*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to commercial and recreational fishing under Alternative 3A range from No to Moderate impacts. The construction of the storm surge barrier and tide gates in Jamaica Bay, the Upper Bay Arthur Kill, the Long Island Sound, and the Raritan are expected to have Moderate impacts on commercial and recreational fishing, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, vessel traffic, and noise. A storm surge barrier is planned in the Lower Bay, however, low impacts are expected because the barrier is located in a small part of the Region. Fishing vessels that typically navigate through the Study Area on the way to other fishing locations would need to travel around areas of active construction, which could result in longer traveling time and increased fuel costs. Construction noise may cause short-term impacts to the presence of fish species sought by commercial and recreational fishers, but fish are expected to return to the area once construction is completed. Physical habitat disturbance is expected to impact demersal and benthic species that are targeted by commercial and recreational fishers, however, most fish are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return to the area after construction is completed.

Commercially important species that are expected to be impacted the most by construction of Alternative 3A are benthic species such as blue mussel, hard clam, soft shell clam, and blue crab. Commercial and recreational oyster reefs are not currently present in the Study Area (NOAA 2018). Several oyster reefs have been installed throughout the NY-NJ Harbor to as restoration habitat but are not commercially or recreationally fished (Baumann et al., 2021). Recreational species that are expected to be impacted include bottom-feeders such as tautog and Atlantic croaker. Demersal and benthic species found in bottom habitat will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates in Jamaica Bay, the Upper Bay/Arthur Kill, Raritan, and Long Island Sound Region; Low to Moderate impacts are expected, depending upon seasonal abundances and the extent of the measure. Impacts are expected to be localized and species will return or re-colonize (bivalves) when construction is complete.

Construction of the seawalls and elevated promenade is expected to have Low impact on commercial and recreational fish species, depending on the extent of the measure. These measures will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls. There is one exception, Levees, which are set back from the shoreline and not expected to impact fish.

Construction activities would include bottom habitat disturbance and the potential loss of forage organisms, such as silversides, killifish, and Atlantic menhaden, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates and fish. The foundation and structure installations can produce the artificial "reef effect," attracting numerous species of algae, shellfish, and other invertebrates. This addition of fish habitat is expected to provide fishing opportunities that benefit anglers that utilize the area.

The storm surge barriers will have Low impacts to regional fishing access during construction and operation and maintenance. The barriers will also disturb benthic habitat during operations; however, under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, impacts are anticipated to be localized and Low.

Barrier closure would hinder vessel traffic to and from fishing locations during potential routine maintenance. Once the barriers are re-opened, commercial and recreational fishing can continue, resulting in no long-term permanent impacts.

The mitigated impact to commercial and recreational fishing ranges from Low to Moderate impact as impacts to commercial and recreational fishing are expected because of habitat disturbance associated with the storm surge barrier measures and the occasional restriction of fishing access within the Study Area.

No impacts are to commercial and recreational fishing are expected in the Capital District and Mid-Hudson Planning Regions because no in-water measures are proposed there under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Commercial and Recreational Fishing.

ALT 4 Commercial and Recreational Fishing Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2+	1	2+	3+
O&M Assumptions	1	1	2	1	1	1	1	2	2
Mitigated Rating	*1*	*1*	*2*	*2*	*1*	*2*	*1*	*2*	*3*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to commercial and recreational fishing under Alternative 4 range from No to Moderate impacts. The construction of the storm surge barrier and tide gates in Jamaica Bay and the Hackensack/Passaic Regions are expected to have Moderate impacts on commercial and recreational fishing, including physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, habitat conversion, vessel traffic, and noise. A storm surge barrier is planned in the Long Island Sound, however, low impacts are expected because the barrier is located in a small part of the Region (Flushing Creek). Fishing vessels that typically navigate through the Study Area on the way to other fishing locations would need to travel around areas of active construction, which could result in longer traveling time and increased fuel costs. Construction noise may cause short-term impacts to the presence of fish species sought by commercial and recreational fishers, but fish are expected to return to the area once construction is completed. Physical habitat disturbance is expected to impact demersal and benthic species that are targeted by commercial and recreational fishers, however, most fish are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return to the area after construction is completed.

Commercially important species that are expected to be impacted the most by construction of Alternative 4 are benthic species such as blue mussel, hard clam, soft shell clam, and blue crab. Commercial and recreational oyster reefs are not currently present in the Study Area (NOAA 2018). Several oyster reefs have been installed throughout the NY-NJ Harbor to as restoration habitat but are not commercially or recreationally fished (Baumann et al., 2021). Recreational species that are expected to be impacted include bottom-feeders such as tautog and Atlantic croaker. Demersal and benthic species found in bottom habitat will be temporarily altered and disturbed during construction of the storm surge barriers and tide gates in Jamaica Bay, the Hackensack/Passaic, and Long Island Sound Region; Low to Moderate impacts are expected, depending upon seasonal abundances and the extent of the measure. Impacts are expected to be localized and species will return or re-colonize (bivalves) when construction is complete.

Construction of the seawalls and elevated promenade is expected to have Low impact on commercial and recreational fish species, depending on the extent of the measure. These measures will be located along the shoreline and construction activities are expected to disturb nearshore habitat. Low impacts are expected from most other Shore-Based Measures, such as berms and floodwalls. There is one exception, Levees, which are set back from the shoreline and not expected to impact fish.

Construction activities would include bottom habitat disturbance and the potential loss of forage organisms, such as silversides, killifish, and Atlantic menhaden, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

One potential benefit of the construction of in-water measures is the attraction of structure-oriented invertebrates and fish. The foundation and structure installations can produce the artificial “reef effect,” attracting numerous species of algae, shellfish, and other invertebrates. This addition of fish habitat is expected to provide fishing opportunities that benefit anglers utilize the area.

The storm surge barriers will have Low impacts to regional fishing access during construction and operation and maintenance. The barriers will also disturb benthic habitat during operations; however under the closure assumptions utilized in this Draft Integrated FR/Tier 1 EIS, impacts are anticipated to be localized and Low.

Barrier closure would hinder vessel traffic to and from fishing locations during potential routine maintenance. Once the barriers are re-opened, commercial and recreational fishing can continue, resulting in no long-term permanent impacts.

The mitigated impact to commercial and recreational fishing ranges from Low to Moderate impact as impacts to commercial and recreational fishing are expected because of habitat disturbance associated with the storm surge barrier measures and the occasional restriction of fishing access within the Study Area.

No impacts are to commercial and recreational fishing are expected in the Lower Bay, Raritan, Capital District and Mid-Hudson Planning Regions because no in-water measures are proposed there under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Commercial and Recreational Fishing.

ALT 5 Commercial and Recreational Fishing Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	2	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to commercial and recreational fishing under Alternative 5 range from No to Low impacts. The construction of the elevated promenade in the Lower Hudson/East River Region is expected to have low impacts on commercial and recreational fishing, due to physical seabed/land disturbance, sediment suspension, potential discharge/release and withdrawals, and noise. No impacts are expected from the levees, which are set back from the shoreline. Construction noise may cause short-term impacts to the presence of fish species sought by commercial and recreational fishers, but fish are expected to return to the area once construction is completed. Physical habitat disturbance is expected to impact species utilizing shoreline habitat that are targeted by commercial and recreational fishers, however, most fish are expected to avoid most active in-water work zones and move to appropriate nearby habitat, then return to the area after construction is completed.

Construction activities would include habitat disturbance and the potential loss of forage organisms, such as silversides, killifish, and Atlantic menhaden, in the immediate vicinity of the placement of new structures or bottom disturbance. Low indirect impacts to fish species may occur due to forage species displacement, temporary loss of forage species habitat and/or temporary loss of forage species individuals.

Maintenance impacts under Alternative 5 are similar to those described for construction; however, maintenance will occur “as needed” and impacts to commercial and recreational fishing are not expected to be significant from the Shore-Based Measures.

The mitigated impact to commercial and recreational fishing ranges from Low to Moderate impact as impacts to commercial and recreational fishing are expected because of habitat disturbance associated with the storm surge barrier measures and the occasional restriction of fishing access within the Study Area.

No impacts to commercial and recreational fishing are expected in the other Planning Regions because no measures are proposed there under Alternative 5, or measures are not extensive enough to produce impacts.

6.1.6 Physical Resources

The following sections discuss the potential adverse impacts and beneficial effects to topography and geology, surface waters, sediment, and land use. In Chapter 4, these resource categories are combined into one collective physical resources category, and their associated magnitude scores are averaged together, to compare the Alternative plans environmental acceptability.

Topography and Geology

Impacts to topography and geology are anticipated to have an impact rating of low impact for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors to topography: physical land disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion. Below is a summary of the potential impacts to bathymetry and topography.

Construction Impact Summary

Temporary and permanent impacts to topography and geology will result from clearing and sediment excavation and fill and/or the presence of a new foundation or structure during the construction of all Shore-Based Measures. Any grading to access the work area or to prepare the work area for placement of measures would change topography. Land disturbance from placement of fill would occur and impacts to topography would exist for as long as the built structures remain in place. Temporary impacts could be managed through implementation of a site-specific SWPPP and construction BMPs. Specific activities subject to BMP implementation include temporary road construction and vehicle operations in areas adjacent to natural watercourses and erosion-prone slopes, propagation of airborne dust from traversing unpaved roads and maintaining effective containment of any contaminated soils present in the project area. Berm construction and wetland/marsh restoration that may be undertaken for mitigation is the only shore-based measure that would alter topography; however those impacts are anticipated to be low.

Operations and Maintenance Impact Summary

During operations and maintenance of the proposed measures, no impact to topography and geology would occur from in-water measures. Runoff from berms may cause additional erosion to the outside landscape, however, the erosion is expected to be localized. The benefit of managing risk to wetlands from flooding during storm events is expected to offset the low impacts caused by the operation and maintenance of berms. The impacts from these changes may be further evaluated during Tier 2 EIS(s).

Beneficial long-term impacts to topography and geology are anticipated once the measures are constructed because the measures may reduce risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats as a result of storm surges. The Shore-Based Measures would be anticipated to minimize potential impacts from large storm events, benefitting the shoreline communities and habitats long-term.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Topography and Geology.

TSP Topography and Geology Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	2
O&M Assumptions	1	1	1	1	1	2	1	1	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction associated with the TSP is expected range from No to Low impact on topography and geology. Low impacts under the TSP will occur the Jamaica Bay, Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic Region, and Long Island Sound Regions. Impacts are related to construction of the variety of Shore-Based Measures planned in each of the Regions. Shore-Based Measures are expected to cause varying degrees of physical land disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion. All shore-based construction measures evaluated under the TSP have a Low impact rating for topography and geology, and in-water measures also carry a Low impact rating.

The Jamaica Bay and Lower Hudson/East River Regions each contain the greatest area of Shore-Based Measures planned under the TSP, followed by the Upper Bay/Arthur Kill, and Hackensack/Passaic Region, respectively. Some Shore-Based Measures are also planned in the Long Island Sound Region; however, these measures are planned in a small creek (Flushing Creek) and the impact is expected to be small. The Jamaica Bay Region and the Hackensack/Passaic Region each have berms planned to be built which account for the Low impact rating under operation and maintenance. The benefit to these berms is the protection of wetlands and landscapes from inundation and erosion. Road raising is planned along Broad Channel in Jamaica Bay and impacts to topography and geology are expected to be Low. Road raisings would be limited to areas surrounding existing road structures, so disturbance is expected to be Low. No impacts are expected to topography and geology during operations and maintenance of any other measure under the TSP.

No impact to topography and geology is expected in the remaining Planning Regions because no measures are planned there under the TSP.

Beneficial long-term impacts to topography and geology are anticipated once the measures are constructed because the measures will protect areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats as a result of storm surges.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Topography and Geology.

ALT 2 Topography and Geology Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	2	2	2	2	2
O&M Assumptions	1	1	1	1	1	2	2	1	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction associated with the Alternative 2 is expected range from No to Low impact on topography and geology. Low impacts under the Alternative 2 will occur in Jamaica Bay, Lower Bay, Long Island Sound, Upper Bay/Arthur Kill, Lower Hudson/East River, Raritan and Hackensack/Passaic Regions. These Regions are expected to be impacted the most because of the variety of Shore-Based Measures planned in each of the Regions. Shore-Based Measures are expected to cause varying degrees of physical land disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion. All shore-based construction measures evaluated under the Planned Action have a Low impact rating for topography and geology, and in-water measures also carry a Low impact rating.

The Jamaica Bay Region, Lower Bay Region, and the Long Island Sound Region each contain the greatest area of Shore-Based Measures planned under Alternative 2, followed by the Upper Bay/Arthur Kill, Hackensack/Passaic Regions, and Raritan Regions. Some Shore-Based Measures are also planned in the Lower Hudson/East River Region and Raritan Region; however, these measures are planned in small parts of each Region and the impacts are expected to be minor. Berms are planned in several Regions, including Jamaica Bay, the Raritan and Hackensack/Passaic Regions. Berms account for the Low impact rating under operation and maintenances. The benefit to these berms is the protection of wetlands and landscapes from inundation and erosion. Road raising is planned along Broad Channel in Jamaica Bay and impacts to topography and geology are expected to be Low. Road raisings would be limited to areas surrounding existing road structures, so disturbance is expected to be Low. No impacts are expected from the other Shore-Based Measures under Alternative 2.

No impact to topography and geology is expected in the Mid-Hudson Region and the Capital District Region because no measures are planned there under Alternative 2.

Beneficial long-term impacts to topography and geology are anticipated once the measures are constructed because the measures will manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats as a result of storm surges.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Topography and Geology.

ALT 3A Topography and Geology Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	2	2	2	2	2
O&M Assumptions	1	1	1	1	1	2	1	1	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction associated with the Alternative 2 is expected range from No to Low impact on topography and geology. Low impacts under the Alternative 3A will occur in Jamaica Bay, Lower Bay, Long Island Sound, Raritan, Hackensack/Passaic, Upper Bay/Arthur Kill and Lower Hudson/East River Planning Regions. Shore-Based Measures are expected to cause varying degrees of physical land disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion. All shore-based construction measures evaluated under the Planned Action have a Low impact rating for topography and geology, and in-water measures also carry a Low impact rating.

The Jamaica Bay Region, Lower Bay Region and the Long Island Sound Region each contain the greatest area of Shore-Based Measures planned under Alternative 3A, followed by the Upper Bay/Arthur Kill and

Hackensack/Passaic Regions. Some Shore-Based Measures are also planned in the Lower Hudson/East River Region and Raritan Region; however, these measures are planned in small parts of each Region and the impacts will be localized. Berms are planned in the Hackensack/Passaic and Jamaica Bay Regions, which account for the Low impact rating under operation and maintenance. The benefit to these berms is the protection of wetlands and landscapes from inundation and erosion. Road raising is planned along Broad Channel in Jamaica Bay and impacts to topography and geology are expected to be Low. Road raisings would be limited to areas surrounding existing road structures, so disturbance is expected to be Low impacts are expected from the other measures planned during operations and maintenance of Alternative 3A.

No impact to topography and geology is expected in the Mid-Hudson Region and the Capital District Region because no measures are planned there under Alternative 3A.

Beneficial long-term impacts to topography and geology are anticipated once the measures are constructed because the measures will reduce risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats as a result of storm surges.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Topography and Geology.

ALT 4 Topography and Geology Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	1	2	1	2	2
O&M Assumptions	1	1	1	1	1	1	1	1	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction associated with Alternative 4 is expected range from No to Low impact on topography and geology. Low impacts under Alternative 4 will occur in Jamaica Bay, Long Island Sound, Hackensack/Passaic, Lower Hudson/East River, and Upper Bay/Arthur Kill Regions. These Regions are expected to be impacted the most because of the variety of Shore-Based Measures planned. Shore-Based Measures are expected to cause varying degrees of physical land disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion. All shore-based construction measures evaluated under the Planned Action have a Low impact rating for topography and geology, and in-water measures also carry a Low impact rating.

The Shore-Based Measures planned in the Long Island Sound Region are a small area of the Region. Berms are planned in the Jamaica Bay Region, which account for the Low impact rating under operation and maintenance. The benefit to these berms is the protection of wetlands and landscapes from inundation and erosion. Road raising is planned along Broad Channel in Jamaica Bay and impacts to topography and geology are expected to be Low. Road raisings would be limited to areas surrounding existing road structures, so disturbance is expected to be Low. No impacts are expected to topography and geology from any other measure during operations and maintenance under Alternative 4.

No impact to topography and geology is expected in the remaining Regions because no measures are planned there under Alternative 4.

Beneficial long-term impacts to topography and geology are anticipated once the measures are constructed because the measures will manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats as a result of storm surges.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Topography and Geology.

ALT 5 Topography and Geology Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	1+	1+	1	1+	1	1	1
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction associated with Alternative 5 is expected range from No to Low impact on topography and geology. Low impacts under Alternative 5 will occur in the Hackensack/Passaic, Lower Hudson/East River, and Upper Bay/Arthur Kill Regions. These Regions are expected to be impacted the most because of the variety of Shore-Based Measures planned. Shore-Based Measures are expected to cause varying degrees of physical land disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion. All shore-based construction measures evaluated under the Planned Action have a Low impact rating for topography and geology, and in-water measures also carry a Low impact rating.

No impacts to topography and geology are expected by operation and maintenance under Alternative 5. No impact to topography and geology is expected in the remaining Regions because no measures are planned there under Alternative 5.

Beneficial long-term impacts to topography and geology are anticipated once the measures are constructed because the measures will manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats as a result of storm surges.

Surface Waters

Impacts to surface waters are anticipated during construction and operations and maintenance activities, depending on the measure and existing conditions. To determine site-specific impacts and potential mitigation requirements, site-specific surface waters delineations may be conducted for the development of the Tier 2 EIS and/or permit applications. Surface waters survey scope would be based on project location and design. The following are impact-producing factors to surface waters: physical seabed/land disturbance, sediment suspension, discharge/release and land use and economic change. Below is a summary of the potential impacts to surface waters.

Construction Impact Summary

Temporary impacts to surface waters will occur during the construction of shore-based measures, including deployable flood barriers, elevated promenades, seawalls, buried seawall/dunes, levees, and floodwalls.

Operations and Maintenance Impact Summary

During operations and maintenance, impacts to surface waters are not anticipated to be significant. The placement of shore-based measures is expected to manage risk from impacts associated with extreme storm events. Storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event. While additional analysis is necessary to assess closure frequency and duration of the storm surge barrier operations and maintenance criteria, this Tier 1 level assessment has assumed a duration and frequency of 1 full tidal cycle (24 hours; 2 high tides and 2 low tides) as a baseline to which to compare environmental consequences of storm surge barrier gate closure. This assumption will be updated as the barrier closure details are refined.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Surface Waters.

TSP Surface Waters Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	3	3	1	3	1	3	3
O&M Assumptions	1	1	1	2	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1+*	*2+*	*1+*	*1+*	*1*	*1+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to surface waters areas under the TSP range from Moderate to No impact. Moderate impacts may occur from the construction of storm surge barriers in the Jamaica Bay Planning Region under the TSP. Moderate impacts may also occur in the Upper Bay/Arthur Kill Region from the construction of the storm surge barriers in the Kill van Kull and Arthur Kill under the TSP. Similarly, Moderate impacts surface waters are expected in the Lower Hudson/East River from the construction of the storm surge barrier in Newtown Creek and in the Long Island Sound Regions with the crossing of Flushing Creek with the storm surge barrier. Moderate impacts to surface waters in the Hackensack/Passaic Region are also expected due to construction of the navigable gate in the Hackensack River included in the TSP.

Operation and maintenance could also have an impact on these Regions when the barriers are closed. However, storm surge barrier closure is anticipated to primarily occur during a coastal storm (e.g. 1% storm event) as water elevations rise or during maintenance procedures to ensure the storm surge barrier gates are functioning properly in preparation for a coastal storm event.

Construction of shore-based measures have the potential to impact surface waters under the TSP, with Moderate impacts expected in the Hackensack/Passaic Region from the construction of floodwalls and Moderate impact expected in Upper Bay/Arthur Kill Region from the construction of berms and levees that may cross streams. Road raising is planned along Broad Channel in Jamaica Bay and impacts to surface waters are expected to be Low. Road raising is expected to occur in areas surrounding existing road structure, so impacts associated with runoff are anticipated to be Low.

The mitigated impact to surface waters ranges from Low to No impact. Low impacts are still possible after avoidance, minimization and mitigation in Regions where in-water measures are planned due to operation and maintenance of the storm surge barriers. No mitigated impacts are associated with any of the other regions where shore-based measures are planned. Implementation of the TSP would be anticipated to provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to surface waters are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Surface Waters.

ALT 2 Surface Waters Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	4	3	3	3	2
O&M Assumptions	1	1	1	1	2	1	1	2	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1+*	*2+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to surface waters areas under Alternative 2 range from Moderate-High to No impact, with the proposed storm surge barrier in the Outer Harbor expect to have the highest impact. Moderate impacts may occur from the construction of the storm surge barrier near the Throgs Neck Bridge and the other smaller storm surge barriers and tide gates in the Long Island Sound Region. Moderate impacts to surface waters may also occur due to placement of navigable gates under Alternative 2 in the Hackensack/Passaic and Lower Bay Regions.

Construction of shore-based measures have the potential to impact surface waters under Alternative 2, with Moderate impacts expected in the Hackensack/Passaic Region from the construction of floodwalls and berms and Moderate impacts in the Raritan Region from construction of levees and floodwalls. Moderate impacts are also expected in the Long Island Sound Region from construction of seawalls that may cross surface waters. Low impacts can be expected due to construction in the Upper Bay/Arthur Kill and Lower Hudson/East River Regions from the construction of floodwalls. Road raising is planned along Broad Channel in Jamaica Bay and impacts to surface waters are expected to be Low. Road raising is expected to occur in areas surrounding existing road structure, so impacts associated with runoff are anticipated to be Low.

The mitigated impact to surface waters ranges from Low to No impact. Low impacts are still possible after avoidance, minimization and mitigation in Regions where in-water measures are planned due to operation and maintenance of the storm surge barriers. No mitigated impacts are associated with any of the other regions where shore-based measures are planned. Implementation of Alternative 2 would be anticipated to provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to surface waters are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under the Alterative 2.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Surface Waters.

ALT 3A Surface Waters Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3	4	3	3	3	3	3
O&M Assumptions	1	1	1	2	2	1	2	2	2
Mitigated Rating	*1*	*1*	*1+*	*2+*	*2+*	*1+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to surface waters under Alternative 3A range from Moderate-High to No impact, with construction of the proposed storm surge barrier in the Verrazano Narrows expected to have the highest impact (Moderate-High). Moderate impacts may also occur from construction the storm surge barrier near the Throgs Neck Bridge and the other smaller storm surge barriers and tide gates in the Long Island Sound Region. Moderate impacts are expected due to construction of storm surge barriers in the Raritan River and the in Intercoastal on the west side of Sandy Hook in the Lower Bay Region. Moderate impacts to surface waters may also occur due to placement of navigable gates under Alternative 3A in the Hackensack/Passaic and Lower Bay Regions.

Construction of shore-based measures have the potential to impact surface waters under Alternative 3A, with Moderate impacts expected in the Hackensack/Passaic Region from the construction of floodwalls and Moderate impact expected in the Raritan Region due to construction of levees. Moderate impacts may also occur in the Long Island Sound Region from construction of seawalls that may cross surface waters. Low impacts can be expected due to construction in the Upper Bay/Arthur Kill, Lower Bay and Lower Hudson/East River Regions from the construction of floodwalls and other shore-based measures, which may cross surface waters. Road raising is planned along Broad Channel in Jamaica Bay and impacts to surface waters are expected to be Low. Road raising is expected to occur in areas surrounding existing road structure, so impacts associated with runoff are anticipated to be Low.

The mitigated impact to surface waters ranges from Low to No impact. Low impacts are still possible after avoidance, minimization and mitigation in Regions where in-water measures are planned due to operation of the storm surge barriers. No mitigated impacts are associated with any of the other regions where shore-based measures are planned. Implementation of Alternative 3A would be anticipated to provide a benefit these resources, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to surface waters are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Surface Waters.

ALT 4 Surface Waters Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	3	3	1	3	1	3	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to surface waters under Alternative 4 range from Moderate to No impact. Moderate impacts may occur from the construction of storm surge barriers in the Jamaica Bay Planning Region under the Alternative 4. Moderate impacts to surface waters are expected in the Lower Hudson/East River from the construction of the storm surge barrier in Newtown Creek and in the Long Island Sound Regions with the crossing of Flushing Creek with the storm surge barrier. Moderate impacts to surface waters in the Hackensack/Passaic Region are also expected due to construction of the storm surge barrier in the Hackensack River included in Alternative 4. Operation and maintenance could also have an impact on these Regions when the barriers are closed.

Construction of shore-based measures have the potential to impact surface waters under Alternative 4, with Moderate impacts expected in the Hackensack/Passaic Region from the construction of floodwalls and levees and Moderate impact expected in Upper Bay/Arthur Kill and Jamaica Bay Regions from the construction of berms and levees that may cross streams. Implementation of Alternative 4 would be anticipated to provide a benefit these resources, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding. Road raising is planned along Broad Channel in Jamaica Bay and impacts to surface waters are expected to be Low. Road raising is expected to occur in areas surrounding existing road structure, so impacts associated with runoff are anticipated to be Low.

No impacts are to surface waters are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Surface Waters.

ALT 5 Surface Waters Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	3	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*2+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to surface waters under Alternative 5 range from Moderate to No impact. Moderate impacts may occur from construction of levees which will affect surface waters the Hackensack/Passaic Planning Region under Alternative 5. Low impacts to surface waters are expected in the Lower Hudson/East River Region as few wetlands occur in the proposed area of impact. Low impacts to surface waters are expected in the Upper Bay/Arthur Kill Region from the construction of levees.

No impacts are expected to surface waters after avoidance, minimization and mitigation are complete. Implementation of Alternative 5 would be anticipated to provide a benefit, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to surface waters are expected in the Capital District, Mid-Hudson, Lower Bay, Jamaica Bay, Long Island Sound, and Raritan Planning Regions because no structures are proposed there under Alternative 5.

Sediment

Impacts to sediment and soil quality and type are anticipated to have an impact rating of low to moderate impact for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors to sediment and soil: physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion. Below is a summary of the potential impacts to sediment.

Construction Impact Summary

Temporary and permanent impacts to soils and sediments will occur during the construction of shore-based measures. Construction activities that would cause physical seabed/land disturbance to soils include clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project area. To reduce impacts to soils and sediments, BMPs could be implemented to control erosion and sedimentation during construction. Temporary access roads and other areas utilized to support construction activities would be restored following construction. Native soils could be impacted during excavation and replaced with fill material or buried during foundation installation of project measures. This would be a long-term permanent impact to soils within the project construction footprints.

During construction there is potential for an inadvertent spill or release of hazardous materials (e.g. equipment fuel) that could impact soils and sediments. The quantity of these materials is anticipated to be controlled through site-specific BMPs, oil spill response plans, and SPCC plans to manage the risk of release and control volume and dispersion of a release.

Based on existing use and conditions, there is the potential for contaminated soils within the project area. As the project becomes more defined, soil and sediments may be characterized prior to construction per existing Federal and State regulations. Refer to Appendix A9 for additional information.

Habitat conversion during construction has potential to impact soils due to removal of vegetation that stabilizes soils and associated increases in erosion. Areas temporarily cleared during construction could be restored following construction. Areas permanently cleared could be stabilized to prevent erosion.

The impact rating for in-water measures such as storm surge barriers and tide gates is moderate for sediments. Temporary impacts to sediments include resuspension during foundation installation, removal during dredging and excavation, and change in type of sediment due to fill activities. Resuspension of contaminants from sediments during construction could occur; however, BMPs will be used to minimize redistribution of contaminants.

During construction, the storm surge barriers and tide gates could cause permanent changes in sedimentation, scouring, and sediment quality.

Operations and Maintenance Impact Summary

During operations and maintenance of the proposed measures, potential impacts to sediments from all in-water measures are anticipated to be low overall. When the barriers are in the open position, no impacts would occur to soils or sediments. When the barriers are in the closed position, minor temporary impacts to sediments are anticipated, such as short-term changes in hydrology, sediment resuspension, and minor increases in turbidity during operation.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Sediment.

TSP Sediment Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	1	2	1	2	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	2+	2+	*1*	2+	*1*	2+	2+

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to sediment associated with construction of the TSP is anticipated to range from No to Moderate impact. Moderate impacts to sediment under the TSP is anticipated with construction of the storm surge barrier and tide gates in the Jamaica Bay and Upper Bay/Arthur Kill Regions. Temporary impacts to sediments include resuspension during foundation installation, sediment removal during dredging and excavation, and change in type of sediment due to fill activities. Within the Long Island Sound Region, a storm surge barrier is proposed at the mouth of Flushing Creek, a small tributary in the Region. Impacts to the Region are anticipated to be localized; therefore, the impact rating is Low.

Temporary and permanent impacts to soils and sediments will occur during the construction of shore-based measures. Construction activities that would cause physical seabed/land disturbance to soils include clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project area. Moderate impacts to sediment are expected from construction of the buried seawall/ dunes feature, which is a shore-based measures. Buried seawalls/dunes are primarily planned to be constructed in the Jamaica Bay Region under the TSP. All other shore-based measures are expected to have low impacts on sediment during construction under the TSP.

Low impacts to sediment are expected from operations and maintenance of the storm surge barrier and tide gates, as well as all shore-based measures under the TSP. Few measures are planned in the Long Island Sound Region and impacts are expected to be minor compared to other Regions.

The potential benefit from these measures is the management of risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impact to sediment is expected in the remaining Planning Regions (Raritan, Lower Bay, Mid-Hudson, and Capital District) under the TSP because no construction is planned there.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Sediment.

ALT 2 Sediment Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	3	2	2	3	3
O&M Assumptions	1	1	1	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*1*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to sediment associated with construction of Alternative 2 is expected to range from No to Moderate impact. The Regions with the greatest impact to sediment under Alternative 2 are the Lower Bay and Long Island Sound Regions. These Regions are expected to be impacted the most because of construction of the storm surge barrier and tide gates, which are in-water measures that produce temporary impacts to sediments including resuspension during foundation installation, sediment removal during dredging and excavation, and change in type of sediment due to fill activities. The construction of storm surge barriers and tide gates has a Moderate impact rating to sediment under Alternative 2.

Temporary and permanent impacts to soils and sediments will occur during the construction of shore-based measures. Construction activities that would cause physical seabed/land disturbance to soils include clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project area. Moderate impacts to sediment are expected from construction of the seawall and sand dunes, which are shore-based measures. Seawalls and sand dunes are primarily planned to be constructed in the Jamaica Bay Region. All other shore-based measures are expected to have low impacts on sediment during construction under Alternative 2.

Low impacts to sediment are expected from operations and maintenance of the storm surge barrier and tide gates, as well as all shore-based measures under Alternative 2. The potential benefit from these measures is the management of risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

Few measures are planned in the Raritan Region and impacts are expected to be Low compared to other Regions.

No impact to sediment is expected in the Lower Hudson/East River Region, Mid-Hudson, and Capital District Regions under Alternative 2 because no measures are planned there.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Sediment.

ALT 3A Sediment Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	3	2	2	3	3	3
O&M Assumptions	1	1	2	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*2*	*2+*	*2+*	*2+*	*2+*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to sediment associated with construction of Alternative 3A is expected to range from No to Moderate impact. The Regions with the greatest impact to sediment under Alternative 3A are Jamaica Bay, Upper Bay/Arthur Kill, Long Island Sound, and Raritan Regions. These Regions are expected to be impacted the most because of construction of the storm surge barrier and tide gates, which are in-water measures that produce temporary impacts to sediments including resuspension during foundation installation, removal during dredging and excavation, and change in type of sediment due to fill activities. The construction of storm surge barriers and tide gates has a Moderate impact rating to sediment under Alternative 3A. Within the Lower Bay Region, a storm surge barrier is proposed in Sandy Hook, which will only impact a small part of the Region; therefore, the impact rating is Low.

Temporary and permanent impacts to soils and sediments will occur during the construction of shore-based measures. Construction activities that would cause physical seabed/land disturbance to soils include clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project area. Moderate impacts to sediment are expected from construction of the seawall and sand dunes, which are shore-based measures. Seawalls and reinforced dunes are primarily planned to be constructed in the Jamaica Bay Region. All other shore-based measures are expected to have Low impacts on sediment during construction under Alternative 3A.

Low impacts to sediment are expected from operations and maintenance of the storm surge barrier and tide gates, as well as all shore-based measures under Alternative 3A. The benefit from these measures is the protection of the landscape from erosion. Few measures are planned in the Raritan Region and impacts are expected to be minor compared to other Regions.

The potential benefit from these measures the management of risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impact to sediment is expected in the Mid-Hudson and Capital District Regions under Alternative 3A because no measures are planned there.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Sediment.

ALT 4 Sediment Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*2+*	*2+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to sediment associated with construction of Alternative 4 is expected to range from No to Moderate impact. The Region with the greatest impact to sediment under Alternative 4 is Jamaica Bay. This region is expected to have Moderate impacts because of construction of the storm surge barrier and tide gates, which are in-water measures that produce temporary impacts to sediments including resuspension during foundation installation, sediment removal during dredging and excavation, and change in type of sediment due to fill activities. The construction of storm surge barriers and tide gates has a Moderate impact rating to sediment under Alternative 4. Within the Long Island Sound Region, a storm surge barrier is proposed at the mouth of Flushing Creek, a small tributary to the Region. Impacts to the creek are anticipated to be localized; therefore, the impact rating is Low.

Temporary and permanent impacts to soils and sediments will occur during the construction of shore-based measures under Alternative 4. Construction activities that would cause physical seabed/land disturbance to soils include clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project area. Moderate impacts to sediment are expected from construction of the seawall and sand dunes, which are shore-based measures. Seawalls and sand dunes are primarily planned to be constructed in the Jamaica Bay Region. All other shore-based measures are expected to have Low impacts on sediment during construction under Alternative 4.

Low impacts to sediment are expected from operations and maintenance of the storm surge barrier and tide gates, as well as all shore-based measures under Alternative 4.

The potential benefit from these measures the management of risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impact to sediment is expected in the Lower Bay, Raritan, Mid-Hudson, and Capital District Regions under Alternative 4 because no measures are planned there.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Sediment.

ALT 5 Sediment Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	2	2	1	2	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to sediment associated with construction of Alternative 5 is expected to range from No to Low impact. The Regions with the greatest impact to sediment under Alternative 5 are the Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Regions. These Regions are expected to be impacted the most because of construction shore-based measures that would cause physical seabed/land disturbance to soils include clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project area. Low impacts to sediment are expected from all shore-based measures under Alternative 5.

The potential benefit from these measures the management of risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impact to sediment is expected in the other Planning Regions under Alternative 5 because no measures are planned there.

Land Use

Construction Impact Summary

The shore-based measures proposed in the NYNJHAT Study in the long-term are expected to maintain current land uses by providing greater stability to areas susceptible to coastal flooding. However, the construction of these structures would require the acquisition of real estate easements from a large number of residential, commercial, and municipal properties. These acquisitions would not significantly affect overall land use of the affected areas. Road raisings will be coordinated with the Department of Transportation and the NYC

Department of Design and Construction, and potentially the NYC Land Use (ULURP) depending on the final design for road elevation. Impact producing factors to land use are habitat conversion and land use and economic change.

Some permanent impacts to land use may occur from conversion of lands to impervious surfaces. Impacts to lands classified as forest, wetland and waters will be permanently impacts by placement of some measures. However, a large percentage of areas where NYNJHAT Study measures are proposed are already classified as urban and dominated by impervious cover, therefore impacts are expected not expected to be significant. Also, in some areas where impervious surfaces are planned outside of urban areas, on beaches, for example, land use would not change with the construction of the buried seawall dune. Acreage of impact and land use conversion assessments may be done in the Tier 2 EIS(s).

Operations and Maintenance Impact Summary

Impacts to Land Use from operations and maintenance is not anticipated.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Land Use

TSP Land Use Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	2	1	2	1	1	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to land use under the TSP range from No to Low impact. Low impacts to land use can be expected in most Planning Regions where shore-based measures are proposed. Impacts will be from conversion of wetland or forest land use types to impervious cover or urban land use with construction of shore-based measures. Impacts in the Jamaica Bay Region under the TSP is primarily due to conversion of lands classified as wetlands from placement of berms and floodwalls. Road raising is planned along Broad Channel in Jamaica Bay and impacts to land use are expected to be Low. Road raising is expected to occur in areas of existing road structure, so impacts are anticipated to be Low. Impacts to the Hackensack/Passaic Region is primarily due to placement of levees and floodwalls in areas classified as forested. Low impacts to the Upper Bay/Arthur Kill Planning Region are expected to lands that are classified as wetland and forest due to placement of berms and floodwalls, but the area of impact is expected to be very small.

No impacts in the Long Island Sound and Lower Hudson/East River Regions are expected as land uses will not be changed by the TSP.

No impacts are expected after avoidance, minimization and mitigation are implemented. The TSP is anticipated to also provide a benefit these resources and maintain existing land uses, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to land use are expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Planning Regions because no structures are proposed there under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Land Use

ALT 2 Land Use Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	2	2	2	2	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to land use under Alternative 2 range from No to Low impact. Low impacts to land use can be expected in most Planning Regions where shore-based measures are proposed. Impacts will be from conversion of wetland or forest land use types to impervious cover or urban land use with construction of shore-based measures. Impacts in the Jamaica Bay Region under Alternative 2 is primarily due to placement of berms and floodwalls. Road raising is planned along Broad Channel in Jamaica Bay and impacts to land use are expected to be Low. Road raising is expected to occur in areas of existing road structure, so impacts are anticipated to be Low. Impacts in the Long Island Sound Regions is primarily due to conversion of wetlands by placement of levees and seawalls. Impacts in the Raritan Regions is expected from conversion of lands classified as wetlands and forests by placement of berms and floodwalls. Impacts to the Hackensack/Passaic Region is primarily due to placement of levees and floodwalls in areas classified as forested. Low impacts to the Upper Bay/Arthur Kill Planning Region are expected to lands classified as wetland and forest due to placement of berms and floodwalls, but the area of impact is expected to be very small. Impacts in the Lower Bay Region from conversion of lands classified as wetlands can be expected for the placement of buried seawall/dune and floodwalls. No impacts are expected to the Lower Hudson/East River Region, as land use where measures are proposed is already classified as urban.

No impacts are expected after avoidance, minimization and mitigation are implemented. Implementation of Alternative 2 is anticipated to also provide a benefit these resources and maintain existing land uses, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to land use are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 2.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Land Use.

ALT 3A Land Use Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	2	2	2	2	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to land use under Alternative 3A range from No to Low impact. Low impacts to land use can be expected in most Planning Regions where shore-based measures are proposed. Impacts will be from conversion of wetland or forest land use types to impervious cover or urban land use with construction of shore-based measures. Impacts in the Jamaica Bay Region under Alternative 3A is primarily due to conversion of lands classified as wetlands from placement of berms and floodwalls. Road raising is planned along Broad Channel in Jamaica Bay and impacts to land use are expected to be Low. Road raising is expected to occur in areas of existing road structure, so impacts are anticipated to be Low. Impacts in the Long Island Sound Regions is primarily due to conversion of wetlands by placement of levees and seawalls. Impacts to the Hackensack/Passaic Region is primarily due to placement of levees and floodwalls in areas classified as forested. Low impacts to the Upper Bay/Arthur Kill Planning Region are expected to lands classified as wetland and forest due to placement of berms and floodwalls, but the area of impact is expected to be very small. Impacts in the Lower Bay Region from conversion of lands classified as wetlands can be expected for the placement of buried seawall/dune and floodwalls.

No impacts in the Lower Hudson/East River Regions are expected as land uses will not be changed by Alternative 3A.

No impacts are expected after avoidance, minimization and mitigation are implemented. Implementation of Alternative 3A is anticipated to also provide a benefit these resources and maintain existing land uses, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.
No impacts are to land use are expected in the Capital District and Mid-Hudson Planning Regions because no structures are proposed there under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Land Use.

ALT 4 Land Use Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	2	1	1	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to land use under Alternative 4 range from No to Low impact. Low impacts to land use can be expected in most Planning Regions where shore-based measures are proposed. Impacts will be from conversion of wetland or forest land use types to impervious cover or urban land use with construction of shore-based measures. Impacts in the Jamaica Bay Region under Alternative 4 is primarily due to conversion of lands classified as wetlands from placement of berms and floodwalls. Road raising is planned along Broad Channel in Jamaica Bay and impacts to land use are expected to be Low. Road raising is expected to occur in areas of existing road structure, so impacts are anticipated to be Low. Impacts to the Hackensack/Passaic Region is primarily due to placement of levees and floodwalls in areas classified as forested or wetland. Low impacts to the Upper Bay/Arthur Kill Planning Region are expected to lands classified as wetland and forest due to placement of berms and floodwalls, but the area of impact is expected to be very small.

No impacts in the Long Island Sound and Lower Hudson/East River Regions are expected as land uses will not be changed by Alternative 4.

No impacts are expected after avoidance, minimization and mitigation are implemented. Implementation of Alternative 4 is anticipated to also provide a benefit these resources and maintain existing land uses, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to land use are expected in the Lower Bay, Raritan, Mid-Hudson, and Capital District Regions because no structures are proposed there under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Land Use.

ALT 5 Land Use Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	2	1	1	1

O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to land use under Alternative 5 range from No to Low impact. Impacts will be from conversion of wetland or forest land use types to impervious cover or urban land use with construction of Shore-Based Measures. Impacts to the Hackensack/Passaic Region is primarily due to placement of levees and floodwalls in areas classified as forested or wetland. Low impacts to the Upper Bay/Arthur Kill Planning Region are expected to lands classified as wetland and forest due to placement of berms and floodwalls.

No impact in the Lower Hudson/East River Region is expected as land uses will not be changed by Alternative 5.
No impacts are expected after avoidance, minimization and mitigation are implemented. Implementation of Alternative 5 is anticipated to also provide a benefit these resources and maintain existing land uses, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are to land use is expected in the Capital District, Mid-Hudson, Lower Bay, Jamaica Bay, Long Island Sound and Raritan Planning Regions because no structures are proposed there under Alternative 5.

6.1.7 Hydrological Resources

The following sections discuss the potential environmental effects to Bathymetry, Coastal Hydrology, Currents, and Circulation, Tides, Tidal Range and Tidal Exchange, Inland Hydrology, and Sediment Transport. These resource categories are combined into one collective category for impact rating scoring purposes to compare Alternative plans for environmental acceptability.

Bathymetry

Impacts to bathymetry are anticipated to have an impact rating of low impact to moderate impact for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors to bathymetry: physical seabed disturbance, sediment suspension, and habitat conversion. Below is a summary of the potential impacts to bathymetry.

Construction Impact Summary

Temporary and permanent impacts to bathymetry will result from clearing and sediment excavation and fill and/or the presence of a new foundation or structure during the construction of all Shore-Based Measures. While primarily Shore-Based Measures, impacts on bathymetry, such as scouring at the toe of the structural measure, may result from increased wave energy and erosion and sediment transport associated with these hardened structures. Water depth changes during physical seabed disturbance are also expected from sedimentation or scour. Temporary impacts could be managed through implementation of a site-specific SWPPP and construction BMPs. Storm surge barriers and tide gates are in water barrier measures include tie-in points on land and will involve impacts similar to those described for the Shore-Based Measures above. The impacts to bathymetry would be moderate for both measures. Temporary in-water impacts to bathymetry during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. The storm surge barriers and tide gates could cause water depth modifications following installation and water depth changes in the area surrounding the hardened structures due to sedimentation and scour.

Beneficial long-term impacts to bathymetry are anticipated once the measures are constructed because the measures may reduce risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats as a result of storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats long-term.

Operations and Maintenance Impact Summary

During operations and maintenance of the proposed measures, potential impacts to bathymetry from storm surge and tide gate measures are anticipated to be low overall. When the barriers/gates are in the open position, localized impacts to bathymetry may occur due to changes in sediment scour and deposition in proximity to the barrier/gate structure. When the barriers/gates are in the closed position, minor temporary impacts could occur depending on closure durations. Changes to sedimentation rates, scour, and erosion could occur behind the barriers during closure. However, a long-term beneficial impact of the storm surge barriers would be flood prevention from rising sea levels. Beneficial impacts to shoreline elevations could occur during storm surge barrier closure to provide protection from flooding and subsequent erosion.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Bathymetry

TSP Bathymetry Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	1	2	1	2	3
O&M Assumptions	1	1	1+	2+	1	1+	1	1+	2+
Mitigated Rating	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to bathymetry associated with construction of the TSP are expected to range from No to Moderate impact. The Regions with the greatest impacts to bathymetry under the TSP are the Jamaica Bay and Upper Bay/Arthur Kill Regions because of construction of the storm surge barrier and tide gates. The Long Island Sound Region also has a storm surge barrier planned; however, the barrier is located within a small creek (Flushing Creek), therefore impacts to bathymetry are expected to be Low.

Temporary in-water impacts to bathymetry during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. The storm surge barriers and tide gates could cause water depth modifications following installation and water depth changes in the area surrounding the hardened structures due to sedimentation or scour. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under the TSP has a Low impact rating to bathymetry. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport that may alter bathymetry locally. Low impacts are expected from construction of Shore-Based Measures in the Upper Bay/Arthur Kill, Lower Hudson/East River Region, Hackensack/Passaic Region, Jamaica Bay, and Long Island Sound Regions.

Impacts to bathymetry associated with operation and maintenance of the storm surge barriers in the Jamaica Bay Region and Upper Bay/Arthur Kill Region are expected to Low. The storm surge barrier within the Long

Island Sound Region is not expected to cause significant impacts because the barrier is planned in a small creek (Flushing Creek). When the barriers/gates are in the open position, localized impacts to bathymetry may occur due to changes in sediment scour and deposition in proximity to the barrier/gate structure. When the barriers/gates are in the closed position, minor temporary impacts could occur, depending on closure duration.

The Jamaica Bay Region and the Hackensack/Passaic Region each have berms planned, which are Shore-Based Measures with a low impact rating under operations and maintenance to bathymetry, depending on the extent of the measure planned. These measures only account for a small area of each Region and impacts are not anticipated to be significant. Temporary impacts to bathymetry from operations and maintenance of Shore-Based Measures include changes in water depth or sedimentation during major storm events. No significant impacts are expected from maintenance of the other Shore-Based Measures.

Beneficial long-term impacts to bathymetry are anticipated once the measures are constructed because they may manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term. No impact to bathymetry is expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan because no measures are planned there under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Bathymetry.

ALT 2 Bathymetry Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	1	3	2
O&M Assumptions	1	1	1+	1+	2+	1+	1	2+	1+
Mitigated Rating	*1*	*1*	*1*	*1+*	*3*	*1*	*1*	*2*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to bathymetry associated with construction of Alternative 2 are expected to range from No to Moderate impact. The Regions with the greatest impacts to bathymetry under Alternative 2 are the Lower Bay and the Long Island Sound because of construction of the storm surge barrier and tide gates. Although the Jamaica Bay Region does not have in-water measures planned under Alternative 2, low impacts are expected to bathymetry along the barrier beach, near the inlet, from the construction of storm surge barrier planned in the Lower Bay Region it borders.

Temporary in-water impacts to bathymetry during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. The storm surge barriers and tide gates could cause water depth modifications following installation and water depth changes in the area surrounding the hardened structures due to sedimentation or scour. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 2 has a Low impact rating to bathymetry. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport that may alter bathymetry locally. Low impacts are expected from construction of Shore-Based Measures in the Lower Hudson/East River, Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic Region, Jamaica Bay, and Long Island Sound Regions. Impacts to the Raritan Region are not anticipated to be significant because the measures account for a small area of the Region.

Impacts to bathymetry associated with operation and maintenance of the storm surge barriers in the Long Island Sound and Lower Bay are expected to Low. When the barriers/gates are in the open position, localized impacts to bathymetry may occur due to changes in sediment scour and deposition in proximity to the barrier/gate structure. When the barriers/gates are in the closed position, minor temporary impacts could occur, depending on closure duration.

The Jamaica Bay Region, Raritan, and the Hackensack/Passaic Region each have berms planned, which could have the potential to produce low impacts to bathymetry, depending on the extent of the measure planned. The benefit from these berms is the protection of wetlands and landscapes from inundation and erosion. These measures only account for a small area of each Region and impacts are not anticipated to be significant. Temporary impacts to bathymetry from operations and maintenance of other Shore-Based Measures include changes in water depth or sedimentation during major storm events. No significant impacts are anticipated that would surpass the impacts produced by a major storm/flood event under the No Action Alternative.

Beneficial long-term impacts to bathymetry are anticipated once the measures are constructed because they may reduce risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact to bathymetry is expected in the Capital District Mid-Hudson because no measures are planned there under Alternative 2.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Bathymetry

ALT 3A Bathymetry Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	2	2	3	3	3
O&M Assumptions	1	1	1+	2+	2+	1+	2+	2+	2+
Mitigated Rating	*1*	*1*	*1*	*2*	*2*	*1*	*2*	*2*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to bathymetry associated with construction of Alternative 3A are expected to range from No to Moderate impact. The Regions with the greatest impacts to bathymetry under Alternative 3A are the Jamaica Bay, Upper Bay/Arthur Kill, Raritan, and the Long Island Sound Region because of construction of the storm surge barrier and tide gates. The Lower Bay Region also have a storm surge barrier planned, however, the barrier would occupy a small area in the Region and impacts to bathymetry would be localized; therefore, Low impacts are expected.

Temporary in-water impacts to bathymetry during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. The storm surge barriers and tide gates could cause water depth modifications following installation and water depth changes in the area surrounding the hardened structures due to sedimentation or scour. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 3A has a Low impact rating to bathymetry. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport that may alter bathymetry locally. Low impacts are expected from construction of Shore-Based Measures in the Lower Bay, Jamaica Bay, Long Island Sound, Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Region. Impacts from Shore-Based Measures in the Raritan Region are not anticipated to be significant because the measures account for a small area of the Region.

Impacts to bathymetry associated with operation and maintenance of the storm surge barriers in the Long Island Sound and Lower Bay are expected to Low. When the barriers/gates are in the open position, localized impacts to bathymetry may occur due to changes in sediment scour and deposition in proximity to the barrier/gate structure. When the barriers/gates are in the closed position, minor temporary impacts could occur, depending on closure duration.

The Jamaica Bay Region, Long Island Sound, and the Hackensack/Passaic Region each have berms planned, which could have the potential to produce low impacts to bathymetry, depending on the extent of the measure planned. The benefit from these berms is the protection of wetlands and landscapes from inundation and erosion. These measures only account for a small area in each Region and impacts are not anticipated to be significant. Temporary impacts to bathymetry from operations and maintenance of other Shore-Based Measures include changes in water depth or sedimentation during major storm events. No significant impacts are anticipated that would surpass the impacts produced by a major storm/flood event under the No Action Alternative.

Beneficial long-term impacts to bathymetry are anticipated once the measures are constructed because they may manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term. No impact to bathymetry is expected in the Capital District and Mid-Hudson Regions because no measures are planned there under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Bathymetry

ALT 4 Bathymetry Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	3	1	2	3
O&M Assumptions	1	1	1+	1+	1	2+	1	1+	2+
Mitigated Rating	*1*	*1*	1	1	*1*	*2*	*1*	1	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to bathymetry associated with construction of Alternative 4 are expected to range from No to Moderate impact. The Regions with the greatest impacts to bathymetry under Alternative 4 are Jamaica Bay and the Hackensack/Passaic because of construction of the storm surge barrier and tide gates. The Long Island Sound Region also has a storm surge barrier planned, however, the barrier would occupy a small area in the Region (Flushing Creek) and impacts to bathymetry would be localized; therefore, Low impacts are expected.

Temporary in-water impacts to bathymetry during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. The storm surge barriers and tide gates could cause water depth modifications following installation and water depth changes in the area surrounding the hardened structures due to sedimentation or scour. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 4 has a Low impact rating to bathymetry. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport that may alter bathymetry locally. Low impacts are expected from construction of Shore-Based Measures in Jamaica Bay, the Long Island Sound, Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Region.

Impacts to bathymetry associated with operation and maintenance of the storm surge barriers in the Jamaica Bay and the Hackensack/Passaic are expected to Low. When the barriers/gates are in the open position, localized impacts to bathymetry may occur due to changes in sediment scour and deposition in proximity to the barrier/gate structure. When the barriers/gates are in the closed position, minor temporary impacts could occur, depending on closure duration. The Long Island Sound Region also has a storm surge barrier planned, however, the barrier would occupy Flushing Creek, so impacts to bathymetry would be localized and are not expected to be significant.

The Jamaica Bay Region and the Hackensack/Passaic Region each have berms planned, which could have the potential to produce low impacts to bathymetry, depending on the extent of the measure planned. These measures only account for a small area in each Region and impacts are not anticipated to be significant. Temporary impacts to bathymetry from operations and maintenance of other Shore-Based Measures include changes in water depth or sedimentation during major storm events. No significant impacts are anticipated that would surpass the impacts produced by a major storm/flood event under the No Action Alternative.

Beneficial long-term impacts to bathymetry are anticipated once the measures are constructed because they may reduce risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term. No impact to bathymetry is expected in the Lower Bay, Raritan, Capital District, and Mid-Hudson Regions because no measures are planned there under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Bathymetry.

ALT 5 Bathymetry Impact Rating by Measure	Capital District Region Measure	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	1	1	1	1	1	1
O&M Assumptions	1	1	1+	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2*	*1*	*1*	1	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to bathymetry associated with construction of Alternative 5 are expected to range from No to Low impact. The Region with the greatest impacts to bathymetry under Alternative 5 is the Lower Hudson/East River because of construction of Shore-Based Measures such as floodwalls and elevated promenade. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport that may alter bathymetry locally. The Hackensack/Passaic and Upper Bay/Arthur Kill also have Shore-Based Measures planned, however, the measures are levees which are set back from the shoreline; therefore, impacts to bathymetry are not anticipated to be significant. No in-water measures are planned under Alternative 5.

Beneficial long-term impacts to bathymetry are anticipated once the measures are constructed because they may manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term. No impact to bathymetry is expected in any other Region because no measures are planned there under Alternative 5.

Inland Hydrology

The following are impact producing factors to inland hydrology: physical seabed disturbance. No impacts to inland hydrology are expected during the construction of any Alternative in the Study Area. Freshwater rivers, lakes, and streams are present within the Study Area, however, the planned measures are specific to coastal and tidally influenced locations. During operations and maintenance, there is potential for inundation of some inland waterbodies when the storm surge barriers are closed. However, these impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative. Therefore, impacts to inland hydrology are not anticipated to be significant under any Alternative in the Study Area, and all Alternative plans reflect a “1” or No Impact rating:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3B (TSP), 2, 3A, 4 and 5 on Inland Hydrology.

ALT 3B (TSP), 2, 3A, 4, and 5 Inland Hydrology Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

Coastal Hydrology, Currents, and Circulation

Impacts to currents and circulation are anticipated to have an impact rating of low impact to moderate impact for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The following is the impact-producing factor: physical seabed/land disturbance. Below is a summary of the potential impacts.

Construction Impact Summary

Temporary impacts to currents may result during the construction of the seawall shore-based measure as this is located at the Mean Higher High Water line. Localized, temporary impacts for the in-water measures are also anticipated on currents, due to increased velocities at the toe of the structural measure, which may result from increased wave energy with these hardened structures. Increased tidal current velocities could cause temporary indirect impacts from sedimentation or scour. Impacts to currents from storm surge barriers and tide gates would be moderate for both measures. Temporary impacts to currents during construction include physical seabed disturbances that increase current velocities, such as foundation installation, dredging, dewatering, and excavation and fill activities. Impacts during construction would be localized and not anticipated to cause long-term permanent changes to hydrodynamics and water flow.

Operations and Maintenance Impact Summary

During operations and maintenance of the proposed measures, potential impacts to currents from storm surge and tide gate measures are anticipated to be low overall. When the storm surge barriers and tide gates are in the open position, potential long-term direct impacts from decreasing current velocities could occur. When the barriers are in the closed position, temporary impacts to tidal currents are anticipated due to decreasing current velocities. In the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study (2019), the modeling of the proposed storm surge barrier across the Jamaica Bay inlet would likely result in minimal changes to flow speeds and directions.

A preliminary model for the effects of flow obstruction by barriers across the estuary-ocean entrance was conducted by Orton and Ralston for the HR estuary above upper Manhattan (Orton and Ralston 2018). Their model indicated that maximum tidal velocities in the vicinity of the barrier openings would be over 5.83 knots (9.83 feet/second), which is consistent with intensified currents found for other studies on surge barrier openings. Based on modeling results, impacts may occur throughout the Study Area as the structures close; however, barrier closure is not anticipated to permanently change hydrodynamics and water flow in the Study Area.

AdH modeling conducted in 2020 for Alternative 2 found that the extensive storm surge barrier planned in the Lower Bay reduced the flow area by 47% and resulted in slight decreases in velocities from inside the barrier (Emiren and McAlpin 2020). AdH modeling for Alternative 3A found reductions in tidal range from within the barriers, but not as much as Alternative 2, and greater than Alternative 3B and Alternative 4 (Emiren and McAlpin 2020). AdH modeling conducted for Alternative 3B found only slight changes to tidal flow (Emiren and McAlpin 2020). Under the Alternative 4 scenario, minor changes to tidal flow occurred, similar to or less than the Alternative 3B scenario (Emiren and McAlpin 2020).

Further modeling of potential impacts to currents from the storm surge barrier closures would be analyzed during the Tier 2 analysis.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Coastal hydrology, Currents, and Circulation.

TSP Coastal Hydrology, Currents, and Circulation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	3+	1	2+	1	2+	3+
O&M Assumptions	1	1	1	2	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to coastal hydrology, currents, and circulation associated with construction of the TSP are expected to range from No to Moderate impact. The Regions with the greatest impacts to coastal hydrology, currents, and circulation under the TSP are the Jamaica Bay and Upper Bay/Arthur Kill Regions because of construction of the storm surge barrier and tide gates. The Long Island Sound Region also has a storm surge barrier planned; however, the barrier is located within a small creek (Flushing Creek), therefore construction impacts are expected to be Low.

Localized, temporary impacts for the in-water measures are anticipated on currents, due to increased velocities at the toe of structural measures, which may result from increased wave energy associated with hardened structures. Indirect impacts may occur from sedimentation or scour. The storm surge barriers and tide gates could cause water depth modifications following installation. Physical seabed disturbances such as foundation installation, dredging, dewatering, and excavation and fill may increase current velocities. Impacts to currents from storm surge barriers and tide gates would be moderate for both measures. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of Shore-Based Measures under the TSP has a Low impact rating to coastal hydrology, currents, and circulation. The installation of hardened structure along the shoreline may increase current velocities, erosion, and sediment transport. Low impacts are expected from construction of Shore-Based Measures in the Upper Bay/Arthur Kill, Lower Hudson/East River Region, Hackensack/Passaic Region, Jamaica Bay, and Long Island Sound Regions.

Impacts to coastal hydrology, currents, and circulation associated with operation and maintenance of the storm surge barriers in the Jamaica Bay Region and Upper Bay/Arthur Kill Region are expected to Low. The storm surge barrier within the Long Island Sound Region is not expected to cause significant impacts because the barrier is planned in a small creek (Flushing Creek). When the storm surge barriers and tide gates are in the open position, potential long-term direct impacts from decreasing current velocities could occur. When the barriers are in the closed position, temporary impacts to tidal currents are anticipated due to decreasing current velocities.

Temporary localized impacts to coastal hydrology, currents, and circulation from operations and maintenance of Shore-Based Measures include changes in current velocities and sedimentation. No significant impacts are expected.

Beneficial long-term impacts to coastal hydrology, currents, and circulation are anticipated once the measures are constructed because they may manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact to coastal hydrology, currents, and circulation is expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan because no measures are planned there under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Coastal hydrology, Currents, and Circulation.

ALT 2 Coastal Hydrology, Currents, and Circulation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	2+	3+	2+	1	3+	2+
O&M Assumptions	1	1	1	1	2	1	1	2	1
Mitigated Rating	*1*	*1*	*1*	*1*	*3*	*1*	*1*	*2*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to coastal hydrology, currents, and circulation associated with construction of Alternative 2 are expected to range from No to Moderate impact. The Regions with the greatest impacts to coastal hydrology, current, and circulation under Alternative 2 are the Lower Bay and the Long Island Sound because of construction of the storm surge barrier and tide gates. Although the Jamaica Bay Region does not have in-water measures planned under Alternative 2, low impacts are expected to coastal hydrology, currents, and circulation along the barrier beach, near the inlet, from the construction of storm surge barrier planned in the Lower Bay Region it borders.

Localized, temporary impacts for the in-water measures are anticipated on currents, due to increased velocities at the toe of structural measures, which may result from increased wave energy associated with hardened structures. Indirect impacts may occur from sedimentation or scour. The storm surge barriers and tide gates could cause water depth modifications following installation. Physical seabed disturbances such as foundation installation, dredging, dewatering, and excavation and fill may increase current velocities. Impacts to currents from storm surge barriers and tide gates would be moderate for both measures. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 2 has a Low impact rating to coastal hydrology, current, and circulation. The installation of hardened structure along the shoreline may increase current velocities, erosion, and sediment transport. Low impacts are expected from construction of Shore-Based Measures in the Lower Hudson/East River, Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic Region, Jamaica Bay, and Long Island Sound Regions. Impacts to the Raritan Region are not anticipated to be significant because the measures account for a small area of the Region.

Impacts to coastal hydrology, currents, and circulation associated with operation and maintenance of the storm surge barriers in the Long Island Sound and Lower Bay are expected to Low. When the storm surge barriers and tide gates are in the open position, potential long-term direct impacts from decreasing current velocities could occur. When the barriers are in the closed position, temporary impacts to tidal currents are anticipated due to decreasing current velocities.
Temporary localized impacts to coastal hydrology, currents, and circulation from operations and maintenance of Shore-Based Measures include changes in current velocities and sedimentation. No significant impacts are expected.

Beneficial long-term impacts to coastal hydrology, current, and circulation are anticipated once the measures are constructed because they may reduce risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact to coastal hydrology, currents, and circulation is expected in the Capital District Mid-Hudson because no measures are planned there under Alternative 2.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Coastal Hydrology, Currents, and Circulation.

ALT 3A Coastal Hydrology, Currents, and Circulation Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2+	3+	2+	2+	3+	3+	3+
O&M Assumptions	1	1	1	2	2	1	2	2	2
Mitigated Rating	*1*	*1*	*1*	*2*	*2*	*1*	*2*	*2*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to coastal hydrology, currents, and circulation associated with construction of Alternative 3A are expected to range from No to Moderate impact. The Regions with the greatest impacts to coastal hydrology, currents, and circulation under Alternative 3A are the Jamaica Bay, Upper Bay/Arthur Kill, Raritan, and the Long Island Sound Region because of construction of the storm surge barrier and tide gates. The Lower Bay Region also have a storm surge barrier planned, however, the barrier would occupy a small area in the Region and impacts would be localized; therefore, low impacts are expected.

Localized, temporary impacts for the in-water measures are anticipated on currents, due to increased velocities at the toe of structural measures, which may result from increased wave energy associated with hardened structures. Indirect impacts may occur from sedimentation or scour. The storm surge barriers and tide gates could cause water depth modifications following installation. Physical seabed disturbances such as foundation installation, dredging, dewatering, and excavation and fill may increase current velocities. Impacts to currents from storm surge barriers and tide gates would be moderate for both measures. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 3A has a Low impact rating to coastal hydrology, currents, and circulation. The installation of hardened structure along the shoreline may increase current velocities, erosion, and sediment transport. Low impacts are expected from construction of Shore-Based Measures in the Lower Bay, Jamaica Bay, Long Island Sound, Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Region. Impacts from Shore-Based Measures in the Raritan Region are not anticipated to be significant because the measures account for a small area of the Region.

Impacts to coastal hydrology, currents, and circulation associated with operation and maintenance of the storm surge barriers in the Long Island Sound and Lower Bay are expected to Low. When the storm surge barriers and tide gates are in the open position, potential long-term direct impacts from decreasing current velocities could occur. When the barriers are in the closed position, temporary impacts to tidal currents are anticipated due to decreasing current velocities.
Temporary localized impacts to coastal hydrology, currents, and circulation from operations and maintenance of Shore-Based Measures include changes in current velocities and sedimentation. No significant impacts are expected.

Beneficial long-term impacts to coastal hydrology, current, and circulation are anticipated once the measures are constructed because they may manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact to coastal hydrology, current, and circulation is expected in the Capital District and Mid-Hudson Regions because no measures are planned there under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Coastal Hydrology, Currents, and Circulation.

ALT 4 Coastal Hydrology, Currents, and Circulation Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2+	2+	1	3+	1	2+	3+
O&M Assumptions	1	1	1	1	1	2	1	1	2
Mitigated Rating	*1*	*1*	1	1	*1*	*2*	*1*	1	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to coastal hydrology, currents, and circulation associated with construction of Alternative 4 are expected to range from No to Moderate impact. The Regions with the greatest impacts to coastal hydrology, current, and circulation under Alternative 4 are Jamaica Bay and the Hackensack/Passaic because of construction of the storm surge barrier and tide gates. The Long Island Sound Region also has a storm surge barrier planned, however, the barrier would occupy a small area in the Region (Flushing Creek) and impacts would be localized; therefore, Low impacts are expected.

Localized, temporary impacts for the in-water measures are anticipated on currents, due to increased velocities at the toe of structural measures, which may result from increased wave energy associated with hardened structures. Indirect impacts may occur from sedimentation or scour. The storm surge barriers and tide gates could cause water depth modifications following installation. Physical seabed disturbances such as foundation installation, dredging, dewatering, and excavation and fill may increase current velocities. Impacts to currents from storm surge barriers and tide gates would be moderate for both measures. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 4 has a Low impact rating to coastal hydrology, currents, and circulation. The installation of hardened structure along the shoreline may increase current velocities, erosion, and sediment transport. Low impacts are expected from construction of Shore-Based Measures in Jamaica Bay, the Long Island Sound, Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Region.

Impacts to coastal hydrology, currents, and circulation associated with operation and maintenance of the storm surge barriers in the Jamaica Bay and the Hackensack/Passaic are expected to Low. When the storm surge barriers and tide gates are in the open position, potential long-term direct impacts from decreasing current velocities could occur. When the barriers are in the closed position, temporary impacts to tidal currents are anticipated due to decreasing current velocities. The Long Island Sound Region also has a storm surge barrier planned, however, the barrier would occupy Flushing Creek, so impacts would be localized and are not expected to be significant.

Temporary localized impacts to coastal hydrology, currents, and circulation from operations and maintenance of Shore-Based Measures include changes in current velocities and sedimentation. No significant impacts are expected.

Beneficial long-term impacts to coastal hydrology, current, and circulation are anticipated once the measures are constructed because they may reduce risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact to coastal hydrology, current, and circulation is expected in the Lower Bay, Raritan, Capital District, and Mid-Hudson Regions because no measures are planned there under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Coastal Hydrology, Currents, and Circulation.

ALT 5 Coastal Hydrology, Currents, and Circulation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2*	*1*	*1*	1	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to coastal hydrology, currents, and circulation associated with construction of Alternative 5 are expected to range from No to Low impact. The Region with the greatest impact under Alternative 5 is the Lower Hudson/East River because of construction of Shore-Based Measures such as floodwalls and elevated promenade. The installation of hardened structure along the shoreline may result in increased current velocities, erosion, and sediment transport. The Hackensack/Passaic and Upper Bay/Arthur Kill also have Shore-Based Measures planned, however, the measures are levees which are set back from the shoreline; therefore, impacts are not anticipated to be significant. No in-water measures are planned under Alternative 5.

Beneficial long-term impacts to coastal hydrology, currents, and circulation are anticipated once the measures are constructed because they may manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact to coastal hydrology, current, and circulation is expected in any other Region because no measures are planned there under Alternative 5.

Tides, Tidal Exchange, and Tidal Range

Impacts to tides are anticipated to have an impact rating of low impact to moderate impact for the Study Area during construction, operations and maintenance activities, depending on the measure and existing conditions. The following is the impact-producing factor to tides: physical seabed/land disturbance. Below is a summary of the potential impacts associated with tides.

Construction Impact Summary

There are no impacts anticipated to the existing tidal regime during construction.

Operations and Maintenance Impact Summary

During operations and maintenance, potential impacts to tides from storm surge barriers and tide gate measures are anticipated to be low, depending on the extent of the measure. When the barriers are in the open position, no impacts to tides would occur. When the barriers are in the closed position, minor temporary impacts are anticipated due to decreasing the tidal range, as well as current velocities and salinity regimes. A conceptual storm surge barrier model analysis has been completed for the Jamaica Bay Planning Region. In the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study (2019), the modeling of the conceptual storm surge barrier estimated a maximum tidal amplitude change of 0.2 feet, which would occur during the highest tides of a tidal cycle. This small impact to tidal amplitude indicates that there would not be any major changes in the water column throughout Jamaica Bay associated with the conceptual storm surge barrier design.

A preliminary model for the effects of flow obstruction by barriers across the estuary-ocean entrance was conducted by Orton and Ralston for the Hudson River estuary above upper Manhattan (2018). Their model of the Sandy Hook-Breezy Point storm surge barrier indicated that tidal range would decrease by 2 to 10 percent, with a reduction in tidal range greater during spring tides than during neap tides. A preliminary AdH Model conducted for the Sandy Hook-Breezy Point (Alternative 3A) storm surge barrier simulated slightly decreased tidal ranges and negligible effects on water surface elevations (Emerin and McAlpin, 2018).

AdH modeling conducted for Alternative 3A that includes five storm surge barriers at Arthur Kill, Throgs Neck, Pelham Bay, Verrazano-Narrows, and Jamaica Bay, found slight decreases in tidal range (Emerin and McAlpin, 2018). AdH modeling conducted for Alternative 3B includes eight storm surge barriers at Arthur Kill, Gowanus, Kill Van Kull, Pelham Bay, Flushing Bay, Newtown Creek, Westchester Creek/Bronx River, and Jamaica Bay, found negligible effects on surface water elevations (Emerin and McAlpin, 2018). AdH modeling conducted for Alternative 4 that includes seven storm surge barriers at Gowanus, Pelham Bay, Flushing Bay, Newtown Creek, Westchester Creek/Bronx River, Hackensack, and Jamaica Bay, found negligible effects on surface water elevations (Emerin and McAlpin, 2018).

Further AdH modeling conducted for Alternative 2 found that the extensive storm surge barrier planned in the Lower Bay reduced the flow area by 47% and resulted in reductions in tidal range and tidal exchange, and slightly decreasing velocities from inside the barrier (Emerin and McAlpin 2020). AdH modeling for Alternative 3A also found reductions in tidal range from within the barriers, but not as much as Alternative 2, and greater than Alternative 3B and Alternative 4 (Emerin and McAlpin 2020). AdH modeling conducted for Alternative 3B found only slight changes to tidal flow (Emerin and McAlpin 2020). Under the Alternative 4 scenario, minor changes to tidal flow occurred, similar to or less than the Alternative 3B scenario (Emerin and McAlpin 2020).

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Tides, Tidal Exchange, and Tidal Range.

TSP Tides, Tidal Exchange, and Tidal Range Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	2	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

There are no impacts to tides, tidal exchange, and tidal range anticipated during construction of the TSP. During operations and maintenance of the proposed measures, potential impacts to tides from storm surge barriers and tide gate measures are anticipated to be low overall. The Regions with the greatest impacts under the TSP are the Jamaica Bay and Upper Bay/Arthur Kill Regions because of the storm surge barrier and tide gate measures. The Long Island Sound Region also has a storm surge barrier planned; however, the barrier is located within a small creek (Flushing Creek), therefore, impacts are not anticipated to be significant. When the barriers are in the open position, no impacts to tides would occur. When the barriers are in the closed position, minor temporary impacts are anticipated due to decreasing the tidal range, as well as current velocities and salinity regimes.

No impact to tides, tidal exchange, and tidal range is expected in the other Regions under the TSP because either the measures are shore-based or no measures are planned at all.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Tides, Tidal Exchange, and Tidal Range.

ALT 2 Tides, Tidal Exchange, and Tidal Range Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	3	1	1	2	1
Mitigated Rating	*1*	*1*	*1*	*1*	*2*	*1*	*1*	*2*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

There are no impacts to tides, tidal exchange, and tidal range anticipated during construction of Alternative 2. During operations and maintenance of the proposed measures, potential impacts to tides from storm surge barriers and tide gate measures are anticipated to range from No to Moderate impact. The Regions with the greatest impacts under Alternative 2 are the Lower Bay and Long Island Sound because of the storm surge barrier and tide gate measures. The storm surge barrier planned in the Lower Bay Region is extensive and would cause Moderate impacts to tides during operation. The barrier in the Long Island Sound Region would cause Low impacts. When the storm surge barriers are in the open position, no impacts to tides would occur. When the barriers are in the closed position, temporary impacts are anticipated due to decreasing the tidal range, as well as current velocities and salinity regimes.

No impact to tides, tidal exchange, and tidal range is expected in the other Regions under Alternative 2 because either the measures are shore-based or no measures are planned at all.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Tides, Tidal Exchange, and Tidal Range.

ALT 3A Tides, Tidal Exchange, and Tidal Range Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1

O&M Assumptions	1	1	1	2	1	1	2	2	2
Mitigated Rating	*1*	*1*	1	1	1	1	1	1	1

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

There are no impacts to tides, tidal exchange, and tidal range anticipated during construction of Alternative 3A. During operations and maintenance of the proposed measures, potential impacts to tides from storm surge barriers and tide gate measures are anticipated to be low overall. The Regions with the greatest impacts under Alternative 3A are Jamaica Bay, the Long Island Sound, the Raritan, and the Upper Bay/Arthur Kill because of the storm surge barrier and tide gate measures. When the barriers are in the open position, no impacts to tides would occur. When the barriers are in the closed position, minor temporary impacts are anticipated due to decreasing the tidal range, as well as current velocities and salinity regimes. The Lower Bay also has a storm surge barrier planned; however, the barrier is located in a small area; therefore, impacts are anticipated to be localized and insignificant.

No impact to tides, tidal exchange, and tidal range is expected in the other Regions under Alternative 3A because either the measures are shore-based or no measures are planned at all.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Tides, Tidal Exchange, and Tidal Range.

ALT 4 Tides, Tidal Exchange, and Tidal Range Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	2	1	1	2
Mitigated Rating	*1*	*1*	1	1	*1*	1	*1*	1	1

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

There are no impacts to tides, tidal exchange, and tidal range anticipated during construction of Alternative 4. During operations and maintenance of the proposed measures, potential impacts to tides from storm surge barriers and tide gate measures are anticipated to be low overall. The Regions with the greatest impacts under Alternative 4 are Jamaica Bay and the Hackensack/Passaic because of the storm surge barrier and tide gate measures. When the barriers are in the open position, no impacts to tides would occur. When the barriers are in the closed position, minor temporary impacts are anticipated due to decreasing the tidal range, as well as current velocities and salinity regimes. The Long Island Sound also has a storm surge barrier planned; however, the barrier is located in a small part of the Region and impacts are anticipated to be localized; therefore, No impacts are expected.

No impact to tides, tidal exchange, and tidal range is expected in the other Regions under Alternative 4 because either the measures are shore-based or no measures are planned at all.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Tides, Tidal Exchange, and Tidal Range.

ALT 5 Tides, Tidal Exchange, and Tidal Range Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	1	1	1	1	1	1	1

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

There are no impacts to tides, tidal exchange, and tidal range anticipated during construction and operations and maintenance of Alternative 5 because all planned measures are shore-based.

Sediment Transport

The following are impact producing factors to sediment transport: physical seabed/land disturbance, sediment suspension, and habitat conversion. Impacts from sediment transport were evaluated by USACE using year-long AdH Model three-dimensional numerical simulations performed for each alternative as well as a base model simulation without the structures in place (No Action Alternative). For the primary reaches of interest, the changes due to the proposed structures are relatively minor with the largest impacts associated with Alternative 2 and Alternative 3a. These two Alternative plans have the largest impacts on the system in terms of flow pathway modifications and reduction in tidal exchange. The reductions in tidal exchange also reduces the velocities and shear stresses present in the system. These reductions in tidal exchange tend to be more pronounced for the higher energy events resulting in increased impacts for sediment resuspension.

Construction Impact Summary

Sediment transport may occur during the construction of land-based measures, when activities such as scouring at the toe of the structural measure and the hardening of land-based structures contributes to runoff. During foundation installation and other construction activities that disturb sediments, potential indirect impacts from the removal of SAV could cause sediments to be more prone to increased turbidity and sediment transport. The Lower Bay Region is the only Planning Region with construction measures planned near mapped SAV (under Alternative 2 and 3A). All other Regions either do not have mapped SAV, or do not have measures planned near mapped SAV.

Operations and Maintenance Impact Summary

Beneficial long-term impacts from sediment transport are anticipated once the measures are constructed because they will protect areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Sediment Transport

TSP Sediment Transport Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2 +	3+	1	2+	1	2+	3+
O&M Assumptions	1	1	1	2	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts from sediment transport associated with construction of the TSP are expected to range from No to Moderate impact. The Regions with the greatest impacts from sediment transport under the TSP are the Jamaica Bay and Upper Bay/Arthur Kill Regions because of construction of the storm surge barrier and tide gates. The Long Island Sound Region also has a storm surge barrier planned; however, the barrier is located within a small creek (Flushing Creek), therefore impacts from sediment transport are expected to be Low.

Temporary in-water impacts from sediment transport during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.
With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under the TSP has a Low impact rating from sediment transport. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport. Low impacts are expected from construction of Shore-Based Measures in the Upper Bay/Arthur Kill, Lower Hudson/East River Region, Hackensack/Passaic Region, Jamaica Bay, and Long Island Sound Regions.

Beneficial long-term impacts from sediment transport are anticipated once the measures are constructed because they are anticipated to manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact from sediment transport is expected in the Capital District, Mid-Hudson, Lower Bay, and Raritan Regions because no measures are planned there under the TSP.

Alternative 2

Alternative 2 results in the largest reduction in tidal exchange and also has the largest reduction in dredge volumes. Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Sediment Transport.

ALT 2 Sediment Transport Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	2+	3+	2+	1	3+	2+
O&M Assumptions	1	1	1	1	2	1	1	2	1
Mitigated Rating	*1*	*1*	*1*	*1*	*3*	*1*	*1*	*2*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts from sediment transport associated with construction of Alternative 2 are expected to range from No to Moderate impact. The Regions with the greatest impacts from sediment transport under Alternative 2 are the Lower Bay and the Long Island Sound because of construction of the storm surge barrier and tide gates.

Temporary in-water impacts from sediment transport during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 2 has a Low impact rating from sediment transport. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport. Low impacts are expected from construction of Shore-Based Measures in the Lower Hudson/East River, Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic Region, Jamaica Bay, and Long Island Sound Regions. Impacts to the Raritan Region are not anticipated to be significant because the measures account for a small area of the Region.

The Jamaica Bay Region, Raritan, and the Hackensack/Passaic Region each have berms planned, which could have the potential to produce low impacts from sediment transport, depending on the extent of the measure planned. The benefit from these berms is the protection of wetlands and landscapes from inundation and erosion. These measures only account for a small area of each Region and impacts are not anticipated to be significant. Temporary impacts from sediment transport during operations and maintenance of other Shore-Based Measures include changes in water depth or sedimentation during major storm events. No significant impacts are anticipated that would surpass the impacts produced by a major storm/flood event under the No Action Alternative.

Beneficial long-term impacts to sediment transport are anticipated once the measures are constructed because they are anticipated to manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact to sediment transport is expected in the Capital District and Mid-Hudson because no measures are planned there under Alternative 2.

Alternative 3A

The impacts of Alternative 3A are primarily associated with reduced dredge volumes in the Anchorage area along with slight reductions for the Newark Bay region through reduced tidal exchange. Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Sediment Transport.

ALT 3A Sediment Transport Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2+	3+	2+	2+	3+	3+	3+
O&M Assumptions	1	1	1	2	2	1	2	2	2
Mitigated Rating	*1*	*1*	*1*	*2*	*2*	*1*	*2*	*2*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts from sediment transport associated with construction of Alternative 3A are expected to range from No to Moderate impact. The Regions with the greatest impacts from sediment transport under Alternative 3A are the Jamaica Bay, Upper Bay/Arthur Kill, Raritan, and the Long Island Sound Region because of construction of the storm surge barrier and tide gates. The Lower Bay Region also have a storm surge barrier planned, however, the barrier would occupy a small area in the Region and impacts from sediment transport would be localized; therefore, Low impacts are expected.

Temporary in-water impacts to sediment transport during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 3A has a Low impact rating to sediment transport. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport. Low impacts are expected from construction of Shore-Based Measures in the Lower Bay, Jamaica Bay, Long Island Sound, Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Region. Impacts from Shore-Based Measures in the Raritan Region are not anticipated to be significant because the measures account for a small area of the Region.

Impacts from sediment transport associated with operation and maintenance of the storm surge barriers in the Long Island Sound and Lower Bay are expected to Low. When the barriers/gates are in the open position, localized impacts may occur due to changes in sediment scour and deposition in proximity to the barrier/gate structure. When the barriers/gates are in the closed position, minor temporary impacts could occur, depending on closure duration.

The Jamaica Bay Region, Long Island Sound, and the Hackensack/Passaic Region each have berms planned, which could have the potential to produce low impacts from sediment transport, depending on the extent of the measure planned. The benefit from these berms is the protection of wetlands and landscapes from inundation and erosion. These measures only account for a small area in each Region and impacts are not anticipated to be significant. Temporary impacts from operations and maintenance of other Shore-Based Measures include changes in water depth or sedimentation during major storm events. No significant impacts are anticipated that would surpass the impacts produced by a major storm/flood event under the No Action Alternative.

Beneficial long-term impacts to sediment transport are anticipated once the measures are constructed because they are anticipated to manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact from sediment transport is expected in the Capital District and Mid-Hudson Regions because no measures are planned there under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Sediment Transport.

ALT 4 Sediment Transport Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	2+	1+	3+	1	2	3+
O&M Assumptions	1	1	1	1	1	2	1	1	2
Mitigated Rating	*1*	*1*	1	1	*1*	*2*	*1*	1	2

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts from sediment transport associated with construction of Alternative 4 are expected to range from No to Moderate impact. The Regions with the greatest impacts from sediment transport under Alternative 4 are Jamaica Bay and the Hackensack/Passaic because of construction of the storm surge barrier and tide gates. The Long Island Sound Region also has a storm surge barrier planned, however, the barrier would occupy a small area in the Region (Flushing Creek) and impacts would be localized; therefore, Low impacts are expected.

Temporary in-water impacts from sediment transport during construction include physical seabed disturbances, such as foundation installation, dredging, dewatering, and excavation and fill activities. These impacts are not anticipated to surpass the impacts produced by a major storm/flood event under the No Action Alternative.

With the exception of levees, which have no impact because they are set back from the shoreline, the construction of each shore-based measure under Alternative 4 has a Low impact rating from sediment transport. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport. Low impacts are expected from construction of Shore-Based Measures in Jamaica Bay, the Long Island Sound, Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Region.
Impacts from sediment transport associated with operation and maintenance of the storm surge barriers in the Jamaica Bay and the Hackensack/Passaic are expected to Low. When the barriers/gates are in the open position, localized impacts may occur due to changes in sediment scour and deposition in proximity to the barrier/gate structure. When the barriers/gates are in the closed position, minor temporary impacts could occur, depending on closure duration. The Long Island Sound Region also has a storm surge barrier planned, however, the barrier would occupy Flushing Creek, so impacts would be localized and are not expected to be significant.

The Jamaica Bay Region and the Hackensack/Passaic Region each have berms planned, which could have the potential to produce low impacts from sediment transport, depending on the extent of the measure planned. The benefit from these berms is the protection of wetlands and landscapes from inundation and erosion. These measures only account for a small area in each Region and impacts are not anticipated to be significant. Temporary impacts from operations and maintenance of other Shore-Based Measures include changes in water depth or sedimentation during major storm events. No significant impacts are anticipated that would surpass the impacts produced by a major storm/flood event under the No Action Alternative.

Beneficial long-term impacts to sediment transport are anticipated once the measures are constructed because they are anticipated to reduce risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact from sediment transport is expected in the Lower Bay, Raritan, Capital District, and Mid-Hudson Regions because no measures are planned there under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenance assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Sediment Transport.

ALT 5 Sediment Transport Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2*	*1*	*1*	1	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Impacts to sediment transport associated with construction of Alternative 5 are expected to range from No to Low impact. The Region with the greatest impacts from sediment transport under Alternative 5 is the Lower Hudson/East River because of construction of Shore-Based Measures such as floodwalls and elevated promenade. The installation of hardened structure along the shoreline may result in increased wave energy, erosion, and sediment transport. The Hackensack/Passaic and Upper Bay/Arthur Kill also have Shore-Based Measures planned, however, the measures are levees which are set back from the shoreline; therefore, impacts are not anticipated to be significant. No in-water measures are planned under Alternative 5.

Beneficial long-term impacts to sediment transport are anticipated once the measures are constructed because they are anticipated to manage risk to areas prone to erosion, minimize long-term requirements for beach nourishment, and minimize the loss of native shoreline habitats due to storm surges. The Shore-Based Measures will minimize potential impacts from large storm events, benefitting the shoreline communities and habitats over the long-term.

No impact from sediment transport is expected in any other Region because no measures are planned there under Alternative 5.

6.1.8 Water Quality

Impacts to salinity are anticipated to have an impact rating of no impact to low impact for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The only impact-producing factor to salinity is inundation of fresh water or freshwater intrusion based on eroded shorelines. Below is a summary of the potential impacts to salinity.

Impacts to dissolved oxygen (DO) are anticipated to have an impact rating of low to moderate impact for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors to DO: physical seabed/land disturbance, sediment suspension, and discharge/release and withdrawals.

Impacts to turbidity are anticipated to have an impact rating of low to moderate impact for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors to turbidity: physical seabed/land disturbance, sediment suspension, discharge/release and withdrawals, and habitat conversion. Below is a summary of the potential impacts to turbidity.

Construction Impact Summary

No impacts to salinity are anticipated during the construction of Shore-Based Measures. During construction of in-water measures, temporary impacts to salinity may occur if there is a physical barrier in-water that prevents full tidal exchange. To protect overall water quality during construction, implementation of site-specific BMPs may be developed.

Temporary impacts to DO may result during the construction of Shore-Based Measures. Minor short-term impacts to DO levels are anticipated during physical seabed/land disturbances that cause increased turbidity and sediment suspension, such as foundation installation, dredging, dewatering, and excavation and fill activities. DO levels are anticipated to return to baseline conditions following construction completion and permanent impacts are not anticipated. Temporary impacts to in-water areas could be managed through implementation of a site-specific SWPPP and construction BMPs. Additional site-specific surveys may need to be conducted based on final design in order to assess potential DO impacts.

Impacts to in-water measures would be low impact to moderate impact. The impact rating for storm surge barriers and tide gates measures to DO is moderate and the impact rating for wetland restoration and stone-toe and rock sill protection is low. Temporary in-water impacts include increased turbidity during construction activities and resuspension of sediments into the water column during foundation installation, dredging, dewatering, and excavation and fill activities. Temporary short-term impacts to DO could occur during vessel anchoring and dewatering activities. Impacts to DO would be minimized through use of BMPs during dewatering and would be short term impacts. Spills or leaks of fuels, lubricants, and coolant from construction equipment could adversely impact DO and water quality. Impacts from inadvertent spills or leaks of hazardous materials are anticipated to be minor because of the low frequency and volume of materials released with implementation of SPCC. Site-specific SPCC plans could be developed and implemented to reduce the risk of release and control volume and dispersion of any release. DO is anticipated to return to baseline conditions after construction activities are completed. Impacts to DO and overall water quality could be minimized by the implementation of these BMPs.

Temporary impacts to turbidity will result during the construction of Shore-Based Measures. Moderate short-term impacts are anticipated during physical seabed/land disturbances that cause increased levels of turbidity and sediment suspension, such as foundation installation, dredging, dewatering, and excavation and fill activities. Turbidity levels are anticipated to return to baseline following construction completion and permanent impacts are not anticipated. Temporary impacts could be managed through implementation of a site-specific SWPPP and construction BMPs. Additional site-specific surveys may need to be conducted based on final design in order to assess potential turbidity impacts.

Impacts to turbidity from in-water measures would be low impact to moderate impact. The impact rating for storm surge barriers and tide gates measures to turbidity is moderate and the impact rating for wetland restoration and stone-toe and rock sill protection is low. Temporary in-water impacts include increased turbidity during construction activities and sediment suspension into the water column during foundation installation, dredging, dewatering, and excavation and fill activities. Temporary short-term impacts to turbidity could occur during vessel anchoring and dewatering activities. Impacts to turbidity could be minimized through use of BMPs during dewatering and would not cause long-term permanent impacts. Discharge/release and withdrawals may cause temporary impacts to turbidity levels but would not cause long-term impacts. Turbidity is anticipated to return to baseline conditions after construction activities are completed. Impacts to turbidity and overall water quality could be minimized by the implementation of BMPs. During foundation installation and other construction activities that disturb sediments, potential indirect impacts from removal of SAV could cause sediments to be more prone to increased turbidity and sediment transport.

Operations and Maintenance Impact Summary

During operations and maintenance of the proposed measures, salinity levels from storm surge barriers, and tide gate measures are anticipated to be low overall. When the barriers are in the open position, no impacts would occur to salinity. When the barriers are in the closed position, potential long-term impacts to salinity include increased stratification due to inhibited mixing of waters. The USACE (2017) conducted a modeling study on the effects of a proposed storm surge barrier across the width of the Rockaway Inlet to water quality under varying rainfall and barrier operating conditions. The model indicated small changes in long-term salinity levels when the gates were closed, on the order of 0.1 parts per thousand (ppt) (USACE, 2017). The impacts from barrier closure to salinity and overall water quality may be further evaluated during Final Feasibility Report/Tier 1 EIS.

During operations and maintenance of the proposed measures, impacts on DO levels from storm surge and tide gate measures are anticipated to be low. When the barriers are in the open position, no impacts would occur to DO. When the barriers are in the closed position, minor temporary impacts to DO levels and water quality are anticipated, such as short-term changes in sediment resuspension and minor increases in turbidity during operation. Potential long-term impacts to DO include decreased DO concentration behind the closed barrier due to inhibited mixing of waters. The USACE (2017) conducted a modeling study on the effects of a proposed storm surge barrier across the width of the Rockaway Inlet to water quality under varying rainfall and barrier operating conditions within Jamaica Bay. Long-term changes in DO concentrations due to the construction of the storm surge barriers would be 0.01 mg/L or less. However, the model predicted in some areas of Jamaica Bay, mainly Grassy Bay and in the channels that lie between the marsh islands in the middle region of Jamaica Bay, bottom DO concentrations would decrease between 1 to 2 mg/L (USACE, 2017). The impacts from barrier closure to DO and overall water quality may be further evaluated during Final Feasibility Report/Tier 1 EIS.

During operations and maintenance of the proposed measures, impacts from turbidity for storm surge and tide gate measures are anticipated to be low overall. When the barriers are in the open position, minor impacts to increased turbidity around the hardened structures could occur. When the barriers are in the closed position, minor temporary impacts to water quality are anticipated, such as short-term changes in hydrology, sediment resuspension and minor increases in turbidity during operation. Potential long-term impacts to turbidity include higher turbidity levels behind the barrier when the barriers are closed, due to inhibited water movement The impacts from barrier closure to turbidity levels and overall water quality may be further evaluated during Final Feasibility Report/Tier 1 EIS.

The implementation and operation of barriers and closures have the potential for significant indirect impacts on water quality based on their potential for altering flow and circulation patterns. These impacts are inherently based on the design of the barrier and closure criteria, such as the number of openings and widths of these openings, which could significantly alter the flow patterns by constricting flows and affecting current velocities.

These flow pattern changes could potentially result in changes in circulation and increased residence times, which could have more profound effects in backwater areas that are already poorly flushed. Restrictions in tidal flows and increases in residence times could affect salinity levels, stratification, nutrients, chlorophyll ‘a’ and dissolved oxygen concentrations. These effects could be exacerbated at times when the gates are closed during a significant storm event when increased freshwater inputs, nutrients, bacteria, and other pollutants discharged from tributaries and point and non-point sources are held in shallow water areas for a longer period.

TSP (Alternative 3B)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Water Quality

TSP Water Quality Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	3	1	2	1	2	3
O&M Assumptions	1	1	1	2	1	2	1	2	2
Mitigated Rating	*1*	*1*	1+	1+	*1*	*1+*	*1*	1+	1+

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to water quality range from No to Moderate impact under the TSP. The Regions with the greatest impact to water quality under the TSP are the Jamaica Bay Region and Upper Bay/Arthur Kill Region. These Regions are expected to be Moderately impacted because of construction of the storm surge barrier and tide gates, which are expected to produce turbidity during construction activities and resuspension of sediments into the water column during foundation installation, dredging, dewatering, and excavation and fill activities. Short-term, moderate impacts to DO are anticipated during the construction of these measures as well. Within the Long Island Sound Region, a storm surge barrier is proposed at the mouth of Flushing Creek, a small tributary in the Region. Impacts to the creek are anticipated to be localized; therefore, the impact rating is Low.

Moderate impacts to water quality are expected from construction of the seawall and reinforced dunes, which are Shore-Based Measures that will temporarily impact DO and turbidity during land disturbances. Seawalls and sand dunes are primarily planned to be constructed in the Jamaica Bay Region. Construction activities such as foundation installation, dredging, and excavation are associated with many Shore-Based Measures which are also expected to produce impacts to water quality. Road raising is planned along Broad Channel in Jamaica Bay and impacts to water quality are expected to be Low. Other Shore-Based Measures are anticipated to have low impacts on water quality during construction under the TSP.

Low impacts to water quality are expected from operations and maintenance of the storm surge barrier and tide gates under the TSP. Impacts to salinity levels are anticipated to be low overall. Maintenance of wetland restoration measures is expected to produce Low impacts to water quality under the TSP, and no water quality impacts are expected from the other measures. Implementation of the TSP also is expected to provide a benefit to water quality, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

Few measures are planned in the Long Island Sound Region and impacts there expected to be minor compared to other Regions.

No impact to water quality is expected in Lower Bay, Raritan, Mid-Hudson, and Capital District Region because no construction is planned there under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Water Quality.

ALT 2 Water Quality Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	2	3	3
O&M Assumptions	1	1	1	2	2	2	2	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1+*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to water quality range from No to Moderate impact under Alternative 2. The Regions with the greatest impact to water quality are the Lower Bay, Jamaica Bay, and the Long Island Sound Regions. These Regions are expected to be impacted by construction of the storm surge barrier and tide gates (Lower Bay and Long Island Sound), which are in-water measures, and the construction of the buried seawall/dune, which are Shore-Based Measures proposed primarily in the Jamaica Bay Region. Impacts to water quality include turbidity caused by resuspension of sediments into the water column during foundation installation, dredging, dewatering, and excavation and fill activities. Moderate short-term impacts are anticipated to DO during construction of storm surge barriers and tide gate measures.

With the exception of the construction of sand dunes, which are anticipated to produce moderate impacts to water quality, all Shore-Based Measures are expected to have low impacts on water quality during construction of Alternative 2. Road raising is planned along Broad Channel in Jamaica Bay and impacts to water quality are expected to be Low.

Low impacts to water quality are expected from operations and maintenance of the storm surge barrier and tide gates under Alternative 2. Impacts to salinity levels are anticipated to be low overall. Maintenance of wetland restoration measures, including berms, is expected to produce low impacts to water quality with the potential for runoff during maintenance. No water quality impacts are expected from operations and maintenance of the other Shore-Based Measures. Implementation of Alternative 2 is expected to provide a benefit to water quality, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding, storm surges.

No impact to water quality is expected in Capital District and the Mid-Hudson Region because no measures are planned in those Regions under Alternative 2.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Water Quality.

ALT 3A Water Quality Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	2	2	3	3	3
O&M Assumptions	1	1	1	2	2	1	2	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to water quality range from No to Moderate impact under Alternative 3A. The Regions with the greatest impact to water quality under Alternative 3A are the Jamaica Bay, Long Island Sound, Upper Bay/Arthur Kill, and the Raritan Regions. These Regions are expected to be impacted the most because of construction of the storm surge barrier and tide gates that are expected to produce moderate impacts to turbidity including the resuspension of sediments into the water column during foundation installation, dredging, dewatering, and excavation and fill activities. Moderate short-term impacts to DO are also anticipated. Within the Lower Bay Region, a storm surge barrier is proposed in Sandy Hook, however, the barrier is planned within a small area of the Region and impacts are expected to be localized. Overall, low impacts are anticipated from construction in the Lower Bay.

Moderate impacts to water quality are expected from construction of the seawall and sand dunes under Alternative 3A, which are Shore-Based Measures that will temporarily impact DO and turbidity during land disturbances. Seawalls and sand dunes are primarily planned in the Jamaica Bay Region. All other Shore-Based Measures are expected to have low impacts on water quality during construction under Alternative 3A. Road raising is planned along Broad Channel in Jamaica Bay and impacts to water quality are expected to be Low. Construction activities such as foundation installation, dredging, and excavation can cause impacts to water quality.

During operations and maintenance of the storm surge barrier and tide gates, low impacts to water quality are expected. Impacts to salinity are anticipated to be low overall. Maintenance of wetland restoration measures is also anticipated to produce low impacts to water quality due to the potential for runoff during maintenance activities. No water quality impacts are expected from operations and maintenance of the other planned measures. Implementation of Alternative 3A is expected to provide a benefit to water quality, by reducing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impact to water quality is expected in the Mid-Hudson Region and Capital District because no measures are planned in those Regions under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Water Quality

ALT 4 Water Quality Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	1	1	1	1	1	2	2
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to water quality range from No to Moderate impact under Alternative 4. Moderate impacts to water quality under Alternative 4 are expected in the Jamaica Bay Region because of construction of the storm surge barrier and tide gates. These measures will produce moderate impacts to turbidity, including the resuspension of sediments into the water column during foundation installation, dredging, dewatering, and excavation and fill activities. Moderate short-term impacts to DO are anticipated as well. Within the Long Island Sound Region, a storm surge barrier is proposed at the mouth of Flushing Creek, a small tributary in the Region. Impacts to the creek are anticipated to be localized; therefore, the impact rating is Low.

Moderate impacts to water quality are expected from construction of the seawall and buried dunes, which are Shore-Based Measures that will temporarily impact DO and turbidity during land disturbances. Seawalls and sand dunes are primarily planned to be constructed in the Jamaica Bay Region. Road raising is planned along Broad Channel in Jamaica Bay and impacts to water quality are expected to be Low. All other Shore-Based Measures are expected to have low impacts on water quality during construction under Alternative 4. Water quality impacts are associated with foundation installation, dredging, and excavation activities.

Low impacts to water quality are expected from operations and maintenance of the storm surge barrier and tide gates under Alternative 4. Impacts to salinity levels are anticipated to be low overall. Maintenance of wetland restoration measures, which are shore-based, will also have low impacts on water quality due to the potential for runoff during maintenance activities. No impacts to water quality are expected from operations and maintenance of the other planned measures. Implementation of Alternative 4 also is expected to provide a benefit to water quality, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impacts are expected in the Lower Bay, Raritan, Mid-Hudson, and Capital District because no measures are planned there under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Water Quality

ALT 5 Water Quality Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to water quality range from No to Low impact under Alternative 5. The Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Regions are expected to have Low construction related impacts to water quality from Shore-Based Measures such as levees and floodwalls.

No water quality impacts are expected from operations and maintenance of the planned measures under Alternative 5. Implementation of Alternative 5 is expected to provide a benefit to water quality, by managing the risk of flooding and erosion damage associated RSLC, storm surges, and coastal flooding.

No impact to water quality is expected in the Lower Bay, Raritan, Jamaica Bay, Long Island Sound, Mid-Hudson, and Capital District because no measures are planned there under Alternative 5.

6.1.9 Regional Ecosystems (NYBEM)

As described in Chapter 2, the New York Bight Ecological Model (NYBEM) was applied to assess aquatic regional ecosystems in the NYNJHAT Study Area. Specifically, the model estimates changes in ecosystem extent and condition associated with changing hydrodynamic conditions in six major ecosystem types: freshwater tidal (fresh.tid), estuarine intertidal (est.int), estuarine subtidal (est.sub), marine intertidal (mar.int), marine subtidal (mar.sub), and marine deepwater (mar.deep). These habitat zones currently represent only hydrodynamic outputs and do not necessarily reflect regulatory definitions of ecosystems. For instance, an area identified as an estuarine, subtidal ecosystem may (or may not) currently host submerged aquatic vegetation or hard-bottom reef environments, which would imply different actions from a mitigation perspective. Subtidal ecosystems consist of coastal ecosystems with bed elevation between Mean Lower Low Water and -2 meters below Mean Sea Level. These outputs do, however, provide broad spatial coverage not feasible to collect for the entire Study Area. As such, NYBEM output should be interpreted as a ***relative*** comparison of infrastructure alternatives on regional ecosystems rather than a direct estimate of impacts and mitigation. Detailed model descriptions are available via online documentation (https://mvr-gis.github.io/NYBEM-Report/), and Appendix A11 summarizes the parameterization of the models for the NYNJHAT Study and more detailed consideration of the results. Note, the NYBEM results will be rated for the Regional Ecosystems category and incorporated into the environmental consequences analysis in the Final Integrated FR/Tier 1 EIS.

Preliminary Alternative Plan Analysis

Two applications of NYBEM were undertaken to inform feasibility study planning. First, ***direct effects*** of management actions were quantified by examining the "footprint" of each structural feature (e.g., floodwalls, storm surge barriers, etc.). Specifically, the existing condition maps of the six ecosystems (from Chapter 2) were intersected with proposed infrastructure actions plus an additional buffered distance of 100 feet. The buffered distance was included to account for potential impacts associated with construction staging areas, access to build a feature, and long-term maintenance corridors. Second, the ***indirect effects*** of actions were quantified by estimating hydrodynamic change associated with storm surge barriers at the system-wide scale. AdH models were executed for each proposed storm surge barrier configuration over an annual simulation window in an open gates, sunny day condition. These hydrodynamic data were then used to parameterize NYBEM and estimate cumulative effects of these features off-site from the infrastructure itself. Future analyses will examine gate closures and operational conditions for the Tentatively Selected Plan. Both analyses are summarized here in “habitat units” representing both the quantity and quality of ecosystems, although area-only analyses were also undertaken (Appendix A11).

The direct effects of NYNJHAT study alternatives on regional ecosystems were estimated for the structural footprint of all features buffered by a 100-foot corridor. Existing condition maps were used for this analysis under the assumption that these represent current habitat and would be the primary focus of mitigation actions. The figure below summarizes the results of this analysis, and notable findings include the following:

- Across all Alternative plans, the majority of effects are in the estuarine intertidal and subtidal zones. This is expected, given the low coverage of marine areas in the NYNJHAT Study Area and minimal presence of structural features in freshwater areas. Within the estuarine zones, the effects are generally even across intertidal and subtidal habitats with shore-based features driving larger effects in intertidal areas.
- Bulkheads, floodwalls, seawalls, and storm surge barriers consistently show the largest sources of project impacts across Alternative plans driven by the more extensive footprint of these actions.
- Alternative 2 has higher direct footprint impacts than the other Alternative plans, and Alternative 3A results in a similar order-of-magnitude of effect.
- Alternative 5 consistently has the lowest direct effects at both alternative-scale as well as on a feature-by-feature basis.
- Alternative 3B has second lowest direct impacts, although these effects are much larger than Alt-5 (i.e., 350% greater). By comparison, Alternative plans 3A and 4 have much greater impacts than Alt-5 (i.e., 600% and 450% greater, respectively).

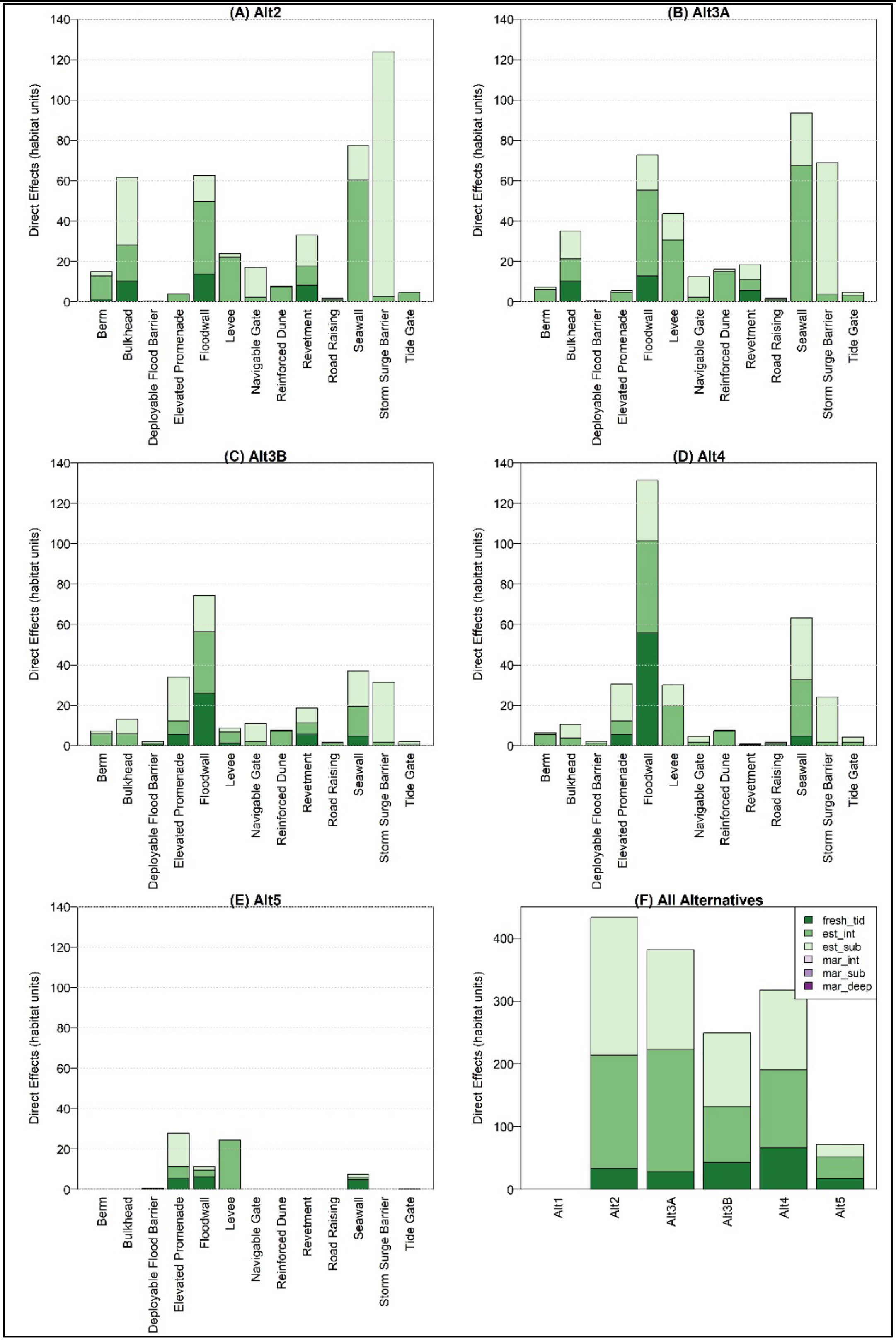


Figure 61: The NYBEM direct effects of Alternatives on regional ecosystems

Indirect effects of management actions are defined here as the changes in regional ecosystems off-site or distant from storm surge barriers resulting from change in hydrodynamics or estuary circulation patterns. In particular, storm surge barriers have the potential to change hydrodynamics and estuarine function beyond the footprint of the structure itself. These "off-site" or indirect effects are addressed here through changes in ecosystem condition as summarized for the project area and regions. For instance, tidal ranges or salinity levels could change at a given patch as a result of a barrier, and these effects could indicate a change in habitat type. Similarly, a barrier could induce a change in a hydrodynamic variable within a given habitat suitability model (e.g., velocity) even in this open gate simulation.

Indirect effects of actions were quantified by estimating hydrodynamic change associated with storm surge barriers at the system-wide scale. AdH models were executed for each proposed storm surge barrier configuration over an annual simulation window in an open gates, sunny day condition (McAlpin and Emiren, Appendix B7). These hydrodynamic data were then used to parameterize NYBEM and estimate cumulative effects of these features off-site from the infrastructure itself.

The following figure summarizes expected changes in ecosystem extent (area) and condition (habitat units) at the scale of the entire project area. Four stipulations assist in interpreting these outcomes.

- Outcomes represent aggregated effects, not site-specific effects. For example, an ecosystem could change at multiple locations, but the net effect could be zero change.
- Indirect effects can only be quantified using hydrodynamic data, and thus, are only shown at the alternative scale with multiple barriers, rather than feature-by-feature.
- Indirect effects require a point of comparison, and all results are presented relative to the existing condition. For instance, did the extent of a given ecosystem type go up or down as the result of an alternative?
- Although “impacts” are typically thought of as unidirectional (i.e., negative), change may be more generally considered in this analysis as deviation from current conditions, and large amounts of change (positive or negative) could be considered impactful.
- Multiple metrics are presented to better characterize and contextualize the changes estimated by these models. Metrics for habitat extent (i.e., area) and quality (i.e., habitat units) can provide useful distinctions between the magnitude of change resulting from tidal and salinity zones versus changes in ecosystem condition. Similarly, the net change from the existing condition baseline may provide a very different outlook that the relative change in ecosystem type or condition at a regional scale.

These results can then be interpreted through the lens of Alternative plans analysis as follows:

- Across alternative plans, NYBEM consistently predicts that storm surge barriers would induce habitat conversion from estuarine intertidal areas to freshwater tidal ecosystems. This finding could be expected given the NYBEM’s use of salinity as a delineating criterion, and the role of barriers in altering salinity influx to the estuary.
- The magnitude of change generally decreases as the alternative plans move farther into the estuary (i.e., Alternative 2 > Alternative 3A > Alternative 3B > Alternative 4 > Alternative 5).
- Marine intertidal and subtidal ecosystems are minimally affected by all alternative plans (12A and 12B), due to their minimal extent in the project area (Section 4 of this appendix). However, these systems show high amounts of relative change (12C and 12D), again because a small change in a small area is a relatively large effect on a percentage basis.
- Conversely, freshwater tidal, estuarine intertidal, and estuarine subtidal ecosystem show small amounts of relative change on a percentage basis because of the large extent of these ecosystems across the region. The systems also show a high amount of net change as a result of the alternative plans.
- Alternative 2 produces the largest amount of total change in ecosystem extent (12A) and condition (12B). Specifically, the alternative shows a large impact on estuarine intertidal areas with a significant amount of habitat switching to freshwater tidal.

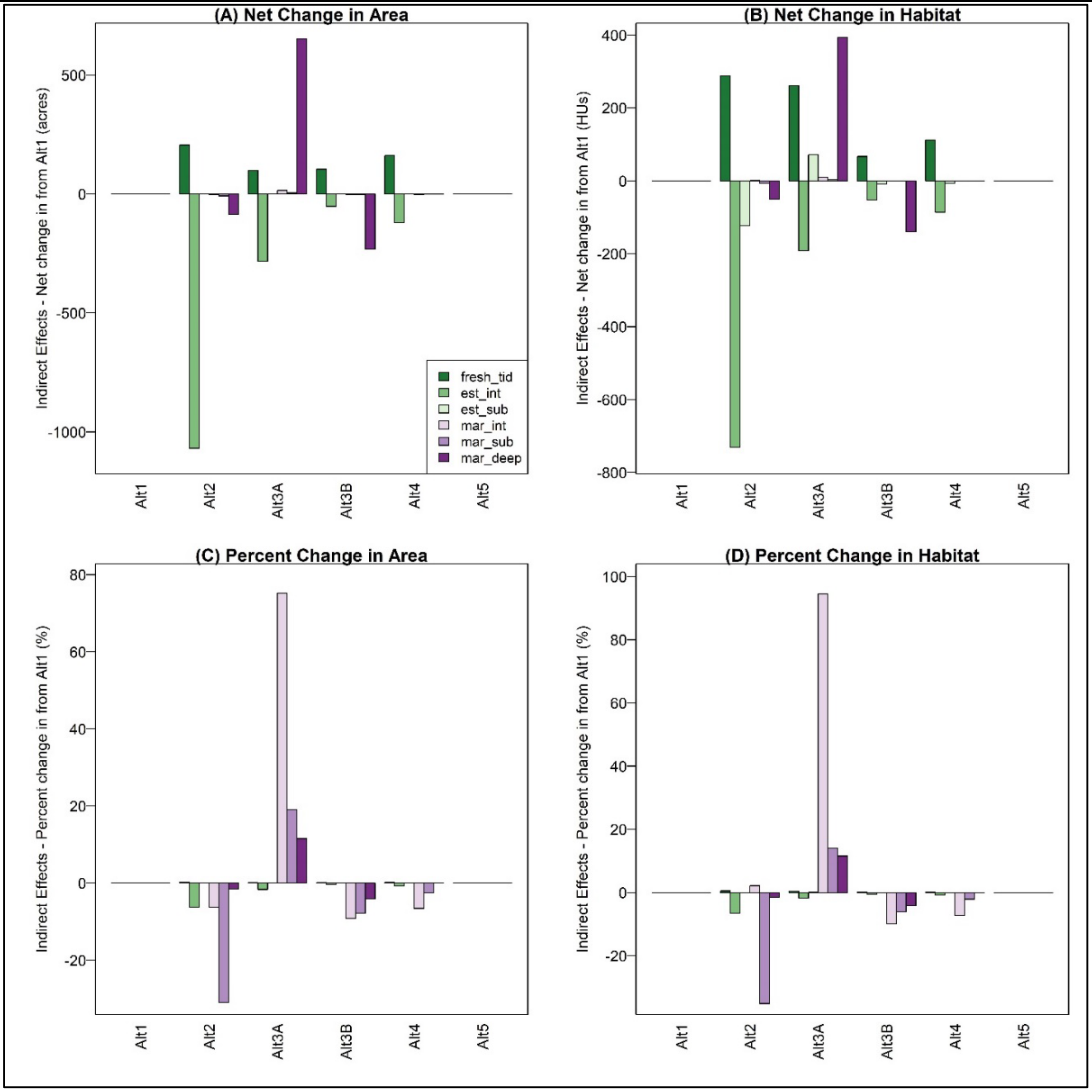


Figure 62: Summary of indirect effects analysis for the entire NYNJHAT Study Area.
Negative values imply reductions from existing condition, and positive values indicate increases. Figures C and D show change normalized by the current extent of an ecosystem.

Although direct and indirect effects may be considered separately, the relative effect of these two potential sources of impact or change may also be considered together. The following figure summarizes these two outcomes for comparison of alternative plans and with each other.

- The relative proportion of direct and indirect effect changes with alternative. For instance, indirect effects are a larger contribution to change for Alternative 2, whereas this ratio inverses for alternative plans with more Shore-Based Measures (i.e., Alternative 3B, Alternative 4, Alternative 5).
- Alternative 2 and Alternative 3A consistently show large magnitudes of change overall, specifically for the indirect effects which are more than triple any other alternative.
- Alternative 5 is consistently the lowest amount of direct or indirect effect.
- Alternative 3B presents a lower amount of change on an ecosystem-by-ecosystem basis than Alternative 4, although when aggregated Alternative 4 shows a lower net magnitude of change.

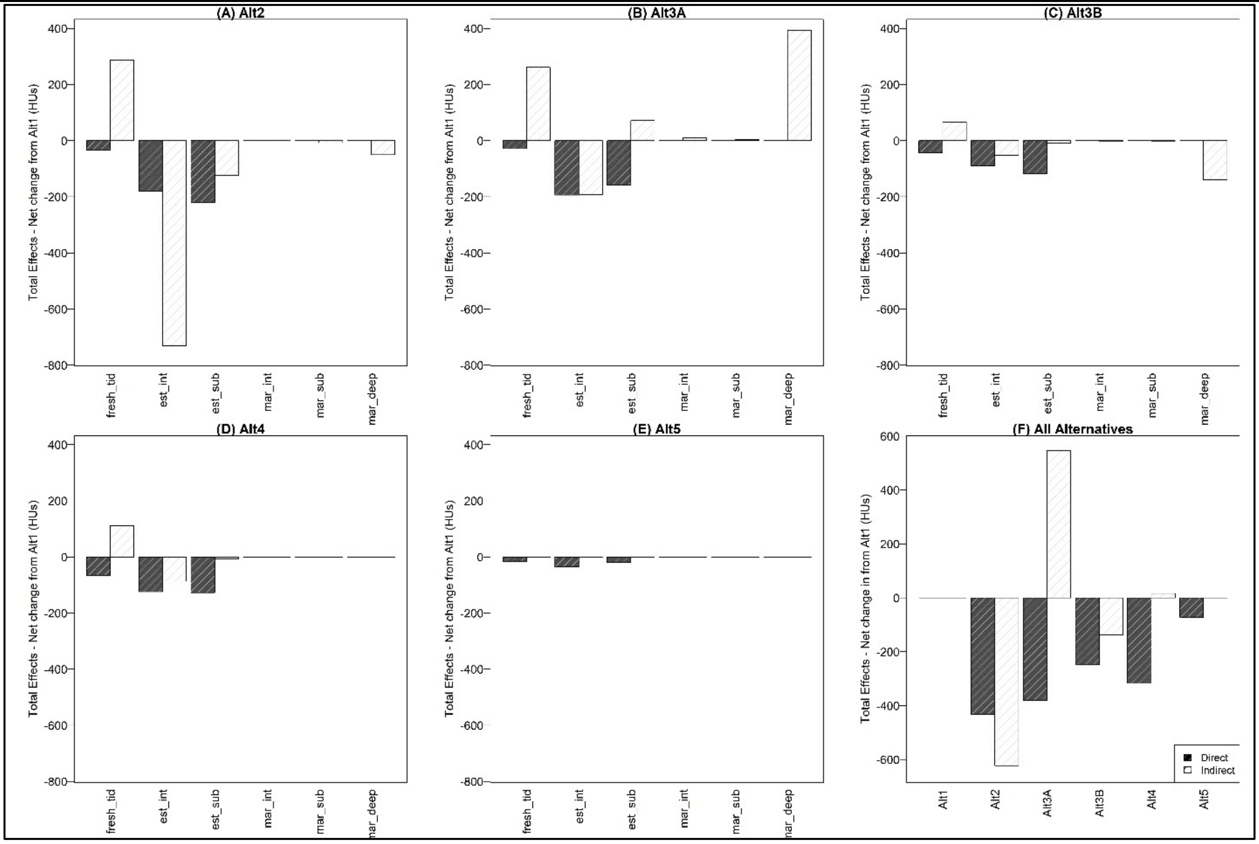


Figure 63: Summary of direct and indirect effects of NYNJHAT Study Alternatives.
Values represent net change in habitat units from the existing condition (Alt1) summarized by ecosystem type.

Tentatively Selected Plan (Alt 3B)

The following figure summarizes the direct effects of Alt3B with metrics of both habitat quantity (area) and ecosystem condition (habitat units). This alternative only shows footprint effects in freshwater tidal, estuarine intertidal, and estuarine subtidal areas. These impacts are dispersed over a large number of features with a majority of the direct effects occurring for actions other than storm surge barriers. Specifically, floodwalls are a significant component of the direct effects of this alternative.

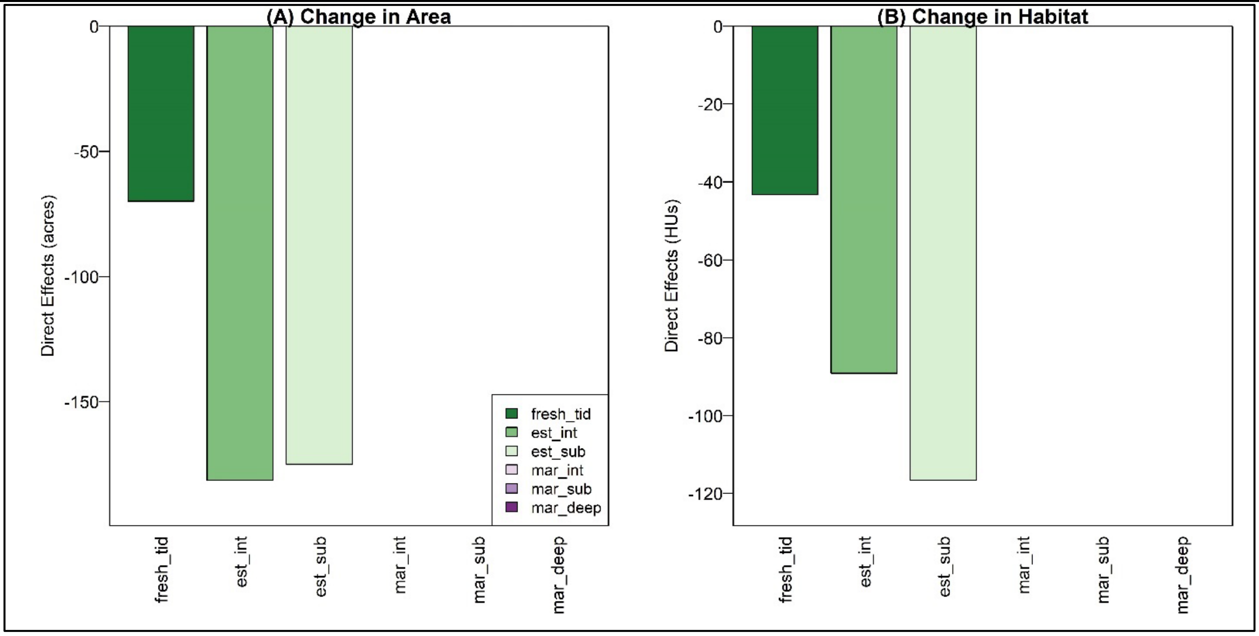


Figure 64: Summary of direct effects of Alt3B for the entire NYNJHAT Study Area.
Values represent net change in area (acres) and habitat quality (habitat units) from the existing condition (Alt1) summarized by ecosystem type.

The following figure summarizes the indirect effects of Alt3B with metrics of net change in habitat quantity and ecosystem condition (Panels A&B) as well as relative change in these metrics (Panels C&D). Freshwater tidal areas are predicted to increase as a result of this alternative, which is not unexpected given the potential for storm surge barriers to alter salinity input to the estuary. Estuarine intertidal areas represent a potential location of impacts associated with this alternative, potentially due to reduced tidal amplitudes behind barriers. Marine deepwater zones are predicted to contract under this alternative, potentially due to a freshening effect in Long Island Sound as described above. Percentage-based metrics indicate significant amounts of change in marine ecosystems, although these areas represent small fractions of the overall NYNJHAT Study Area.

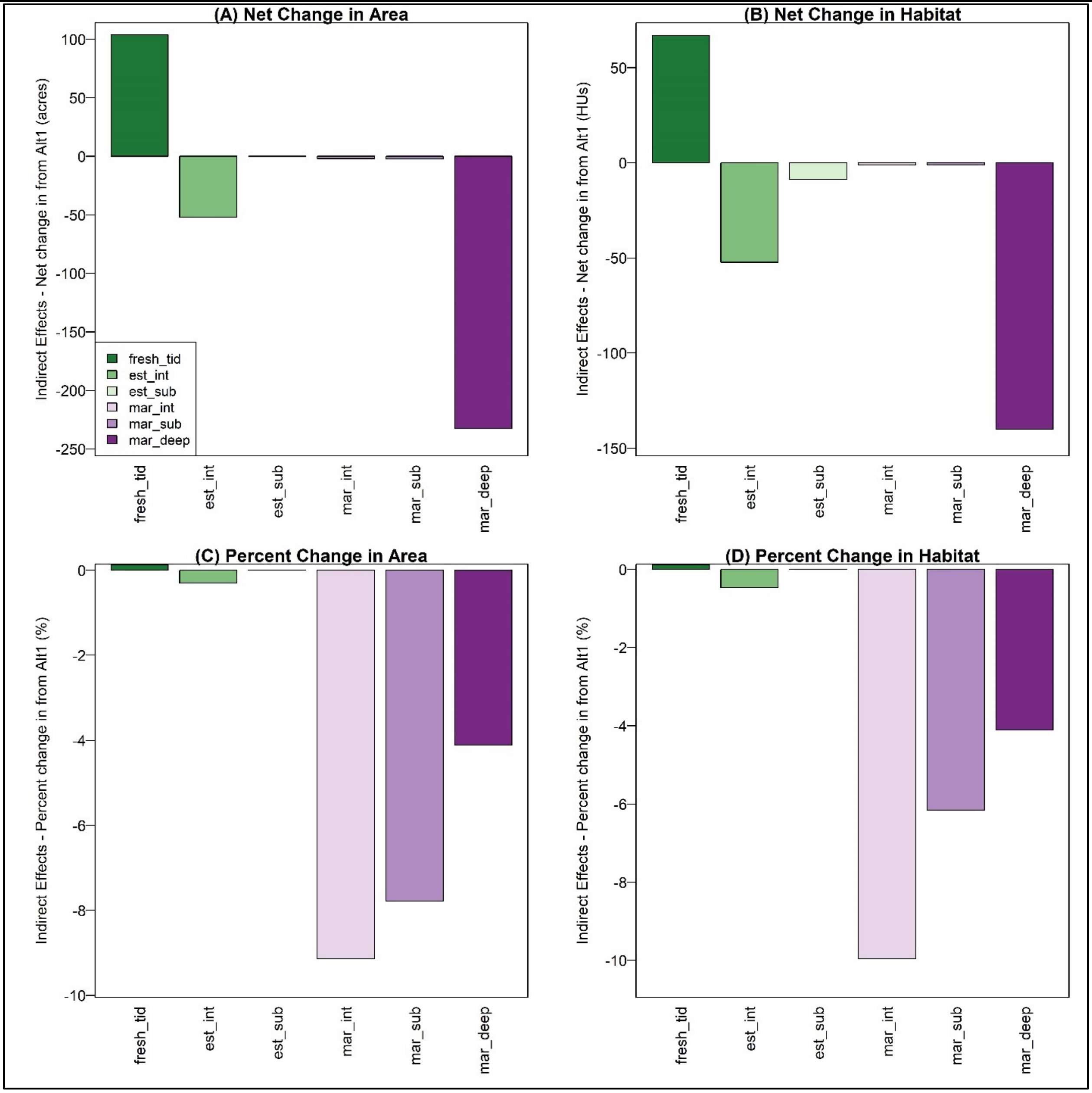


Figure 65: Summary of indirect effects of Alt3B for the entire NYNJHAT Study Area.
Values represent change from the existing condition (Alt1) summarized by ecosystem type. (A) net change in area in acres, (B) net change in habitat quality in habitat units, (C) percent change in area, and (D) percent change in habitat units.

The following sections summarize key direct and indirect effects on a region-by-region basis. The objective of this analysis is to note major trends and outcomes, not break-down specific locations of impact or attribute those effects to a specific piece of proposed infrastructure.

Capital District, Mid-Hudson, and Raritan Region

The Capital District, Mid-Hudson, and Raritan regions are unique in the relatively small (or non-existent) effects of the TSP. For instance, there are no features proposed in the two Hudson River regions, and the indirect effects only represent negligible change in ecosystem extent or condition.

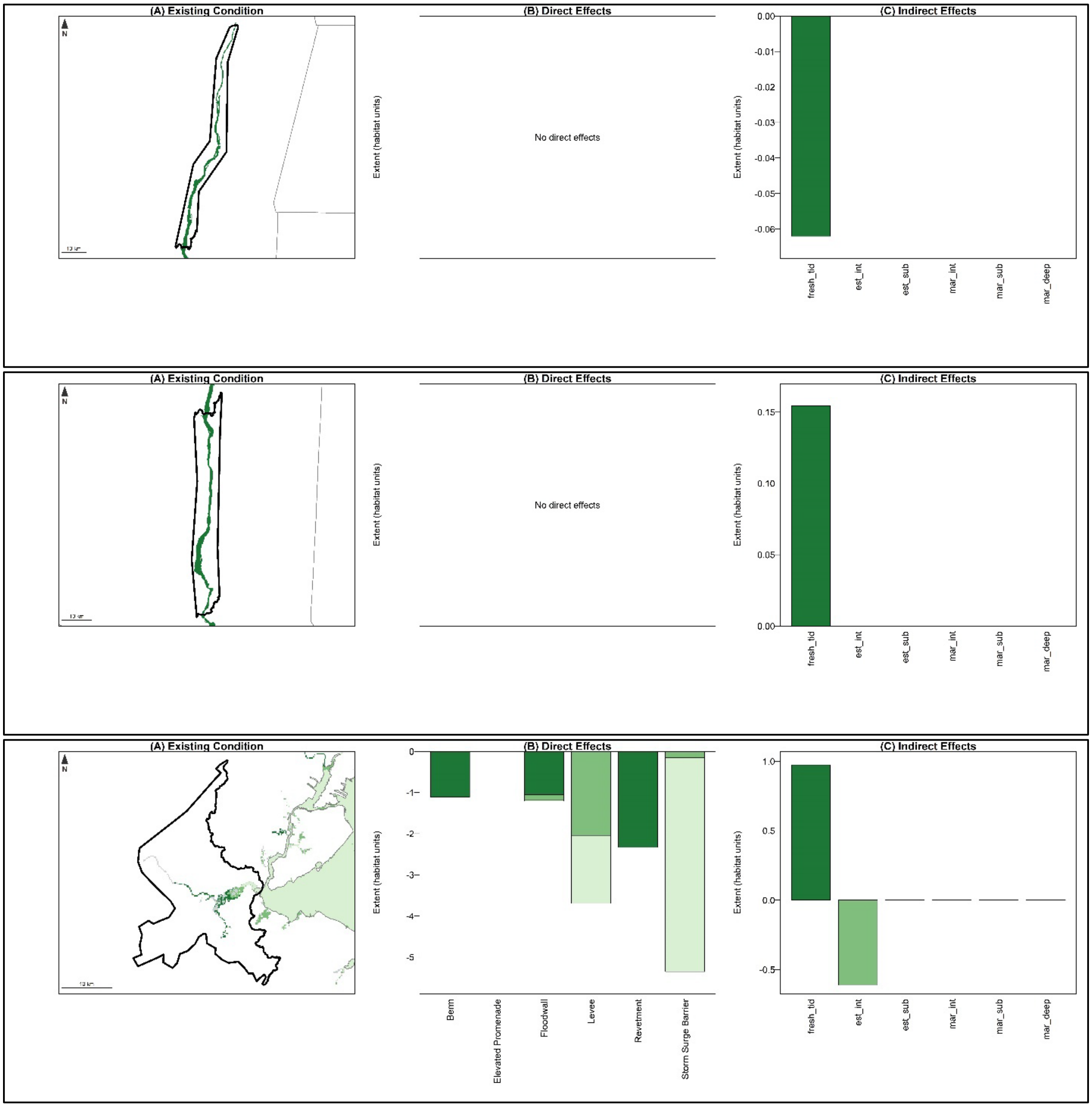


Figure 66: Summary of Alt3B effects for the Capital District (top), Mid-Hudson (middle), and Raritan (bottom) Regions.

Lower Hudson/East River Regions

The Lower Hudson-East River Region represents a key transitional zone between freshwater and estuarine ecosystems, and both direct and indirect effects reflect this transition. Direct effects include a variety of features, which collectively represent a large footprint of actions with one of the largest impact areas of any region. The indirect effects in this region are reflecting a change in the transitional point between salinity zones, and a general freshening resulting from multiple small storm surge barriers.

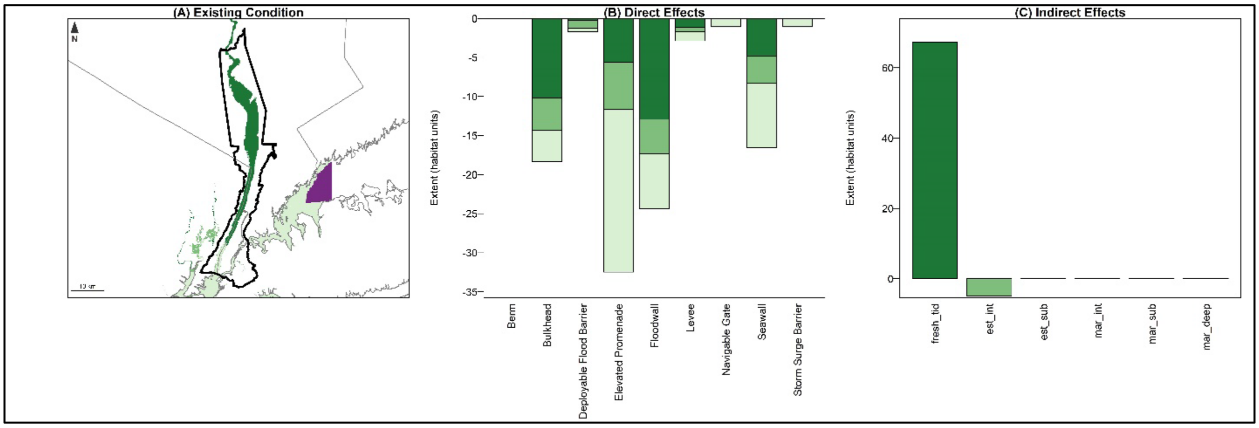


Figure 67: Summary of Alt3B effects for the Lower Hudson-East River Region.

Hackensack-Passaic Region

Alt3B provides substantial direct effects in the Hackensack-Passaic region. Specifically, floodwall and levee features are the major source of impact in this region. Indirect effects are very small and likely resulting from the cumulative effects of the Arthur Kill and Kill Van Kull storm surge barriers.

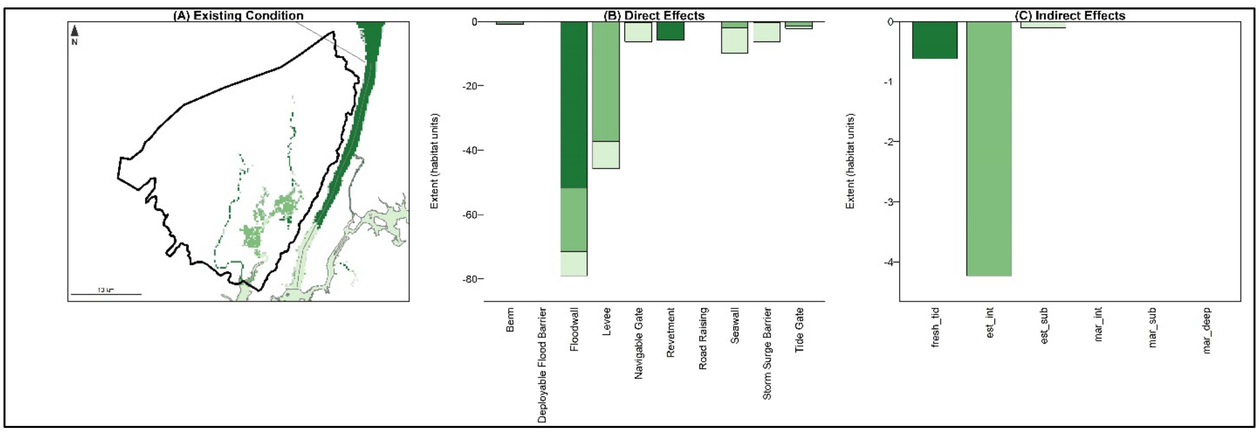


Figure 68: Summary of Alt3B effects for the Hackensack-Passaic Region.

Jamaica Bay Region

The Jamaica Bay region is a primary focal point for Alt3B with both shore-based and in-water features. As anticipated, the Shore-Based Measures have predictable direct effects on the estuarine intertidal areas of this region, and the storm surge barrier would also alter these ecosystems due to changes in tidal regime.

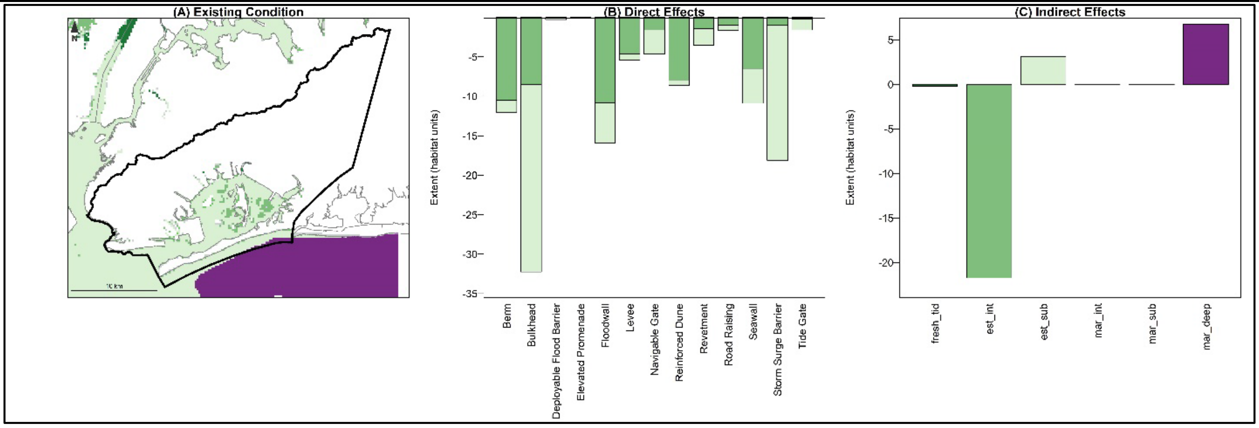


Figure 69: Summary of Alt3B effects for the Jamaica Bay Region.

Long Island Sound Region

The TSP leads to substantial direct effects in this region, partially due to Risk Reduction Features addressed flood risks without storm surge barriers. The indirect effects in the region are due to a predicted shift in the estuarine-marine salinity, which would decrease the overall extent of marine ecosystems.

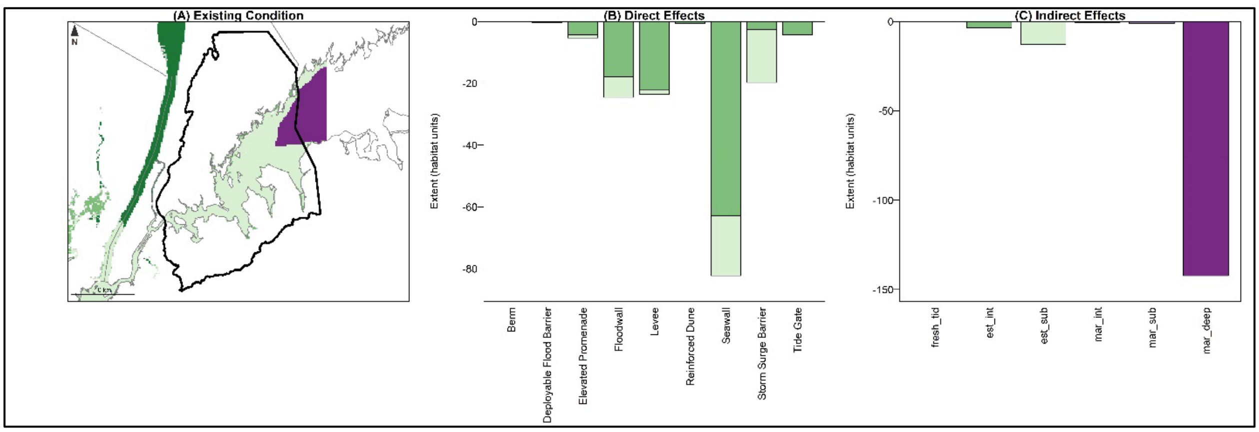


Figure 70: Summary of Alt3B effects for the Long Island Sound Region.

Lower Bay Region

The Arthur Kill storm surge barrier is the primary driver of direct and indirect effects in the Lower Bay region. However, the indirect effects are quite small in this region, and direct effects are significantly larger than indirect changes (i.e., 20-40X).

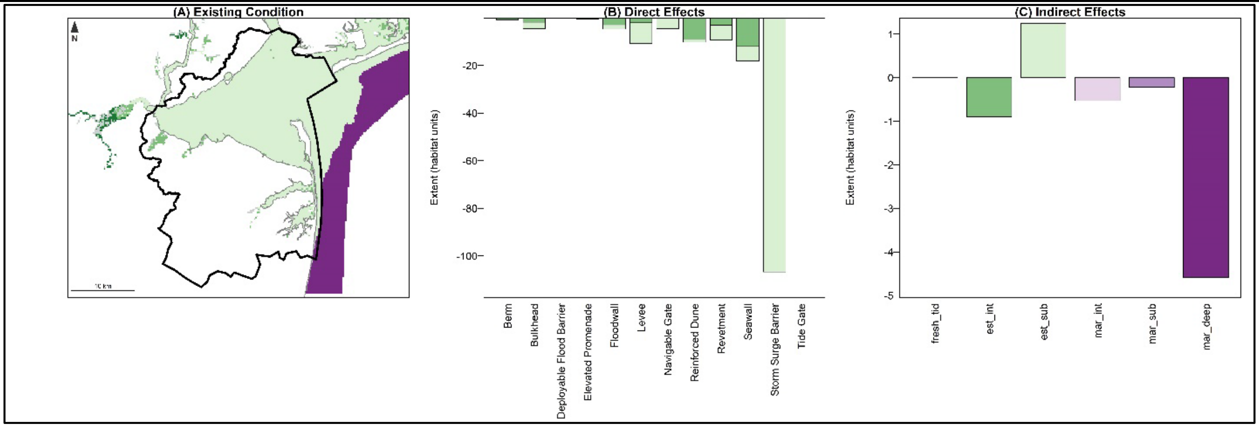


Figure 71: Summary of Alt3B effects for the Lower Bay Region.

Upper Bay-Arthur Kill Region

Alt3B has a substantial effect on the Upper Bay-Arthur Kill Region. The direct effects in this region are driven by the Kill Van Kull storm surge barrier and floodwall projects, and the indirect effects are driven by the combined effect of the Kill Van Kull and Arthur Kill barriers.

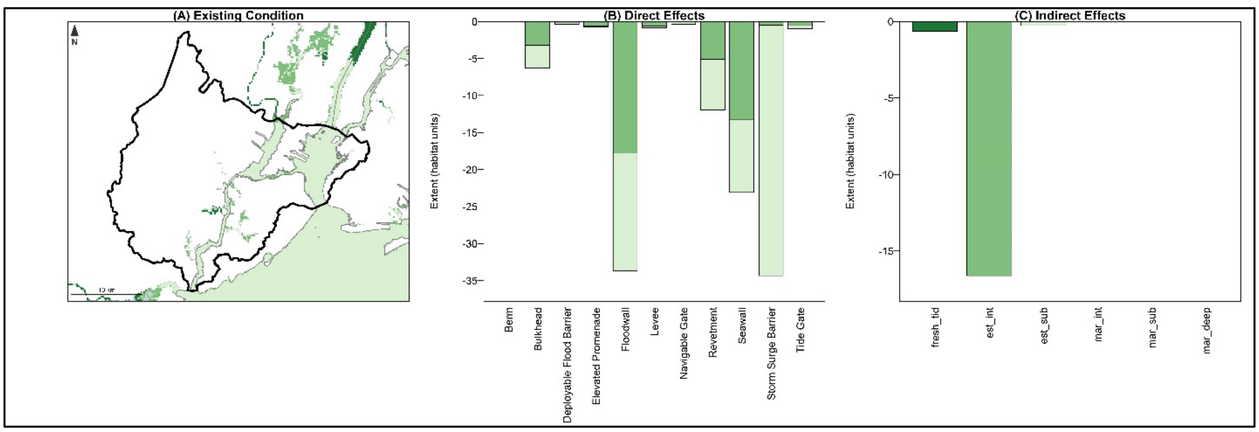


Figure 72: Summary of Alt3B effects for the Upper Bay-Arthur Kill Region.

6.1.10 Air Quality and Clean Air Act

Emissions from Federal Actions, such as the NYNJHAT project, are regulated under 40 CFR §93 Subpart B, General Conformity, which aims to ensure that emissions from Federal Actions do not impede a state's progress toward achieving or maintaining compliance with NAAQS under their applicable State Implementation Plan (SIP). Projects with emissions below specified threshold levels are not subject to requirements beyond documentation of the de minimis level of emissions.

Emissions from construction of the NYNJHAT TSP will be below all of these de minimis levels on a yearly basis. Refer to Appendix A6 for additional information on the CAA assessment on the TSP. The sole impact producing factor to air quality and CAA is regulated air emissions, which will be below General Conformity significance. Therefore, all Alternative plans are rated "1" or No Impact:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3B (TSP), 2, 3A, 4 and 5 on Air Quality and Clean Air Act

ALT 3B (TSP), 2, 3A, 4, and 5 Air Quality and Clean Air Act Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

Greenhouse Gas

The generation of greenhouse gas (GHG) emissions associated with the project's construction activities will be temporary in nature, spanning only the construction period. The primary GHG emitted from diesel-fueled equipment is carbon dioxide (CO_2). Although nitrous oxides (N_2O) and methane (CH_4) have significantly higher global warming potentials (298 times CO_2 for N_2O and 25 times CO_2 for CH_4), they are emitted at significantly lower rates, resulting in minimal fractional increases in carbon dioxide equivalents (CO_2e) when compared with CO_2 alone.

Construction Impact Summary

The NYNJHAT Project will produce temporary localized emission increases from the diesel-powered construction equipment working at the various project locations. The localized emission increases from the diesel-powered equipment will last only during the project's construction period in each location and then end when the project phase is complete at each location, thus any potential impacts will be temporary in nature and geographically dispersed over the project duration. The Project's General Conformity-related annual emissions are below the de minimis threshold levels for the relevant pollutants. Therefore, by rule (40 CFR §93.153 (b)), the Project is considered de minimis and will have only a temporary impact around the construction activities, with no long-term impacts and no negative effects on the applicable SIP.

Operations and Maintenance Impact Summary

The NYNJHAT Study includes the protection of ecosystems associated with shorelines, inlets, barrier islands, back bays, and mainland upland areas, and restoration of vegetation lost through erosion, all of which will contribute to carbon sequestering and dune structural resiliency during storms. The protection of these ecosystems provided by the project will enable the greater coastal ecosystem to continue to sequester carbon through sustainable vegetation growth resulting from the project and will minimize future storm damage further inland and associated reconstruction emissions. As a result, generation of emissions, including CO2, during future emergency response clean-up and restoration of the coastline will be limited or avoided. It is anticipated that the project will have a net benefit long-term local impact related to climate change. Therefore, the project will be compliant with the CAA (see Appendix A6), and all Alternative plans are rated "1" or No Impact:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3B (TSP), 2, 3A, 4 and 5 on GHG

ALT 3B (TSP), 2, 3A, 4, and 5 GHG Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

6.1.11 Climate, Climate Change, and Relative Sea Level Change

USACE projects must consider RSLC when planning and designing projects, per Engineering Regulation (ER) 1100-2-8162 (December 31, 2013). ER 1100-2-8162 requires that future RSLC projections must be incorporated into the planning, engineering design, construction, and operation of all civil works projects. The sole adverse impact producing factor to RSLC/climate change is air emissions.

Throughout the construction and life of the project, RSLC/climate change is anticipated to continue causing increases in mean water elevation and increases in storm severity and frequency. Construction of measures are expected to mitigate damage from anticipated RSLC and climatic changes. Appropriately defining the design condition related to the expected RSLC scenario is important. Since 1900, relative sea level has risen by more than a foot within the Study Area due to global climate change and local land subsidence (NPCC2, 2013). According to the NYS 2100 Commission Report (2013), RSLC in NYC and Long Island is projected to be as much as six feet within the next 90 years. Coastal storms will cause flooding at increased heights and over larger areas than in the past as RSLCs. It is also projected that frequency and intensity of coastal storms will increase (NPCC, 2013). USACE projections for the Battery, NY range from an increase of 0.7 feet for the low scenario, increase of 1.8 feet for the intermediate, and up to 5 feet for the high scenario through 2100.

The Alternative plans are evaluated in consideration of the “low”, “intermediate”, and “high” potential rates of future RSLC for both “with” and “without project” conditions. ER 1100-2-8162 considers the historic rate of RrelatiSLC as the low rate. The intermediate and high rates are computed from the modified National Research Council (NRC) Curve I and III respectively, considering both the most recent IPCC projections and modified NRC projections with the local rate of vertical land movement added.

As impact producing factors are air emissions, and as indicated in the Air Quality, Clean Air Act, and GHG Sections the project will be compliant with the Clean Air Act; therefore, all Alternative plans are rated “1” or No Impact:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3B (TSP), 2, 3A, 4 and 5 on Climate, Climate Change, and Relative Sea Level Change.

ALT 3B (TSP), 2, 3A, 4, and 5 Climate, Climate Change, and Relative sea level change Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures

Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

6.1.12 Cultural Resources

Adverse effects are anticipated for historic and cultural resources within the NYNJHAT Study Area. Depending on the final location of project features, ground disturbing activities have the potential to adversely affect the integrity of archaeological sites and installation of above-ground features has the potential to diminish the characteristics of historic structures that make them eligible for inclusion in the S/NRHP. For the discussion of the Visual Impact Area (Indirect Effects), please see Section 5.2.13 Aesthetics. Additional analysis of the anticipated effects and development of the APE, please see the Cultural Resource Appendix A8.

Alternative 1: No Action Alternative (FWOP Condition)

The no action or no-build alternative was evaluated against the project purpose and need. The no action or no-build alternative would have impacts to existing aesthetic, visual, historical, or cultural resources since there would be no measures to manage future flood risks that are expected to be exacerbated by RSLC. Thousands of archaeological and aboveground resources in the Study Area are at risk of damage or destruction from coastal flooding and sea-level rise. Additionally, submerged resources may be affected by underwater storm action and changes in seawater flow that accompany sea-level rise and flooding.

Without coastal storm risk management measures, roughly 184 square miles of the Planning Region will be within the 1% floodplain, of which 74 square miles are in New York and 110 square miles are in New Jersey (Figure 4.1). The affected area includes parts of all the Planning Regions, except for the Capital District Region. In New York, this area contains: at least three cemeteries (the Canarsie Cemetery, the Sleight Family Graveyard, and an unidentified cemetery that appears on a United States Geological Survey [USGS] map); 1,691 listed properties, of which 1,651 individual properties and 31 are districts properties; 1,070 properties that are eligible for the Register (1,030 individual properties and 40 districts); 160 archaeological sites cataloged in the NYSHPO CRIS (of which 12 are NRHP listed, 20 are NRHP-eligible, and 128 have not been investigated to the extent needed to determine whether they are NRHP-eligible); 39 archaeological sites recorded by the NYSM; and 331 NYSM archaeological areas.

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Alternative 3B: Tentatively Selected Plan

The Direct APE for this alternative consists of the physical footprint of individual measures and a 100 meters (328 feet) buffer around each measure which consists of a total area of 10.35 sq mi (36.8 sq km) with a risk managed area estimated to protect approximately 2,414 cultural resources. Alternative 3B has the potential for adverse effects to historic properties in and adjacent to the 100-m (328 feet) Direct APE. This Section provides the results of a preliminary review of cultural resources data available in the NYS OPRHP and NJ HPO databases, as well as the NOAA ENC database and the NYC Landmarks Preservation Commission's internet-accessible geographic information system, for proposed measures in Alternative 3B. To protect archaeological sites, in compliance with Federal and State laws, their locations and names are not provided in this Draft Tier 1 EIS report.

The features for Alternative 3B involve the construction of structures that have a potential to affect directly historic properties and cultural resources in both terrestrial and submerged environments. The proposed alternative is in an area that would be considered to have a moderate to high probability for terrestrial and submerged cultural resources to occur. At the most general level, Native American archaeological sites are most likely to be located near water; by definition, submerged resources are in water and early non-Native American settlements clustered near water, particularly in the time before plumbing and sanitary sewer systems. For further discussion and analysis of project features please see the Cultural Resource Appendix A8.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with TSP (Alternative 3B) on Cultural Resources

TSP Cultural Resources Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3+	3+	3+	3+	3+	3+	4+
O&M Assumptions	1	1	1+	1+	2+	1+	1+	1+	2+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*2+*

New York. The Direct APE for Alternative 3B in New York is approximately 8 sq mi (20.5 sqkm). This Direct APE intersects: 19 SHPO-cataloged archaeological sites (of which four are listed in the NRHP, four are NRHP-eligible; and 11 have not been investigated sufficiently to determine their NR-eligibility); 15 NYSM archaeological areas; 94 above-ground historic properties that are NR eligible (of which 83 are individual properties and 11 are historic districts); 212 NR-listed individual properties; eight NR-listed historic districts; 21 LPC landmarks; and a National Recreation Area (the Jamaica Bay Unit of the Gateway National Recreation Area) (Table 37). The NOAA ENC database lists 21 shipwrecks in the New York portion of the Direct APE. The SHPO data does not indicate there are any cemeteries in the APE.

New Jersey. The Direct APE in New Jersey is approximately 2.44 sq mi (6.3 sq km). This area overlaps with: 31 NJSHPO archaeological grids (of which three contain NR-listed sites, 13 have eligible sites, and 15 have sites that have not been investigated to determine their NR-eligibility); 31 National Register-eligible aboveground properties (of which 20 are individual properties and 11 are districts); seven NR-listed individual properties; nine NR-listed historic districts; one identified cohesive area (the Elizabethport Cohesive Area); and two National Historic Landmarks (the Holland Tunnel and the Clark Thread Company Historic Districts) (Table 37). The NOAA ENC database shows five shipwrecks in the New Jersey portion of the Direct APE.

***Table 37: Preliminary Totals of Cultural Resources within 100 meters (328 feet) of Alternative 3B* (after data from the NYSHPO, NYSM, NJSHPO, NPS, NOAA, and the NYC LPC).**

Historic Property Type	Number of properties in New York Direct APE	Number of properties in New Jersey Direct APE
National Historic Landmark	0	1
Historic District, NR-listed	5	3
Historic District, NR-eligible	9	10
Individual aboveground property, NR-listed	200	5
Individual aboveground property, NR-eligible	76	13
NYC LPC individual landmarks	4	-
NYC LPC landmark districts	4	-
Archaeological site, NR-listed*	3	3
Archaeological site, NR-eligible*	3	9

Archaeological site, undetermined eligibility*	8	15
NYSM archaeological site	5	-
NYSM archaeological area	17	-
Shipwreck	43	4
National Recreation Area	1	1
Cemeteries	0	-

Figure 73: Location of Units in the Gateway National creation Area. (NPS Brochure Map, Gateway National Recreation Area)

Alternative 2

The Direct APE for this alternative consists of the physical footprint of individual measures and a 100 m (328 feet) buffer around each measure which consists of a total area of 11.88 sq mi (30.8 sq km) with a risk managed area estimated to protect approximately 3234 cultural resources. Alternative 2 has the potential for adverse effects to historic properties in and adjacent to the 100-m (328 feet) Direct APE. This Section provides the results of a preliminary review of cultural resources data available in the NYS OPRHP and NJ HPO databases, as well as the NOAA ENC database and the NYC Landmarks Preservation Commission's internet-accessible geographic information system, for proposed measures in Alternative 2. To protect archaeological sites, in compliance with Federal and State laws, their locations and names are not provided in this Draft Tier 1 EIS report.

The features proposed for Alternative 2 could involve the construction of structures that have a potential to affect directly historic properties and cultural resources in both terrestrial and submerged environments. The proposed alternative is in an area that would be considered to have a moderate to high probability for terrestrial and submerged cultural resources to occur. At the most general level, Native American archaeological sites are most likely to be located near water; by definition, submerged resources are in water; and early non-Native American settlements clustered near water, particularly in the time before plumbing and sanitary sewer systems.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Cultural Resources

ALT 2 Cultural Resources Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3+	3+	4+	3+	3+	3+	4+
O&M Assumptions	1	1	2+	2+	3+	2+	2+	2+	3+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1+*	*1+*	*2+*

New York. The Direct APE for the alternative in New York is approximately 7.78 sq mi (20.2 sq km). This area intersects: 14 SHPO-cataloged archaeological sites (of which three are listed in the NRHP, three are NRHP-eligible; and eight have not been investigated sufficiently to determine their NR-eligibility); five archaeological sites in the NYSM inventory; 17 NYSM archaeological areas; 85 above-ground historic properties that are NR eligible (of which 76 are individual properties and 9 are historic districts); 200 NR-listed individual properties; five NR-listed historic districts; four LPC individual properties; four LPC districts and a National Recreation Area (the Jamaica Bay Unit of the Gateway National Recreation Area) (Table 38). The NOAA ENC database lists 43 shipwrecks in the New York portion of the Direct APE. The SHPO data does not indicate there are any cemeteries in the APE.

New Jersey. The Direct APE in New Jersey is approximately 4.1 sq mi (10.6 sq km). This area overlaps with: 27 NJSHPO archaeological grids (of which three contain NR-listed sites, nine have eligible sites, and 15 have sites that have not been investigated to determine their NR-eligibility); 23 National Register-eligible aboveground properties (of which 13 are individual properties and 10 are districts); five NR-listed individual properties; three NR-listed historic districts; one National Historic Landmark (the Fort Hancock Sandy Hook Proving Ground Historic District National Historic Landmark); and a National Recreation Area (the Sandy Hook Unit of the Gateway National Recreational Area) (Table 38). The NOAA ENC database shows four shipwrecks in the Direct APE in New Jersey.

***Table 38: Preliminary Totals of Cultural Resources within 100 meters (328 feet) of Alternative 2.* (after data from the NYSHPO, NYSM, NJSHPO, NPS, NOAA, and the YC LPC).**

Historic Property Type	Number of properties in New York Direct APE	Number of properties in New Jersey Direct APE
National Historic Landmark	0	1
Historic District, NR-listed	5	3
Historic District, NR-eligible	9	10
Individual aboveground property, NR-listed	200	5

Individual aboveground property, NR-eligible	76	13
NYC LPC individual landmarks	4	-
NYC LPC landmark districts	4	-
Archaeological site, NR-listed*	3	3
Archaeological site, NR-eligible*	3	9
Archaeological site, undetermined eligibility*	8	15
NYSM archaeological site	5	-
NYSM archaeological area	17	-
Shipwreck	43	4
National Recreation Area	1	1
Cemeteries	0	-

Note: for New Jersey refer to LUCY archaeological grids, which may contain more than one archaeological site.

Alternative 3A

The Direct APE for this alternative consists of the physical footprint of individual measures and a 100 m (328 feet) buffer around each measure which consists of a total area of 13.58 sq mi (35.2 sq km) with a risk managed area estimated to protect approximately 3192 cultural resources. Alternative 3A has the potential for adverse effects to historic properties in and adjacent to the 100-m (328 feet) Direct APE. This Section provides the results of a preliminary review of cultural resources data available in the NYS OPRHP and NJ HPO databases, as well as the NOAA ENC database and the NYC Landmarks Preservation Commission's internet-accessible geographic information system, for proposed measures in the alternative. To protect archaeological sites, in compliance with Federal and State laws, their locations and names are not provided in this Draft Tier 1 EIS report.

The features proposed for Alternative 3A could involve the construction of structures that have a potential to affect directly historic properties and cultural resources in both terrestrial and submerged environments. Based on the high number of cultural resources around the APE (See Cultural Resource Appendix A8), it is highly likely that additional survey work will identify additional National Register Eligible resources within the Area of Potential Effect. Based on this likelihood, the USACE New York District expects this project to have adverse impacts to National Register Eligible cultural resources. At the most general level, Native American archaeological sites are most likely to be located near water; by definition, submerged resources are in water; and early non-Native American settlements clustered near water, particularly in the time before plumbing and sanitary sewer systems. To guide the identification and evaluation of historic properties in the Area of Potential Effect a Programmatic Agreement is being coordinated between the USACE New York District, New York and New Jersey State Historic Preservation Offices, New York City Landmarks Preservation Commission, Federally Recognized Tribes, and Interested parties (See Public and Agency Coordination). Appendix A8 presents the details of this coordination. The PA outlines that any properties requiring mitigation will be addressed with a treatment plan. Potential mitigation measures include recordation following State Historic Preservation Office or Historic American Building Survey/Historic American Engineering Record guidelines, salvage and donation of significant structural elements to museums, or data recovery for archaeological sites eligible for the National Register of Historic Places under criterion D.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Cultural Resources

ALT 3A Cultural Resources Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3+	3+	3+	3+	3+	3+	4+
O&M Assumptions	1	1	2+	2+	2+	1+	1+	2+	+2
Mitigated Rating	*1*	*1*	*2*	*1*	*2*	*1*	*1*	*1*	*2*

New York. The Direct APE in New York is approximately 9.86 sq mi (25.5 sq km). The alternative's Direct APE intersects: 17 SHPO-cataloged archaeological sites (of which three are listed in the NRHP, three are NRHP-eligible; and 11 have not been investigated sufficiently to determine their NR-eligibility); five archaeological sites in the NYSM inventory; 33 NYSM archaeological areas; 72 above-ground historic properties that are NR eligible (of which 62 are individual properties and 10 are historic districts); 174 NR-listed individual properties; six NR-listed historic districts; seven LPC landmarks; and a National Recreation Area (the Jamaica Bay Unit of the Gateway National Recreation Area) (Table 39). The NOAA ENC database lists 23 shipwrecks in the New York portion of the Direct APE. The SHPO data does not indicate there are any cemeteries in the APE.

New Jersey. The Direct APE in New Jersey is approximately 3.72 sq mi. This area overlaps with: 30 NJSHPO archaeological grids (of which two contain NR-listed sites, 17 have eligible sites, and 11 have sites that have not been investigated to determine their NR-eligibility); 33 NR-eligible aboveground properties (of which 15 are individual properties and 18 are districts); six NR-listed individual properties; three NR-listed historic districts; one identified cohesive area (the Elizabethport Cohesive Area); two National Historic Landmarks (the Fort Hancock Sandy Hook Proving Ground Historic District National Historic Landmark and the Clark Thread Company Historic District); and a National Recreation Area (the Sandy Hook Unit of the Gateway National Recreation Area) (Table 39). The NOAA ENC database shows six shipwrecks in the New Jersey portion of the Direct APE.

Table 39: Preliminary Totals of Cultural Resources within 100 meters (328 feet) of Alternative 3A Measures (Direct APE).
(after data from the NYSHPO, NYSM, NJSHPO, NPS, NOAA, and the NYC LPC)

Historic Property Type	Number of properties in New York Direct APE	Number of properties in New Jersey Direct APE
National Historic Landmark	0	2
Historic District, NR-listed	6	3
Historic District, NR-eligible	10	18
Individual aboveground property, NR-listed	174	6
Individual aboveground property, NR-eligible	62	15
NYC LPC individual landmarks	7	-
NYC LPC landmark districts	0	-
Archaeological site, NR-listed*	3	2
Archaeological site, NR-eligible*	3	17

Archaeological site, undetermined eligibility*	11	11
NYSM archaeological site	5	-
NYSM archaeological area	33	-
Shipwreck	23	6
National Recreation Area	1	1
Cemeteries	0	-

for New Jersey refer to LUCY archaeological grids, which may contain more than one archaeological site.

Alternative 4

The Direct APE for this alternative consists of the physical footprint of individual measures and a 100 m (328 feet) buffer around each measure which consists of a total area of 12.95 sq mi (33.5 sq km) with a risk managed area estimated to protect approximately 2288 cultural resources. Alternative 4 has the potential for adverse effects to historic properties in and adjacent to the 100-m (328 feet) Direct APE. This Section provides the results of a preliminary review of cultural resources data available in the NYS OPRHP and NJ HPO databases, as well as the NOAAENC database and the NYC Landmarks Preservation Commission's internet-accessible geographic information system, for proposed measures in Alternative 4. To protect archaeological sites, in compliance with Federal and State laws, their locations and names are not provided in this Draft Tier 1EIS report.

The features proposed for Alternative 4 could involve the construction of structures that have a potential to affect directly historic properties and cultural resources in both terrestrial and submerged environments. The proposed alternative is in an area that would be considered to have a moderate to high probability for terrestrial and submerged cultural resources to occur. At the most general level, Native American archaeological sites are most likely to be located near water; by definition, submerged resources are in water; and early non-Native American settlements clustered near water, particularly in the time before plumbing and sanitary sewer systems.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Cultural Resources

ALT 4 Cultural Resources Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	3+	3+	3+	3+	3+	3+	4+
O&M Assumptions	1	1	1	1+	2	1+	2+	2+	3+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*2+*	*1+*	*1+*	*1+*	*2+*

New York. The Direct APE in New York is approximately 7.4 sq mi (19.2 sq km). The Direct APE intersects: 15 SHPO-cataloged archaeological sites (of which four are listed in the NRHP, two are NRHP-eligible; and nine have not been investigated sufficiently to determine their NR-eligibility); 15 NYSM archaeological areas; 100 above-ground historic properties that are NR eligible (of which 90 are individual properties and 10 are historic districts); 212 NR-listed individual properties; eight NR-listed historic districts; 19 LPC landmarks (of which 17 are individual properties and 2 are districts); and a National Recreation Area (the Jamaica Bay Unit of the Gateway National Recreation Area) Table 40). The NOAA ENC database lists 14 shipwrecks in the New York portion of the Direct APE. The SHPO data does not indicate there are any cemeteries in the APE.

New Jersey. The Direct APE in New Jersey is approximately 5.56 sq mi (14.4 sq km). This area overlaps with: 43 NJSHPO archaeological grids (of which two contain NR-listed sites, 14 have eligible sites, and 27 have sites that have not been investigated to determine their NR-eligibility); 61 National Register-eligible aboveground properties (of which 25 are individual properties and 36 are districts); six NR-listed individual properties; 11 NR-listed historic districts; two identified cohesive areas (the Elizabethport Cohesive Area and the Kellogg Park Cohesive Area); and one Tunnel) (Table 40). The NOAA ENC database shows eight shipwrecks in the New Jersey portion of the Direct APE.

Table 40: Preliminary Totals of Cultural Resources within 100 meters (328 feet) of Alternative 4 Measures (Direct APE).
(after data from the NYSHPO, NYSM, NJSHPO, NPS, NOAA, and the NYC LPC)

Historic Property Type	Number of properties in New York Direct APE	Number of properties in New Jersey Direct APE
National Historic Landmark	0	1
Historic District, NR-listed	8	11
Historic District, NR-eligible	10	36
Individual aboveground property, NR-listed	212	6
Individual aboveground property, NR-eligible	90	25
NYC LPC individual landmarks	17	-
NYC LPC landmark districts	2	-
Archaeological site, NR-listed*	4	2
Archaeological site, NR-eligible*	2	14
Archaeological site, undetermined eligibility*	9	27
NYSM archaeological site	0	-
NYSM archaeological area	15	-
Shipwreck	14	8
National Recreation Area	1	0
Cemeteries	0	-

Note: for New Jersey refer to LUCY archaeological grids, which may contain more than one archaeological site.

Alternative 5

The Direct APE for this Alternative consists of the physical footprint of individual measures and a 100 m (328 feet) buffer around each measure which consists of a total area of 3.69 sq mi (9.6 sq km) with a risk managed area estimated to protect approximately 1522 cultural resources. Alternative 5 has the potential for adverse effects to historic properties in and adjacent to the 100-m (328 feet) Direct APE. This Section provides the results of a preliminary review of cultural resources data available in the NYS OPRHP and NJ HPO databases, as well as the NOAA ENC database and the NYC Landmarks Preservation Commission’s internet-accessible geographic information system, for proposed measures in Alternative 5. To protect archaeological sites, in compliance with Federal and state laws, their locations and names are not provided in this Draft Tier 1 EIS report.

The features proposed for Alternative 5 could involve the construction of structures that have a potential to affect directly historic properties and cultural resources in both terrestrial and submerged environments. The proposed Alternative is in an area that would be considered to have a moderate to high probability for terrestrial and submerged cultural resources to occur. At the most general level, Native American archaeological sites are most likely to be located near water; by definition, submerged resources are in water; and early non-Native American settlements clustered near water, particularly in the time before plumbing and sanitary sewer systems.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Cultural Resources

ALT 5 Cultural Resources Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	3+	3+	4+	3+	3+	1	1
O&M Assumptions	1	1	1	1	2	1	2+	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*

New York. The Direct APE in New York is approximately 1.33 sq mi (3.4 sq km). This APE intersects:10 SHPO-cataloged archaeological sites (of which three are listed in the NRHP, two are NRHP-eligible; and five have not been investigated sufficiently to determine their NR- eligibility); five NYSM archaeological areas; 27 above-ground historic properties that are NR eligible (of which 23 are individual properties and four are historic districts); 133 NR-listed individual properties; four NR-listed historic districts; and three LPC landmarks (all individual properties) (Table 41). The NOAA ENC database lists two shipwrecks in the New York portion of the Direct APE. The SHPO data does not indicate there are any cemeteries in the APE.

New Jersey. The Direct APE in New Jersey is approximately 2.36 sq mi. This area overlaps with: 13 NJSHPO archaeological grids (of which four have eligible sites and nine have sites that have not been investigated to determine their NR-eligibility); 16 National Register-eligible aboveground properties (of which 11 are individual properties and five are districts); one NR-listed individual property; two NR-listed historic districts; and one National Historic Landmark (the Holland Tunnel) (Table 41). The NOAA ENC database does not indicate there are any shipwrecks in the Direct APE.

Table 41: Preliminary Totals of Cultural Resources within 100 meters (328 feet) of Alternative 5 Measures (Direct APE).
(after data from the NYSHPO, NYSM, NJSHPO, NPS, NOAA, and the NYC LPC)

Historic Property Type	Number of properties in New York Direct APE	Number of properties in New Jersey Direct APE
National Historic Landmark	0	1
Historic District, NR-listed	4	2
Historic District, NR-eligible	4	5
Individual aboveground property, NR-listed	133	1
Individual aboveground property, NR-eligible	23	11
NYC LPC individual landmarks	3	-
NYC LPC landmark districts	0	-
Archaeological site, NR-listed*	3	0

Archaeological site, NR-eligible*	2	4
Archaeological site, undetermined eligibility*	5	9
NYSM archaeological site	0	-
NYSM archaeological area	5	-
Shipwreck	2	0
National Recreation Area	0	0
Cemeteries	0	-

Note: for New Jersey refer to LUCY archaeological grids, which may contain more than one archaeological site.

6.1.13 Aboveground Resources and National Historic Landmarks

All the project Alternative plans have the potential to directly affect aboveground cultural resources in New York (Table 42). As was the case with archaeological sites, the no-action Alternative (Alternative 1) potentially will have the greatest effect on aboveground resources; there are over 2,500 known aboveground resources in the area that would likely be flooded within the next century should the project not be built. The build Alternative plans will potentially affect roughly similar numbers of sites, relative to each other; of those Alternative plans, Alternative 4 is within 100 meters of the most aboveground resources (N = 340), and Alternative 5 is within 100 meters of the fewest (N = 167). Portions of the Jamaica Bay Unit of the Gateway National Recreational Area (NRA) will be affected by Alternative plan 2, 3A, 3B, and 4.

Table 42: Total aboveground historic properties in Alternative Direct APEs in New York.

	Total Properties in Direct APE							
	NR-listed Individual	NR-listed district	NR-eligible individual	NR-eligible district	NHL	LPC landmark	NRA	Total
Alternative 1	1,651	31	1,030	40				2,752
Alternative 2	200	5	76	9	0	8	1	299
Alternative 3A	174	6	62	10	0	7	1	260
Alternative 3B	212	8	83	11	0	21	1	336
Alternative 4	212	8	90	10	0	19	1	340
Alternative 5	133	4	23	4	0	3	0	167

All the project Alternative plan have the potential to directly affect aboveground cultural resources in New Jersey (Table 43). The number of historic properties within the build Alternative Direct APEs varies significantly: Alternative 4 will potentially affect 79 properties, while the Alternative 5 Direct APE intersects only 20 properties. Portions of the Sandy Hook Unit of the Gateway National Recreational Area (NRA) will be affected by Alternative plan 2 and 3A. Parts of three National Historic Landmarks are also within the Direct APEs for the build Alternatives: the Fort Hancock Sandy Hook Proving Ground Historic District National Historic Landmark is within 100 meters of Alternative 2; the Clark Thread Company Historic District is in the Direct APE for Alternative plan 3A and 3B; and the Holland Tunnel is within 100 meters of Alternative plan 3B, 4, and 5.

Table 43: Total aboveground historic properties in Alternative APEs in New Jersey.

	Total Properties in Direct APE						
	NR-listed Individual	NR-listed district	NR-eligible individual	NR-eligible district	NHL	NRA	Total
Alternative 2	5	3	13	10	1	1	33
Alternative 3A	6	3	15	18	2	1	45
Alternative 3B	7	9	20	11	2	0	49

Alternative 4	6	11	25	36	1	0	79
Alternative 5	1	2	11	5	1	0	20

All the project Alternative plans have the potential to affect the setting of aboveground cultural resources in New York (Table 44). Based solely on topography, the areas within which alternative measures will be visible within a mile of the project vary between 75.5 and 85.6 percent of that terrain (Table 45). Alternative 4 would be visible from the largest proportion of its surroundings (85.6 percent), and Alternative 5 from the smallest relative area (75.5 percent). There are a large number of aboveground properties in the viewsheds of all the build alternatives:

Alternative 3B would be visible from the most historic properties (N = 15,716), while Alternative 5 would be visible from the fewest (N = 10,532). Undoubtedly, these numbers will be somewhat attenuated when vegetation and the built environment are factored into the viewshed calculations. However, they will likely remain somewhat high, given the density of historic properties in New York City.

Table 44: Above ground historic properties within project Alternative viewsheds in New York.

	Total Properties in Indirect APE				
	NR-listed Individual	NR-listed district	NR-eligible individual	NR-eligible district	Total
Alternative 2	8,193	47	2,280	48	10,568
Alternative 3A	9,016	48	2,459	51	11,574
Alternative 3B	12,302	51	3,316	47	15,716
Alternative 4	12,085	51	3,005	46	15,187
Alternative 5	8,382	33	2,096	21	10,532

Table 45: Comparison of Alternative viewsheds in New York.

Alternative	Total Area within a mile of project (sq mi)	Total area within 1 mile of project where undertaking structures are visible (sq mi)	Percentage of total area within 1 mile of project where undertaking structures are visible
Alternative 2	165.9	126.5	76.2
Alternative 3A	195.1	152.3	78
Alternative 3B	127.7	100.7	78.8
Alternative 4	115.4	98.8	85.6
Alternative 5	22.1	16.7	75.5

Another (and perhaps more effective) way to express the alternatives' potential overall effects on aboveground resources is to explore the number of historic properties from which project alternatives would be visible as a ratio of the number of properties in the viewsheds to the total viewshed area: i.e., the number of properties in the viewsheds per viewshed square mile (Table 46). The values of the ratio vary significantly among the alternatives: Alternative 3A has the lowest ratio – it would be visible from 76 historic properties per viewshed square mile; Alternative far, the highest ratio – it would be visible from 630.7 historic properties per viewshed
are mile.

Table 46: Aboveground historic properties in New York within project Alternative viewsheds, per square mile of terrain where the project is visible.

	Total Properties in viewshed, per square mile

Alternative	NR-listed Individual	NR-listed district	NR-eligible individual	NR-eligible district	Total
Alternative 2	64.8	0.4	18	0.4	83.5
Alternative 3A	59.2	0.3	16.1	0.3	76
Alternative 3B	122.2	0.5	32.9	0.5	156.1
Alternative 4	122.3	0.5	30.4	0.5	153.7
Alternative 5	501.9	2	125.5	1.3	630.7

All the project alternatives have the potential to affect the setting of aboveground cultural resources in New Jersey. Based solely on topography, the areas within which alternative measures will be visible within a mile of the project vary between 47.8 and 69.1 percent of that terrain (Table 47). Alternative 4 would be visible from the largest proportion of its surroundings, and Alternative 3B from the smallest relative area.

Table 47: Comparison of Alternative viewsheds in New Jersey.

Alternative	Total Area within a mile of project (sq mi)	Total area within 1 mile of project where undertaking structures are visible (sq mi)	Percentage of total area within 1 mile of project where undertaking structures are visible
Alternative 2	102.3	62.8	61.4
Alternative 3A	98.1	56.4	57.5
Alternative 3B	61.7	29.5	47.8
Alternative 4	66.5	46	69.1
Alternative 5	27.3	18.7	68.4

6.1.14 Archaeological and Submerged Resources

A small sample of the NRHP-Listed properties that would be directly (physically) affected by the no-action Alternative includes: the Washington, Manhattan, and Brooklyn Bridges; the United States Military Academy; the SoHo Historic District; the Holland Tunnel; Greenwich Village Historic District; Governor's Island; the New York Stock Exchange; Brooklyn Navy Yard; the East Harlem Historic District; and the Old Croton Aqueduct.

Table 48: Total archaeological sites with NR-listed, NR-eligible, or identified in Alternative Direct APEs in New York.

Total archaeological sites in Alternative Direct APEs in New York.				
	Archaeological Sites in Direct APE*			
	NR-listed	NR-eligible	Undetermined NR eligibility	Total
Alternative 1	12	20	128	160
Alternative 2	3	3	8	14
Alternative 3A	3	3	11	17
Alternative 3B	4	4	11	19
Alternative 4	4	2	9	15
Alternative 5	3	2	5	10
*Does not include NYSM data; many NYSM sites may also be represented in the SHPO CRIS data.				

All of the project alternatives have the potential to affect archaeological resources in New Jersey (Table 49). Assessment of the precise number of sites that will be affected by the no-build alternative is beyond the scope of this investigation. The build alternatives will potentially affect roughly similar numbers of sites; of those alternatives, Alternative 4 is within 100 meters of the most archaeological grids with identified, NR-listed, or NR-eligible sites (N = 43), and Alternative 5 is within 100 meters of the fewest (N = 13). For Alternatives 2 to 4 in New Jersey, the total number of grids that are within 100 meters of measures are roughly double the corresponding totals for alternatives in New York. This perhaps reflects differences in the amounts of post ca. AD1800 urban development that have occurred near the undertaking APEs in the respective states.

Table 49: Total archaeological LUCY grids with NR-listed, NR-eligible, or identified in alternative Direct APEs in New Jersey.

	Total LUCY Grids with archaeological sites			
	NR-listed	NR-eligible	Undetermined NR eligibility	Total
Alternative 2	3	9	15	27
Alternative 3A	2	17	11	30
Alternative 3B	3	13	15	31
Alternative 4	2	14	27	43
Alternative 5	0	4	9	13

NY SHPO CRIS data records no submerged archaeological sites not related to shipwrecks within the Direct APE for any of the build alternatives in New York. NOAA ENC data indicates the build alternative Direct APEs overlap with the locations of between two and 43 shipwrecks in New York (Table 50). The Direct APE for Alternative 2 overlaps with the most shipwrecks (N = 43) and Alternative 5 overlaps with the fewest (N = 2).

Table 50: Shipwrecks in the Direct APEs of project alternatives in New York.

Alternative	Total shipwrecks (NOAA ENC database)
Alternative 2	43
Alternative 3A	23
Alternative 3B	21
Alternative 4	14
Alternative 5	2

The NJ LUCY data does not have a dedicated layer for submerged archaeological resources, although offshore sites may be indicated by the system's archaeological grids. In this case, some of the archaeological sites noted above could be submerged resources. NOAA ENC data indicates the build alternative Direct APEs overlap with the locations of up to eight shipwrecks in New Jersey Table 51). The Direct APE for Alternative 4 overlaps with the most shipwrecks (N = 8) and Alternative 5 overlaps with the fewest (none).

Table 51: Shipwrecks in the Direct APEs of project alternatives in New Jersey.

Alternative	Total shipwrecks (NOAA ENC database)
Alternative 2	4
Alternative 3A	6
Alternative 3B	5
Alternative 4	8
Alternative 5	0

6.1.15 Native American Lands

None of the proposed alternatives occur on or near land held in trust by the U.S. government, tribal reservations, or privately held tribal lands and therefore none are expected to result in adverse impacts to Native American Lands. Therefore, all Alternatives have been rated "1" or No Impact. Implementation of all plans including the tentatively selected plan would not result in adverse impacts to Native American Lands. As part of the consideration of effects, consultation with the appropriate federally recognized tribes was initiated on May 23, 2022 and is ongoing.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternatives 2, 3A, 3B, 4 and 5 on Native American Lands.

ALT 3B (TSP), 2, 3A, 4, and 5 Native American Lands Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

6.1.16 Hazardous, Toxic, and Radioactive Waste

The following sections provide a summary of potential impacts that HTRW sites may cause to the construction, operation, and maintenance of proposed CSRM measures. An HTRW site indicates the presence of contaminated media (soil, groundwater, sediment) that poses a risk to human health and the environment. The HTRW Sites described in this Section are identified in the HTRW Survey Report (Appendix A9). Table 52presents the overall number of HTRW sites within each Planning Region. This information is used to develop the impact assessment.

Due to the highly urban nature of the NYNJHAT Study Area where Alternatives are proposed, HTRW sites are widespread throughout many of the Planning Regions. As a result, relocating measures to avoid one HTRW site may result in co-location with a different HTRW site. Thus, it is likely that footprints of numerous CSRM measures will be co-located with HTRW sites.

Where it is possible for a CSRM measure to be relocated away from an HTRW site, there may still be an impact associated with the need to redesign the measure, which may increase the measure's construction cost and delay its construction.

Where a CSRM measure cannot be relocated away from an HTRW site or an area with widespread sediment concerns (such as the operable units of the Diamond Alkali Superfund Site and the recently designated Lower Hackensack River Superfund Site), USACE would coordinate with the U.S. EPA and other Federal, State, Local Agencies, as applicable, in order to minimize impacts to the ongoing remedial investigations/remedial action in those areas and activities necessary to allow for construction of the measure. This coordination would further ensure that impact minimization strategies are implemented throughout the construction phase. The strategies would include best management practices to minimize disturbance to contaminated areas outside of the construction footprint, as well as minimizing exposure of construction workers to contaminants.

For HTRW sites either actively undergoing clean-up (often referred to as remediation) or where the clean-up has not yet started, increased costs and delays to the construction of the measure may occur due to the potential need to initiate and complete the clean-up process, which may involve conducting human health and ecological risk assessments, preparing plans and designs, and receiving regulatory approval for clean-up by the responsible party. It is assumed that for larger HTRW Sites, that partial clean-up of the Site may be possible to allow clearance of a corridor for the proposed construction of the CSRM measure. Any remediation required to advance the Study will be coordinated with the non-Federal sponsor, at 100% non-Federal, work-in-kind costs. The HTRW sites are themselves present adverse conditions because they pose potential risks to human health and the environment, but their removal is considered a positive outcome for alternatives that require partial or full clean-up of the HTRW Site. Likewise, the Tentatively Selected Plan, and other Alternatives, may provide benefits even when an HTRW site is not co-located with a CSRM measure where the HTRW site is located within the risk managed areas of the Alternative alignments. For these HTRW sites, the operation of the CSRM measure would be anticipated to reduce potential coastal storm related flooding from damaging the HTRW site and reduce the potential for migration or resuspension of contaminants or cause new contaminant spills at those HTRW sites. HTRW sampling samples (e.g. soil, groundwater, sediment, and other media as applicable) will be collected for analysis along the Tentatively Selected Plan alignment. Sampling will occur during the Tier 2 EIS (s) and Preconstruction Engineering and Design phase, at 100% non-Federal, work-in-kind costs, which will help identify any potential remedial requirements prior to construction.

Table 52: Approximate number of HTRW Sites by Region and Alternative.

PLANNING REGION	HTRW APPENDIX REGION NAME	ALTERNATIVE[3]				
		2	3A	3B	4	5
Hackensack/Passaic Region Measures	Hackensack Passaic - Line A	24	20	42	40	20
	Hackensack Passaic - Line B	0	0	0	0	15
Jamaica Bay Region Measures	Jamaica Bay	12	30	35	35	2
Long Island Sound Region Measures	Long Island Sound	30	30	5	5	0
	Port Washington / Long Island Sound	30	30	0	0	0
Lower Bay Region Measures	Lower Bay	10	50	20	15	0
Raritan Region Measures	Raritan	4	0	0	0	0
Upper Bay/Arthur Kill Region Measures	Upper Bay	40	40	60	60	20
Lower Hudson/East River Region Measures	Manhattan (Lower Hudson / East River)	15	17	50	40	40
Mid-Hudson Region Measures	Not assessed, no measures	0	0	0	0	0
Capital District Region Measures	Not assessed, no measures	0	0	0	0	0
New York/New Jersey Bight Region	Not assessed, no measures	0	0	0	0	0
TOTAL HTRW Sites[2]		**165**	**217**	**212**	**195**	**97**

Notes:
1. Only HTRW sites from Groups A, B, C and E are included here (see HTRW Appendix A9 for a definition of these groups).
2. Because Alternatives can span more than one Planning Region, the same HTRW site may be counted here as being co-located with more than one Alternative.
3. Proximity of a measure to HTRW sites does not necessarily indicate impacts would be incurred or that HTRW sites would be impacted by the Alternatives. This information is provided for relative comparison of Planning Region trends; however further analysis is necessary in the Tier 2 EIS(s) and Preconstruction Engineering and Design to further assess HTRW-related impacts.

The following sections describe the general impacts that HTRW sites would have on the construction, operation, and maintenance of measures within each Alternative. Impacts of HTRW sites on CSRM measures are primarily associated with costs and schedule delays associated with the redesign and construction of the measure. Following construction of a measure, an HTRW site would have negligible or no impacts on the operation and maintenance of the measure. Therefore, the impacts described herein are limited to the design and construction phase of CSRM measures.

The analysis for each Alternative also identifies the Planning Regions where measures are proposed. Individual tables identifying the impacts of HTRW sites within each Planning Region are presented below. As previously described, the remediation of HTRW sites would be a beneficial impact, and potential beneficial effects have been marked with a "+" in the following impact rating tables.

TSP (Alternative 3B)

Under the TSP, Alternative 3B, construction of proposed measures is anticipated to be impacted by co-located HTRW sites. The below Table identifies the numerical impact rating for each Planning Region where TSP measures are proposed. Lower Bay, Raritan, Mid-Hudson, and Capital District Regions have a numerical score of 1 because there are no TSP measures proposed in those Planning Regions.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on HTRW Sites

TSP HTRW Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	3+	2+	3+	1	2+	3+
O&M Assumptions	1	1	1	2+	1	2+	1	2+	1
Mitigated Rating	1	1	2+	2+	1	2+	1	2+	2+

HTRW sites are extensive along the Passaic River and Hackensack River in the Hackensack/Passaic Region. These HTRW sites include large Federal and state Superfund sites, as well as widespread areas of contaminated sediments in both the Passaic and Hackensack rivers. In the Hackensack/Passaic Region, the TSP has proposed measures that are located along the Hackensack and Passaic river shorelines, and many of the measures are co-located with HTRW sites and cross the Hackensack or Passaic rivers where contaminated sediment is present. These HTRW sites may require complex remediation programs, and the widespread extent of sediment contamination provides few opportunities to relocate TSP measures outside of an HTRW site.

The Lower Hudson Region has numerous HTRW sites, including many along and associated with the Hudson River's eastern bank and western bank in Jersey City, and smaller lead-contamination related sites near the northern extent of the TSP measures in this Region. Where HTRW sites and proposed TSP measures are co-located, impacts would be extensive unless the HTRW sites are remediated, or the TSP measures are relocated.

The Upper Bay/Arthur Kill Region has numerous Superfund and other HTRW sites along Newark Bay's industrialized waterfront. Many TSP measures are proposed in this area. Where HTRW sites and proposed TSP measures are co-located, impacts would be extensive unless the HTRW site is remediated, or the TSP measure is relocated.

The Jamaica Bay Region has numerous HTRW sites, many of which are small in area and isolated from other HTRW sites. Smaller HTRW sites often are less complex to remediate, or easier to avoid through relocation of the TSP measure. Several Jamaica Bay TSP measures are co-located with a Federal Superfund Site where the extent of contamination has not yet been fully delineated. It is possible that the TSP measures could be located in areas where contamination exists but has not yet been identified.

Within the Long Island Sound Region, many of the HTRW sites are small inland auto service stations. These small HTRW sites are generally easier to remediate than Superfund sites. For smaller HTRW sites that cannot be readily remediated, it may be possible to relocate the TSP measure to avoid those sites.

The Lower Bay Region contains an industrial area with many HTRW sites. Although a relatively short segment of proposed TSP measures is co-located with several of these HTRW sites, the densely clustered HTRW sites limit the feasibility of relocating this segment of TSP measures outside of an HTRW site.

Alternative 2

Under Alternative 2, construction of proposed measures is anticipated to be impacted by co-located HTRW sites. The below Table identifies the numerical impact rating for each Planning Region where Alternative 2 measures are proposed. Capital District and the Mid-Hudson Region have a numerical score of 1 because there are no TSP measures proposed in those Regions.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on HTRW

ALT 2 HTRW Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2+	3+	3+	3+	2+	3+	2+
O&M Assumptions	1	1	1	2+	2+	2+	2+	2+	2+
Mitigated Rating	1	1	2+	2+	3+	2+	2+	3+	1

The Upper Bay/Arthur Kill Region has numerous Superfund and other HTRW sites located along Newark Bay's industrialized waterfront. The widespread extent of HTRW sites reduces the opportunity to relocate the Alternative 2 measures away from an HTRW site. Therefore, remediation of selected HTRW sites that are co-located with the proposed Alternative 2 measures would be likely.

The Lower Hudson Region has many Federal and State listed HTRW sites, including many along and associated with the Hudson River's eastern back and western bank in Jersey City. In addition, there are a number of smaller lead-contamination related sites in the northern extent of the Lower Hudson Region where Alternative 2 measures are proposed. However, the small size of these HTRW sites increases the feasibility that a co-located HTRW site could be remediated, or the proposed Alternative 2 measure could be relocated away from the HTRW site.

The construction and implementation of Alternative 2 measures in the Lower Bay Region would be impacted by numerous HTRW sites located in the industrialized portion of this area.

In the Hackensack Passaic Region, the lower Passaic River area has extensive State Superfund sites located along the western shoreline, and the Passaic River itself is a Federal Superfund site due in part to widespread contaminated sediments. Due to historic industrialized use of the waterfront, construction of Alternative 2 measures would require remediation of the HTRW sites or large-scale re-location of the Alternative 2 measures.

Alternative 2 is the only alternative with measures located in the Raritan Region. The HTRW sites in this region are concentrated along Main Street and Whitehead Avenue. However, the proposed Alternative 2 measures are located in this area. Therefore, remediation of the co-located HTRW sites or re-location of the measures would be required.

The Alternative 2 measures proposed in the Long Island Sound Region are co-located with HTRW sites primarily in the Whitestone and Bayside Areas, as well as HTRW sites located in the western areas identified as Port Washington. Although Alternative 2 measures are extensive in the Long Island Sound Region, the majority of proposed Alternative 2 measures are not co-located with the HTRW sites.

The Alternative 2 measures proposed in the Jamaica Bay Region are primarily located along the southern shoreline. This area includes Formerly Used Defense Sites (FUDS) where unexploded ordnance (UXO) may be present. Prior to construction, additional data review or investigations may be required to ensure UXO are not present within the footprint of the proposed measure.

Alternative 3A

Under Alternative 3A, construction of proposed measures is anticipated to be impacted by co-located HTRW sites. The Table below identifies the numerical impact rating for each Planning Region where Alternative 3A measures are proposed. The Mid-Hudson, Raritan, and Capital District Regions have a numerical score of 1 because there are no Alternative 3A measures proposed in those Regions.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on HTRW

ALT 3A HTRW Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2+	3+	3+	3+	1	3+	3+
O&M Assumptions	1	1	1	2+	2+	2+	1	2+	1
Mitigated Rating	*1*	*1*	2+	2+	3+	2+	*1*	3+	2+

The Lower Hudson Region has numerous HTRW sites, including many along and associated with the Hudson River's eastern bank and western bank in Jersey City, and smaller lead-contamination related sites near the northern extent of the Alternative 3A measures in this Region. Where HTRW sites and proposed Alternative 3A measures are co-located, impacts would be extensive unless the HTRW site are remediated or the Alternative 3A measures are relocated.

The Upper Bay/Arthur Kill Region has numerous Superfund and other HTRW sites along Newark Bay's industrialized waterfront and where many Alternative 3A measures are proposed. Where HTRW sites and proposed Alternative 3A measures are co-located, impacts would be extensive unless the HTRW sites are remediated or the Alternative 3A measures are relocated.

The Lower Bay Region contains an industrial area with many HTRW sites. Although a relatively short segment of proposed Alternative 3A measures is co-located with several of these HTRW sites, the dense clustering of HTRW site in this area limits the feasibility of relocating the Alternative 3A measures outside of an HTRW site.

The Alternative 3A measures proposed in the Lower Bay Region would be impacted by the numerous HTRW sites located in the industrialized portion of this area, as well as the numerous HTRW sites located along the Sandy Hook Bay shoreline.

HTRW sites are extensive along the Passaic River and Hackensack River in the Hackensack/Passaic Region. These HTRW sites include large Federal and state Superfund sites, as well as widespread areas of contaminated sediments in both the Passaic and Hackensack rivers. In the Hackensack/Passaic Region, Alternative 3A has proposed measures that are located along the Hackensack and Passaic river shorelines, and many of the measures are co-located with HTRW sites and cross the Hackensack or Passaic rivers where contaminated sediment is present. These HTRW sites may require complex remediation programs, and the widespread extent of sediment contamination provides few opportunities to relocate Alternative 3A measures outside of an HTRW site.

The Long Island Sound Region's HTRW sites co-located with this Alternative are mainly focused the Whitestone and Bayside Areas, as well as State and Federal Sites located in the western areas identified as Port Washington. Though this Alternative proposed extensive measures throughout this region, the majority of the proposed measures are not co-located with the HTRW sites.

The Jamaica Bay Region has numerous HTRW sites, though many are isolated or have small spills and releases with confined extents. Smaller HTRW sites may be more readily remediated or avoided. Jamaica Bay measures cross a Federal Superfund Site which is not fully delineated. Therefore, relocating a measure away from a contaminated area may not be feasible because the extent of contamination may be widespread and occur throughout the proposed measure footprint.

Alternative 4

Under Alternative 4, construction of proposed measures is anticipated to be impacted by co-located HTRW sites. The Table below identifies the numerical impact rating for each Planning Region where Alternative 4 measures are proposed. Lower Bay, Raritan, Mid-Hudson, and Capital District Regions have a numerical score of 1 because there are no Alternative 4 measures proposed in those Regions.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on HTRW

ALT 4 HTRW Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2+	3+	1	4+	1	2+	3+
O&M Assumptions	1	1	1	2+	1	2+	1	2+	1
Mitigated Rating	*1*	*1*	2+	2+	*1*	4+	*1*	2+	2+

The Lower Hudson Region has numerous HTRW sites, including many along the Hudson River's eastern bank and western bank in Jersey City, and smaller lead-contamination related sites near the northern extent of the Alternative 4 measures in this Region. Where HTRW site and proposed Alternative 4 measures are co-located, impacts would be extensive unless the HTRW site are remediated, or the Alternative 4 measures are relocated away from an HTRW site.

The Upper Bay/Arthur Kill Region has numerous Superfund and other HTRW sites along Newark Bay's industrialized waterfront and where many Alternative 4 measures are proposed. Where HTRW site and proposed Alternative 4measures are co-located, impacts would be extensive unless the HTRW site are remediated, or the Alternative 4 measures are relocated away from an HTRW site.

HTRW sites are extensive along the Passaic River and Hackensack River in the Hackensack/Passaic Region. These HTRW sites include large Federal and state Superfund sites, as well as widespread areas of contaminated sediments in both the Passaic and Hackensack rivers. In the Hackensack/Passaic Region, Alternative 4 has proposed measures that are located along the Hackensack and Passaic river shorelines, and many of the measures are co-located with HTRW sites and cross the Hackensack or Passaic rivers where contaminated sediment is present. These HTRW sites may require complex remediation programs, and the widespread extent of sediment contamination provides few opportunities to relocate Alternative 4 measures outside of an HTRW site.

Within the Long Island Sound Region, many of the HTRW site are small auto service stations and not near the waterfront. These small HTRW sites are generally easier to remediate than Superfund sites. For smaller HTRW sites that cannot be readily remediated, it may be possible to relocate the Alternative 4 measure to avoid those sites.

The Jamaica Bay Region has numerous HTRW sites, many of which are small in area and isolated from other sites. Smaller HTRW sites often are less complex to remediate, or easier to avoid by relocating the Alternative 4 measure. Several Alternative 4 measures are co-located with a Federal Superfund site where the extent of contamination has not yet been fully delineated. Therefore, relocating a measure away from a contaminated area may not be feasible because the extent of contamination may be widespread and occur throughout the proposed measure footprint.

ALTERNATIVE 5

Under Alternative 5, construction of proposed measures is anticipated to be impacted by co-located HTRW sites. The Table below identifies the numerical impact rating for each Planning Region where Alternative 5 measures are proposed. Lower Bay, Raritan, Jamaica Bay, Long Island Sound, Mid-Hudson, and Capital District Regions have a numerical score of 1 because there are no Alternative 5 measures proposed in those Regions.

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on HTRW

ALT 5 HTRW Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2+	2+	1	2+	1	1	3+
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*2+*	*2+*	*1*	*2+*	*1*	*1*	*2+*

The Lower Hudson Region has numerous HTRW sites, including many along and associated with the Hudson River's eastern bank and western bank in Jersey City, and smaller lead-contamination related sites near the northern extent of the Alternative 5 measures in this Region. Where HTRW site and proposed Alternative 5 measures are co-located, impacts would be extensive unless the HTRW site are remediated, or the Alternative 5 measures are relocated away from an HTRW site.

The proposed Alternative 5 measures are primarily located along Interstate 76 in the northeast portion of the Upper Bay/Arthur Kill Region. This area has many smaller State listed HTRW and spill sites. These smaller HTRW sites are generally easier to remediate than Superfund sites. For smaller HTRW sites that cannot be readily remediated, it may be possible to relocate the Alternative 5 measure to avoid those sites.

HTRW sites are extensive along the Passaic River and Hackensack River in the Hackensack/Passaic Region. These HTRW sites include large Federal and state Superfund sites, as well as widespread areas of contaminated sediments in both the Passaic and Hackensack Rivers. In the Hackensack/Passaic Region, Alternative 5 has proposed measures that are located in the upper Passaic River area, where there fewer Federal and State HTRW sites as compared with the lower Passaic River area. For smaller HTRW sites that cannot be readily remediated, it may be possible to relocate the Alternative 5 measures to avoid those sites.

The Jamaica Bay Region has numerous HTRW sites, many of which are small in area and isolated from other sites. Smaller HTRW sites often are less complex to remediate, or easier to avoid by relocating the Alternative 5 measure. Several Alternative 5 measures are co-located with a Federal Superfund site where the extent of contamination has not yet been fully delineated. Therefore, relocating a measure away from a contaminated area may not be feasible because the extent of contamination may be widespread and occur throughout the proposed measure footprint.

6.1.17 Navigation

Impacts to navigation are anticipated to have an impact rating of no impact to low impact for the Study Area during construction, and operations and maintenance. USACE will continue to coordinate with the USCG, a Cooperating Agency on the NYNJHAT Study, to ensure no to low impacts to navigation. The following are impact-producing factors to navigation: physical seabed/land disturbance and land use and economic change. Below is a summary of the potential impacts to navigation.

Construction Impact Summary

Temporary short-term impacts are anticipated from the presence of construction equipment that could prohibit navigational access within the Study Area. Navigation routes that are typically used in the Study Area may have to be altered to navigate around areas of active construction, resulting in short-term impacts to travel time and associated fuel expenses. Construction of the project measures is temporary in nature and would not cause long-term access impacts to navigation routes.

Operations and Maintenance Impact Summary

There would be no impacts to navigation when the barriers are in the open position. Impacts to navigation are not expected when the barriers are closed during large storm events because large vessels and vessel traffic are not anticipated to be present during large storm events. Barrier closure would hinder vessel movement throughout the Study Area during potential routine maintenance if the barriers require closure outside of a large storm event. Once the barriers are re-opened, navigation through the Study Area can continue, resulting in no long-term permanent impacts. Maintenance could be scheduled, and the schedule communicated to vessels transiting the Study Area to the extent practicable.

Alternative 3B (TSP)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Navigation

TSP Navigation Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	2	1	1	1	1	2
O&M Assumptions	1	1	1	2	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to navigation range from No to Low impact under the TSP. The Regions expected to have Low impacts to navigation are Jamaica Bay and the Upper Bay/Arthur Kill Regions because of construction of the storm surge barriers and tide gates under the TSP. One storm surge barrier is also planned in the Long Island Sound Region, however, the barrier is located in a small creek (Flushing Creek) and impacts are expected to be localized and not significant. Shore-Based Measures will not impact navigation.

Temporary short-term impacts are anticipated from the presence of construction equipment that could prohibit navigational access within the Study Area. Navigation routes that are typically used in the Study Area may have to be altered to navigate around areas of active construction, resulting in short-term impacts to travel time and associated fuel expenses. Construction of the project measures is temporary in nature and would not cause long-term access impacts to navigation routes.

During operations and maintenance, there would be no impacts to navigation when the barriers are in the open position. Impacts to navigation are not expected when the barriers are closed during large storm events because large vessels are not anticipated to occur during large storm events

No impacts to navigation are expected in the Hackensack/Passaic and Lower Hudson/East River Regions because no in-water measures are planned there. No impacts are expected to the other Regions under the TSP because no measures are planned there.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Navigation

ALT 2 Navigation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	2	1	1	2	1
O&M Assumptions	1	1	1	1	2	1	1	2	1
Mitigated Rating	*1*	*1*	*1*	*1*	*2*	*1*	*1*	*2*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to navigation range from No to Low impact under Alternative 2. The Regions expected to have Low impacts to navigation are the Long Island Sound Region and the Lower Bay Region because of construction of the storm surge barriers and tide gates under Alternative 2. Shore-Based Measures will not impact navigation.
Temporary short-term impacts are anticipated from the presence of construction equipment that could prohibit navigational access within the Study Area. Navigation routes that are typically used in the Study Area may have to be altered to navigate around areas of active construction, resulting in short-term impacts to travel time and associated fuel expenses. Construction of the project measures is temporary in nature and would not cause long-term access impacts to navigation routes.

During operations and maintenance, there would be no impacts to navigation when the barriers are in the open position. Impacts to navigation are not expected when the barriers are closed during large storm events because large vessels are not anticipated to occur during large storm events

No impacts to navigation are expected in Jamaica Bay, the Raritan, Upper Bay/Arthur Kill, the Hackensack/Passaic, and Lower Hudson/East River Regions because no in-water measures are planned there. No impacts are expected to the Mid-Hudson and Capital District Regions under Alternative 2 because no measures are planned there.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Navigation

ALT 3A Navigation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	2	1	1	2	2	2
O&M Assumptions	1	1	1	2	1	1	2	2	2
Mitigated Rating	*1*	*1*	*1*	*2*	*1*	*1*	*2*	*2*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to navigation range from No to Low impact under Alternative 3A. The Regions expected to have Low impacts to navigation are Jamaica Bay, the Long Island Sound Region, the Raritan, and the Upper Bay/Arthur Kill because of construction of the storm surge barriers and tide gates under Alternative 3A. The Lower Bay has one storm surge barrier planned there, however, the barrier is in a small part of Sandy Hook and impacts are expected to be localized. Shore-Based Measures will not impact navigation.

Temporary short-term impacts are anticipated from the presence of construction equipment that could prohibit navigational access within the Study Area. Navigation routes that are typically used in the Study Area may have to be altered to navigate around areas of active construction, resulting in short-term impacts to travel time and associated fuel expenses. Construction of the project measures is temporary in nature and would not cause long-term access impacts to navigation routes.
During operations and maintenance, there would be no impacts to navigation when the barriers are in the open position. Impacts to navigation are not expected when the barriers are closed during large storm events because large vessels are not anticipated to occur during large storm events

No impacts to navigation are expected in the Hackensack/Passaic and Lower Hudson/East River Regions because no in-water measures are planned there. No impacts are expected to the Mid-Hudson and Capital District Regions under Alternative 3A because no measures are planned there.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Navigation

ALT 4 Navigation Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	1	1	1	1	1	1	2
O&M Assumptions	1	1	1	1	1	1	1	1	2
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to navigation range from No to Low impact under Alternative 4. The Region expected to have the most impact to navigation is Jamaica Bay because of construction of the storm surge barriers and tide gates. The Long Island Sound Region has one storm surge barrier planned there, however, the barrier is in a small part of the Region (Flushing Creek) and impacts are expected to be localized. Shore-Based Measures will not impact navigation under Alternative 4.

Temporary short-term impacts are anticipated from the presence of construction equipment that could prohibit navigational access within the Study Area. Navigation routes that are typically used in the Study Area may have to be altered to navigate around areas of active construction, resulting in short-term impacts to travel time and associated fuel expenses. Construction of the project measures is temporary in nature and would not cause long-term access impacts to navigation routes.

During operations and maintenance, there would be no impacts to navigation when the barriers are in the open position. Impacts to navigation are not expected when the barriers are closed during large storm events because large vessels are not anticipated to occur during large storm events

No impacts to navigation are expected in the Upper Bay/Arthur Kill, Hackensack/Passaic and Lower Hudson/East River Regions because no in-water measures are planned there. No impacts are expected to the other Planning Regions under Alternative 4 because no measures are planned there.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Navigation

ALT 5 Navigation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region	Jamaica Bay Region Measures
Construction/Footprint	1	1	1	1	1	1	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction and operations and maintenance impacts to navigation are not expected under Alternative 5. Shore-Based Measures will not impact navigation and no in-water measures are planned under Alternative 5.

6.1.18 Noise and Vibration

Impacts associated with noise are anticipated to have an impact rating of low impact to moderate impact for the Study Area during construction and operations and maintenance activities, depending on the measure and existing conditions. The following are impact-producing factors associated with noise: physical seabed/land disturbance. Below is a summary of the potential impacts associated with noise.

Construction Impact Summary

Temporary impacts from noise will occur during construction of the Shore-Based Measures. Minor short-term impacts from increased noise levels from construction equipment use are anticipated during construction activities, including physical seabed/land disturbances such as foundation installation, dredging, dewatering, and excavation and fill activities. Minor short-term impacts are anticipated from noise increases above ambient levels from construction equipment use. Construction equipment usually exceeds the ambient sound levels by 20 to 50 dBA in an urban environment and up to 30 to 35 dBA in a suburban area (Environmental Protection Agency [EPA], 1978).

Minor short-term indirect impacts from traffic noise are anticipated during construction of the Shore-Based Measures. BMPs would potentially include using noise suppressing mufflers on construction equipment. Noise levels are anticipated to return to baseline ambient conditions following construction completion and permanent noise impacts are not anticipated. Temporary impacts to mitigate increased noise levels could be managed through implementation of site-specific BMPs and permit requirements.

Once the project measures are further refined, local noise ordinances may be evaluated during Tier 2 analysis to determine if additional site-specific noise surveys or monitoring are required to mitigate for increased noise levels. All municipalities throughout the project area have noise-control ordinances that designate maximum permissible sound levels from sources to receiving properties/receptors, or time-of-day restrictions on construction activities near residential or sensitive noise receptor areas. Within residential communities, sensitive receptors include schools, churches, residences, libraries, parks, recreational areas, hospitals, senior citizen homes, and rehabilitation centers. Sensitive receptors also extent to wildlife habitat, or ecologically significant locations.

Operations and Maintenance Impact Summary

During operations and maintenance of the proposed measures, noise and vibrations from storm surge and tide gate measures will occur. When the barriers are in the open position, no noise impacts would occur. When the barriers are moving to the closed position, minor temporary impacts to underwater noise levels are anticipated. The impacts from barrier closure on underwater noise levels may be further evaluated during Tier 2 EIS(s).

Alternative 3B (TSP)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Noise and Vibration

TSP Noise and Vibration Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	1	2	1	2	3
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to noise and vibration range from No to Moderate impact under the TSP. The Regions expected to have Moderate impacts to noise and vibration are Jamaica Bay and the Upper Bay/Arthur Kill Regions because of construction of the storm surge barriers and tide gates, as well as Shore-Based Measures planned in each Region. Low impacts to noise and vibration are expected in the Lower Hudson/Hudson/East River, Hackensack/Passaic, and Long Island Sound Regions due to the construction of Shore-Based Measures.

Short-term impacts are anticipated from noise increases above ambient levels from construction equipment use for the in-water measures in the Jamaica Bay Region. Temporary in-water noise level impacts would occur during construction activities, including foundation installation, dredging, dewatering, and excavation and fill activities. Equipment used for construction includes barges and dredges that may increase noise levels both underwater and in nearby residential communities. Wildlife habitat would be susceptible to underwater noise generated by construction, however most aquatic animals are expected to avoid construction noise. Construction activities may be more audible near the less-developed bay and marsh islands. The construction of Shore-Based Measures along Rockaway Beach, Coney Island, and the Brooklyn shoreline will contribute to some localized noise impacts to beach communities. Ambient noise is highly variable in the Region however, so shore-based construction may not have significant impacts to noise in the more urbanized and developed areas of the Region. Noise levels are anticipated to return to baseline ambient conditions following construction completion and permanent noise impacts are not anticipated.

Impacts to noise and vibration within the Upper Bay/Arthur Kill are similar to those described for Jamaica Bay; however, the Upper Bay/Arthur Kill is highly developed and ambient noise is expected to be less variable than in Jamaica Bay. Moderate impacts to underwater noise and vibration are anticipated during construction of the in-water measures, which would impact aquatic wildlife habitat. However, depending on the location of shore-based construction (all Shore-Based Measures), impacts are expected to be Low or may not be significant because of higher ambient noise in the highly developed Region.

Within the Hackensack/Passaic and Lower Hudson/East River Regions, shore-based construction is planned in highly developed locations where ambient noise is expected to be in the mid-high range. Noise and vibration impacts to those Regions are expected to be localized and Low, or potentially not significant, depending on the location of the construction. No in-water measures are planned in the Regions. Within the Lower Bay, no construction is planned so impacts to noise and vibration are not anticipated to be significant. Shore-based construction within the Jamaica Bay Region borders the Lower Bay, however, noise associated with the construction is not expected to be significantly higher than day-to-day noise from boat traffic and automobiles that already occurs over the water in the Region. The Navy also conducts periodic demolition training in the Region.

Noise and vibration impacts associated with construction in the Long Island Sound Region are anticipated to be Low. One storm surge barrier is planned in the Region, however the barrier is located in a small, highly developed area (Flushing Creek) where ambient noise is already expected to be high. Shore-based construction is not extensive in the Region and impacts are expected to be Low.

During operations and maintenance of the proposed measures, noise levels from storm surge and tide gate measures are not anticipated to be significant. When the barriers are in the open position, no noise impacts would occur. When the barriers are moving to the closed position, minor temporary impacts to wildlife habitat may occur due to increased underwater noise levels. It is assumed the barriers will be closed during major storm events, so the frequency of closures would be low. Maintenance activities for all measures (shore-based and in-water) will occur “as-needed”, and are not anticipated to be ongoing; therefore, impacts to noise and vibration during maintenance are not expected to be significant.

No impacts to noise and vibration are expected in the Raritan, Mid-Hudson, and Capital District Regions under the TSP because no measures are planned there.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Noise and Vibration

ALT 2 Noise and vibration Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	3	2	2	3	2
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*2*	*1*	*1*	*2*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to noise and vibration range from No to Moderate impact under Alternative 2. The Regions expected to have Moderate impacts to noise and vibration are Long Island Sound Region and the Lower Bay because of construction of the storm surge barriers and tide gates. Low impacts to noise and vibration are expected in Jamaica Bay, the Raritan, Upper Bay/Arthur Kill, Lower Hudson/East River and Hackensack/Passaic Regions due to the construction of all Shore-Based Measures.

Short-term impacts are anticipated from noise increases above ambient levels from construction equipment use for the in-water measures in the Lower Bay and Long Island Sound Region. Temporary in-water noise level impacts would occur during construction activities, including foundation installation, dredging, dewatering, and excavation and fill activities. Equipment used for construction includes barges and dredges that may increase noise levels both underwater and in nearby residential communities. Wildlife habitat would be susceptible to underwater noise generated by construction, however most aquatic animals are expected to avoid construction noise. The construction of Shore-Based Measures under Alternative 2 along Sandy Hook and Monmouth Beach (Lower Bay) and Rockaway Beach (Jamaica Bay) will contribute to localized noise impacts to the beaches in each Region. The ambient noise in beach communities is expected to be quieter, so noise generated by construction will be more audible. The northwestern part of the Long Island Sound Region is expected to have low-mid ambient noise and construction of the Shore-Based Measures is expected to have low impacts to the surrounding areas. Noise levels are anticipated to return to baseline ambient conditions following construction completion and permanent noise impacts are not anticipated.

Impacts to noise and vibration within the Hackensack/Passaic, Upper Bay/Arthur Kill, and Lower Hudson/East River is expected to be Low. Within each of these highly developed Regions, the construction of shore-based measures is not expected to greatly surpass day-to-day ambient noise generated by automobiles, air traffic, and/or boat traffic. Depending on the location of the shore-based measures, construction impacts may not be significant at all. No in-water measures are planned in the Regions under Alternative 2.

Noise and vibration impacts associated with construction in the Raritan Region are anticipated to be Low. Ambient noise in the Region is expected to be Low, however shore-based construction is only planned in a small part of the Region. Impacts will be localized. No in-water measures are planned in the Region under Alternative 2.

During operations and maintenance of the proposed measures, noise levels from storm surge and tide gate measures are not anticipated to be significant. When the barriers are in the open position, no noise impacts would occur. When the barriers are moving to the closed position, minor temporary impacts to wildlife habitat may occur due to increased underwater noise levels. It is assumed the barriers will be closed during major storm events, so the frequency of closures would be low. Maintenance activities for all measures (shore-based and in-water) will occur "as-needed", and are not anticipated to be ongoing; therefore, impacts to noise and vibration during maintenance are not expected to be significant.

No impacts to noise and vibration are expected in the Mid-Hudson and Capital District Regions under Alternative 2 because no measures are planned there.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Noise and Vibration

ALT 3A Noise and vibration Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	3	2	2	3	3	3
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*2*	*1*	*1*	*2*	*2*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to noise and vibration range from No to Moderate impact under Alternative 3A. The Regions expected to have Moderate impacts to noise, and vibration are Long Island Sound, Jamaica Bay, the Raritan, and the Upper Bay/Arthur Kill because of construction of the storm surge barriers and tide gates. The shore-based measures planned in each of the Regions are expected to produce Low impacts to noise and vibration. Similarly, Low impacts to noise and vibration are expected in the Lower Bay, Lower Hudson/Hudson/East River and Hackensack/Passaic Regions due to the construction of all shore-based measures. One storm surge barrier is planned near Sandy Hook in the Lower Bay, however the barrier is located in a small part of the Region; therefore, noise impacts associated with the barrier are anticipated to be Low.

Short-term impacts are anticipated from noise increases above ambient levels from construction equipment use for the in-water measures in the Long Island Sound, Jamaica Bay, Raritan, and the Upper Bay/Arthur Kill Region. Temporary in-water noise level impacts would occur during construction activities, including foundation installation, dredging, dewatering, and excavation and fill activities. Equipment used for construction includes barges and dredges that may increase noise levels both underwater and in nearby residential communities. Wildlife habitat would be susceptible to underwater noise generated by construction, however most aquatic animals are expected to avoid construction noise. The construction of shore-based measures under Alternative 3A near Sandy Hook (Lower Bay) and along Rockaway Beach (Jamaica Bay) will contribute to localized noise impacts to the beaches in each Region. The ambient noise in beach communities is expected to be quieter, so noise generated by construction will be more audible. The northwestern part of the Long Island Sound Region is expected to have low-mid ambient noise and construction of the shore-based measures is expected to have low impacts to the surrounding areas. Noise levels are anticipated to return to baseline ambient conditions following construction completion and permanent noise impacts are not anticipated.

Impacts to noise and vibration from construction of the shore-based measures within the Hackensack/Passaic, Upper Bay/Arthur Kill, and Lower Hudson/East River is expected to be Low. Within each of these highly developed Regions, the construction of shore-based measures is not expected to greatly surpass day-to-day ambient noise generated by automobiles, air traffic, and/or boat traffic. Depending on the location of the shore-based measures, construction impacts may not be significant at all. No in-water measures are planned in the Hackensack/Passaic and Lower Hudson/East River Regions under Alternative 3A.

During operations and maintenance of the proposed measures, noise levels from storm surge and tide gate measures are not anticipated to be significant. When the barriers are in the open position, no noise impacts would occur. When the barriers are moving to the closed position, minor temporary impacts to wildlife habitat may occur due to increased underwater noise levels. It is assumed the barriers will be closed during major storm events, so the frequency of closures would be low. Maintenance activities for all measures (shore-based and in-water) will occur “as-needed”, and are not anticipated to be ongoing; therefore, impacts to noise and vibration during maintenance are not expected to be significant.

No impacts to noise and vibration are expected in the Mid-Hudson and Capital District Regions under Alternative 3A because no measures are planned there.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Noise and Vibration

ALT 4 Noise and Vibration Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	1	2	1	2	3
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to noise and vibration range from No to Moderate impact under Alternative 4. The Region expected to have Moderate impacts to noise and vibration is the Jamaica Bay Region because of construction of the storm surge barriers and tide gates. All shore-based measures planned in the Region are expected to produce Low impacts to noise and vibration. One storm surge barrier is also planned in the Long Island Sound and Hackensack/Passaic Region, however, the barriers are not as extensive as the Jamaica Bay barrier and ambient noise is likely higher; therefore, impacts are expected to be localized and Low. Low impacts to noise and vibration is expected from construction of the shore-based measures in Hackensack/Passaic, the Upper Bay/Arthur Kill, and the Lower Hudson/Hudson/East River Region.

Short-term impacts are anticipated from noise increases above ambient levels from construction equipment use for the in-water measures in the Long Island Sound, Jamaica Bay, the Upper Bay/Arthur Kill Region. Temporary in-water noise level impacts would occur during construction activities, including foundation installation, dredging, dewatering, and excavation and fill activities. Equipment used for construction includes barges and dredges that may increase noise levels both underwater and in nearby residential communities. Wildlife habitat would be susceptible to underwater noise generated by construction, however most aquatic animals are expected to avoid construction noise. The construction of shore-based measures under Alternative 4 along Rockaway Beach (Jamaica Bay) will contribute to localized noise impacts to the beach. The ambient noise in beach communities is expected to be quieter, so noise generated by construction will be more audible. The Upper Bay/Arthur Kill, Hackensack/Passaic and Lower Hudson/East River are anticipated to have mid-high levels of ambient noise due to daily use of automobiles, air traffic, and/or boat traffic; therefore, impacts to noise and vibration associated with construction of the shore-based measures in each Region are expected to be Low.

During operations and maintenance of the proposed measures, noise levels from storm surge and tide gate measures are not anticipated to be significant. When the barriers are in the open position, no noise impacts would occur. When the barriers are moving to the closed position, minor temporary impacts to wildlife habitat may occur due to increased underwater noise levels. It is assumed the barriers will be closed during major storm events, so the frequency of closures would be low. Maintenance activities for all measures (shore-based and in-water) will occur "as-needed", and are not anticipated to be ongoing; therefore, impacts to noise and vibration during maintenance are not expected to be significant.

No impacts to noise and vibration are expected in the Mid-Hudson and Capital District Regions under Alternative 4 because no measures are planned there.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Noise and Vibration

ALT 5 Noise and Vibration Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region**	**Jamaica Bay Region Measures**
Construction/Footprint	1	1	2	2	1	2	1	1	1
O&M Assumptions	1	1	1	1	1	1	1	1	1
Mitigated Rating	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to noise and vibration range from No to Low impact under Alternative 5. The Regions expected to have Low impacts to noise and vibration are the Hackensack/Passaic, Upper Bay/Arthur Kill, and Lower Hudson/East River because of construction of each shore-based measure planned. Minor short-term impacts are anticipated from noise increases above ambient levels from construction equipment use for the shore-based measures.

Short-term impacts are anticipated from noise increases above ambient levels from construction equipment use. Each of the locations where shore-based measures are planned under Alternative 5 are highly developed; therefore, noise generated from construction is not expected to greatly surpass the ambient noise in each Region. The Upper Bay/Arthur Kill, Hackensack/Passaic and Lower Hudson/East River are anticipated to have mid-high levels of ambient noise due to daily use of automobiles, air traffic, and/or boat traffic; therefore, impacts to noise and vibration associated with construction of the shore-based measures in each Region are expected to be Low.

Maintenance activities for all measures under Alternative 5 will occur "as-needed" and are not anticipated to be ongoing; therefore, impacts to noise and vibration during maintenance are not expected to be significant.

No impacts to noise and vibration are expected in Jamaica Bay, the Long Island Sound, the Raritan, the Lower Bay, Mid-Hudson, and Capital District Regions under Alternative 5 because no measures are planned there.

6.1.19 Environmental Justice

For the Tier 1 level analysis the alternative footprint and associated risk managed areas were compared to the compiled list of census tracts that met the criteria for environmental justice to determine how many tracts intersected with the project alternative. Using the same measurements for environmental justice communities, the risk managed areas were compared with the location of census tracts to obtain a rough measure of how many environmental justice communities would benefit from the project.

Construction Impact Summary

Environmental Justice impacts were evaluated based on whether they would be expected to exacerbate existing inequity in environmental exposures, in this case including construction, view obstruction, and other disruptions that would arise if the measure were built within an environmental justice community. Temporary negative impacts to environmental justice areas may result during the construction of project features. Minor short-term impacts to environmental justice areas are anticipated from noise increases above ambient levels from construction equipment use. Construction equipment usually exceeds the ambient sound levels by 20 to 50 dBA in an urban environment and up to 30 to 35 dBA in a suburban area. Minor short-term indirect impacts to traffic are anticipated, with traffic disruptions during construction of the shore-based measures. Construction impacts of in-water measures are anticipated to be minor since these measures are located further offshore. Minor short-term impacts are anticipated from noise and vessel traffic transiting to the construction area.

Operations and Maintenance Impact Summary

Intended beneficial long-term impacts are anticipated to environmental justice communities by managing coastal storm risk. Adverse impacts from storm damage to communities with high levels of poverty are further impacted from limited financial resources available for rebuilding structures and replacing damaged possessions. Coastal environmental justice areas and their communities would be protected during large storm events and from the financial difficulties in the aftermath of a storm.

Alternative 3B (TSP)

The TSP, Alternative 3B, is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Environmental Justice.

TSP Environmental Justice Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound / Port Washington Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2	2	1	2	1	2	2

O&M Assumptions	1	1	2	2	1	2	1	2	2
Mitigated Rating	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*

Construction impacts to environmental justice communities range from No to Low impact under the TSP. The Regions expected to have Low impacts to environmental justice are Jamaica Bay, the Long Island Sound Region, the Hackensack/Passaic, Upper Bay/Arthur Kill, and the Lower Hudson/East River Region, primarily because of construction of the shore-based measures under the TSP. Of these five Regions, Jamaica Bay and the lower Hudson/East River will have the most shore-based construction planned under the TSP. Storm surge barrier and tide gate measures are planned in Jamaica Bay, the Upper Bay/Arthur Kill, and Long Island Sound Regions, however in-water measures are expected to have minor impacts on environmental justice communities because they are located off-shore.

Construction of shore-based measures (including deployable flood barriers, seawall, buried seawall/dune, floodwall, floodwall with park, stone toe-protection, rock sill structure, and road raising) may result in minor short-term impacts to environmental justice areas due to noise increases above ambient levels from construction equipment use. Minor short-term indirect impacts to traffic are anticipated, with traffic disruptions during construction of the shore-based measures. BMPs that could be utilized to reduce adverse impacts would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, covering trucks with tarps to prevent airborne dust, and use of BMPs to control fugitive dust during construction. Minor short-term impacts are anticipated from noise and vessel traffic during construction of the storm surge barrier and tides, which are in-water measures.

During operations and maintenance, similar impacts are expected as those during construction, however the impacts would be reduced and only occur during maintenance. The beneficial long-term impacts are the managed coastal storm risk to communities. Adverse impacts from storm damage to communities with high levels of poverty are further impacted from limited financial resources available for rebuilding structures and replacing damaged possessions. Coastal environmental justice areas and their communities would be protected during large storm events and from the financial difficulties in the aftermath of a storm.

No impacts to environmental justice are expected in the Lower Bay, Raritan, Mid-Hudson, and Capital District Regions under the TSP because no measures are planned there.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Environmental Justice

ALT 2 Environmental Justice Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	2+	1+	2+	2+	2+	2+
O&M Assumptions	1	1	2+	2+	2+	2+	2+	2+	2+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to environmental justice communities range from No to Low impact under Alternative 2. The Regions expected to have Low impacts to environmental justice are the Lower Bay, Jamaica Bay, the Long Island Sound Region, the Hackensack/Passaic, Upper Bay/Arthur Kill, and the Lower Hudson/East River Region, and the Raritan, primarily because of construction of the shore-based measures under Alternative 2. Of these seven Regions, Jamaica Bay, the Lower Bay, and the Long Island Sound Regions will have the most shore-based construction planned under Alternative 2. Storm surge barrier and tide gate measures are planned in the Lower Bay and Long Island Sound Regions, however in-water measures are expected to have minor impacts on environmental justice because they are located off-shore.

Construction of shore-based measures (including deployable flood barriers, seawall, buried seawall/dune, floodwall, floodwall with park, stone toe-protection, rock sill structure, and road raising) may result in minor short-term impacts to environmental justice areas due to noise increases above ambient levels from construction equipment use. Minor short-term indirect impacts to traffic are anticipated, with traffic disruptions during construction of the shore-based measures. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, covering trucks with tarps to prevent airborne dust, and use of BMPs to control fugitive dust during construction. Minor short-term impacts are anticipated from noise and vessel traffic during construction of the storm surge barrier and tides, which are in-water measures.

During operations and maintenance, similar impacts are expected as those during construction, however the impacts would be managed and only occur during maintenance. The beneficial long-term impacts are the managed coastal storm risk to communities. Adverse impacts from storm damage to communities with high levels of poverty are further impacted from limited financial resources available for rebuilding structures and replacing damaged possessions. Coastal environmental justice areas and their communities would be protected during large storm events and from the financial difficulties in the aftermath of a storm.

No impacts to environmental justice are expected in the Mid-Hudson and Capital District Regions under Alternative 2 because no measures are planned there.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Environmental Justice.

ALT 3A Environmental Justice Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	2+	1+	2+	2+	2+	2+
O&M Assumptions	1	1	2+	2+	1+	2+	2+	2+	2+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to environmental justice range from No to Low impact under Alternative 3A. The Regions expected to have Low impacts to environmental justice are the Lower Bay, Jamaica Bay, the Long Island Sound Region, the Hackensack/Passaic, Upper Bay/Arthur Kill, the Lower Hudson/East River Region, and the Raritan, primarily because of construction of the shore-based measures under Alternative 3A. Of these seven Regions, Jamaica Bay, the Lower Bay, and the Long Island Sound Regions will have the most shore-based construction planned under Alternative 3A. Storm surge barrier and tide gate measures are planned in the Lower Bay, Jamaica Bay, the Long Island Sound, the Upper Bay/Arthur Kill, and the Raritan Regions, however in-water measures are expected to have minor impacts on environmental justice because they are located off-shore.

Construction of shore-based measures (including deployable flood barriers, seawall, buried seawall/dune, floodwall, floodwall with park, stone toe-protection, rock sill structure, and road raising) may result in minor short-term impacts to environmental justice areas due to noise increases above ambient levels from construction equipment use. Minor short-term indirect impacts to traffic are anticipated, with traffic disruptions during construction of the shore-based measures. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, covering trucks with tarps to prevent airborne dust, and use of BMPs to control fugitive dust during construction. Minor short-term impacts are anticipated from noise and vessel traffic during construction of the storm surge barrier and tides, which are in-water measures.

During operations and maintenance, similar impacts are expected as those during construction, however the impacts would be managed and only occur during maintenance. The beneficial long-term impacts are the managed coastal storm risk to communities. Adverse impacts from storm damage to communities with high levels of poverty are further impacted from limited financial resources available for rebuilding structures and replacing damaged possessions. Coastal environmental justice areas and their communities would be protected during large storm events and from the financial difficulties in the aftermath of a storm.

No impacts to environmental justice are expected in the Mid-Hudson and Capital District Regions under Alternative 3A because no measures are planned there.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Environmental Justice

ALT 4 Environmental Justice Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound / Port Washington Region Measures	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	2+	1	2+	1	2+	2+
O&M Assumptions	1	1	2+	2+	1	2+	1	2+	2+
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1+*	*1+*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to environmental justice range from No to Low impact under Alternative 3B. The Regions expected to have Low impacts to environmental justice are Jamaica Bay, the Long Island Sound Region, the Hackensack/Passaic, Upper Bay/Arthur Kill, and the Lower Hudson/East River Region, primarily because of construction of the shore-based measures under Alternative 3B. Of these five Regions, Jamaica Bay, the Hackensack/Passaic, and the Upper Bay/Arthur Kill will have the most shore-based construction planned under Alternative 3B. Storm surge barrier and tide gate measures are planned in Jamaica Bay and the Long Island Sound Regions, however in-water measures are expected to have minor impacts on environmental justice because they are located off-shore.

Construction of shore-based measures (including deployable flood barriers, seawall, buried seawall/dune, floodwall, floodwall with park, stone toe-protection, rock sill structure, and road raising) may result in minor short-term impacts to environmental justice areas due to noise increases above ambient levels from construction equipment use. Minor short-term indirect impacts to traffic are anticipated, with traffic disruptions during construction of the shore-based measures. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, covering trucks with tarps to prevent airborne dust, and use of BMPs to control fugitive dust during construction. Minor short-term impacts are anticipated from noise and vessel traffic during construction of the storm surge barrier and tides, which are in-water measures.

During operations and maintenance, similar impacts are expected as those during construction, however the impacts would be managed and only occur during maintenance. The beneficial long-term impacts are the managed coastal storm risk to communities. Adverse impacts from storm damage to communities with high levels of poverty are further impacted from limited financial resources available for rebuilding structures and replacing damaged possessions. Coastal environmental justice areas and their communities would be protected during large storm events and from the financial difficulties in the aftermath of a storm.

No impacts to environmental justice are expected in the Lower Bay, Raritan, Mid-Hudson, and Capital District Regions under Alternative 3B because no measures are planned there.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Environmental Justice.

ALT 5 Environmental Justice Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region	Jamaica Bay Region Measures
Construction/Footprint	1	1	2+	2+	1	2+	1	1	1
O&M Assumptions	1	1	2+	2+	1	2+	1	1	1
Mitigated Rating	*1*	*1*	*1+*	*1+*	*1*	*1+*	*1*	*1*	*1*

+ indicates anticipated beneficial effects, in addition to potential adverse impacts.

Construction impacts to environmental justice range from No to Low impact under Alternative 5. The Regions expected to have Low impacts to environmental justice are the Hackensack/Passaic, Upper Bay/Arthur Kill, and the Lower Hudson/East River Regions, primarily because of construction of the shore-based measures under Alternative 5. Of these Regions, the Lower Hudson/East River will have the most shore-based construction planned under Alternative 5. No storm surge barrier and tide gate measures are planned under Alternative 5.

Construction of shore-based measures (including deployable flood barriers, seawall, buried seawall/dune, floodwall, floodwall with park, stone toe-protection, and rock sill structure) may result in minor short-term impacts to environmental justice areas due to noise increases above ambient levels from construction equipment use. Minor short-term indirect impacts to traffic are anticipated, with traffic disruptions during construction of the shore-based measures. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, covering trucks with tarps to prevent airborne dust, and use of BMPs to control fugitive dust during construction

During operations and maintenance, similar impacts are expected as those during construction, however the impacts would be managed and only occur during maintenance. The beneficial long-term impacts are the managed coastal storm risk to communities. Adverse impacts from storm damage to communities with high levels of poverty are further impacted from limited financial resources available for rebuilding structures and replacing damaged possessions. Coastal environmental justice areas and their communities would be protected during large storm events and from the financial difficulties in the aftermath of a storm.

No impacts to environmental justice communities are expected in the Lower Bay, Raritan, Jamaica Bay, the Long Island Sound, Mid-Hudson, and Capital District Regions under Alternative 5 because no measures are planned there.

6.2 BUILT ENVIRONMENT (INFRASTRUCTURE)

While the alternative plans will provide CSRM benefits to many built environment resources, the impacts of the alternatives are not expected to be uniformly positive nor negative. Further, the magnitude of impacts on built environment resources will vary, both between alternatives and across Planning Regions (e.g., under the TSP, aviation resources in the Jamaica Bay Region are expected to benefit, whereas those in the Lower Hudson/East River Region are expected to be negatively impacted). The impact of a given alternative on a built environment resource during construction can also vary from the expected impacts arising from operation and maintenance. In alignment with guidance for evaluating Other Social Effects (IWR 2013), impacts to built environment resources are assessed using the following scoring criteria:

Table 5.2. Built environment impact scoring criteria

Score	Relative to the Future Without-Project condition, the alternative has:
-3	Significant negative impacts (showstopper)
-2	Moderate negative impacts
-1	Minor negative impacts
0	Negligible impact (no effect)
1	Minor beneficial impact
2	Moderate beneficial impact
3	Significant beneficial impact

Using this scoring criteria, the impacts of each project alternative are assessed by Planning Region for each major built environment category. Impacts by construction/project footprint and operations/maintenance are assessed separately for each project alternative. Larger scores denote larger impacts, with scores of ±3 denoting significant beneficial or negative impacts relative to Alternative 1, the No Action Alternative. A score of 0 denotes no impacts to a given resource relative to Alternative 1.

This Section details the specific impacts the TSP and other alternatives are expected to have on a variety of built environment resources presented in Chapter 2.

6.2.1 Roads, Bridges, and Tunnels

Alternative 1: No Action Alternative (Future Without-Project Condition)

Under Alternative 1, in which no action is undertaken (i.e., the future without-project condition), roads, bridges, and tunnels would remain exposed to coastal flood risk. In particular, the lowest lying coastal communities, such as Red Hook in Brooklyn are likely to experience significant and increasingly more frequent surface road flooding under the future without-project condition. Major highways in the region would remain exposed to coastal flood risk which is expected to become increasingly more frequent and severe with expected RSLC. Under Alternative 1, tidal current-induced bridge abutment scour would also become increasingly frequent. Particularly under the higher RSLC expected towards the end of the century, major vehicular tunnels in the Study Area would also be increasingly exposed to coastal flood risk in the future without-project condition, though it is assumed the ongoing Holland Tunnel rehabilitation and resilience improvements would provide substantive flood risk management in the future without-project condition (PANYNJ, 2020). In the Upper Bay and Hackensack/Passaic Regions, several stretches of I-95 (NJ Turnpike) in Perth Amboy, Linden, Newark (adjacent to Newark Liberty International Airport), the Meadowlands, and Teaneck are expected to be exposed to coastal flood risk by end of century under the intermediate RSLC condition. Similarly, portions of I-278 and the West Shore Expressway in Staten Island are also exposed to coastal flood risk by 2100 under the USACE intermediate RSLC projection. In New York City, portions of Route 9A on the West Side, unelevated portions of FDR Drive, significant portions of the Belt Parkway in Brooklyn and Queens, I-495, I-95 in the Bronx, the Grand Central Parkway, and the Cross Island Expressway are all expected to be exposed to coastal flood risk by end of century under the intermediate RSLC condition. Highway connections from Queens into the Bronx, namely I-678 (Whitestone Expressway), I-295 (approaches to Throgs Neck Bridge) are similarly vulnerable.

Alternative 3B: Tentatively Selected Plan

The TSP would provide significant CSRM benefits to roadway infrastructure within the Study Area, reducing flood-related damages to roadways, supporting infrastructure, bridges, and vehicular tunnels. The management of coastal flood risk would also reduce the rate of deterioration of roadway infrastructure assets which would otherwise be exposed to the corrosive effects of salt water on a more frequent basis as compared to the no project alternative. The management of coastal flood risk for roadway infrastructure would have also additional indirect economic and social benefits, as the avoidance of coastal inundation of roadways would result in less flood-related travel disruption. The value of such direct and indirect benefits to roadway infrastructure is not included in the economic analysis; only CSRM benefits are included in the economic modeling.

Surface Roads

Surface roads in low-lying coastal neighborhoods would be inundated less frequently under the TSP, particularly in areas behind Risk Reduction Features, minimizing the future mobility impacts of flooding and RSLC. Additionally, vehicles parked on such surface roads would also benefit from the CSRM provided under the TSP, further minimizing the mobility impacts of future flood risk for residents of low-lying coastal neighborhoods. While the TSP would provide significant benefits to surface roads, there are a significant number of vehicular gates proposed under the TSP that would cross or be otherwise directly deployed across surface roads. For example, the proposed alignment of shore-based measures in the Red Hook neighborhood in Brooklyn includes several vehicular gates that, when deployed, would block vehicular, bicycle, and pedestrian traffic. A small number of road raisings are also proposed for Risk Reduction Features and are also likely to have a negative impact during construction, may adversely impact access to adjacent properties, and may require the relocation of underground utilities, depending on the height required to reach the target design elevations.

Highways

Highways within the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound, and Jamaica Bay regions would benefit from the CSRM provided by the TSP, though highways within the Capital

District, Mid-Hudson, Lower Bay, and Raritan regions along with some highways within the Long Island Sound region would not benefit under the TSP. More specifically, low-lying stretches of I-95 from Perth Amboy to Teaneck in New Jersey would benefit from the CSRM provided under the TSP. Similarly, the TSP would provide CSRM benefits for portions of I-278 and the West Shore Expressway in Staten Island, Route 9A and FDR Drive in Manhattan, portions of the Belt Parkway in Brooklyn and Queens, portions of the Long Island Expressway, Grand Central Parkway, and Whitestone Expressway in Queens. Portions of the Belt Parkway in Brooklyn, the Grand Central Parkway and Cross Island Expressway in Queens, I-95, I-678 (Whitestone Expressway), I-295 (approaches to Throgs Neck Bridge) in the Bronx may all remain vulnerable under the TSP.

Bridges

While the shore-based measures proposed under the TSP would not influence tidal currents, the placement and operation of the storm surge barriers proposed under the TSP would influence tidal currents. The bridges that are behind storm surge barriers (within the Upper Bay/Arthur Kill, Hackensack/Passaic, and Jamaica Bay regions) are likely to benefit from managed risk of scour related damage to piers and abutments. Bridges not benefitted by storm surge barriers (e.g., the Marine Parkway Bridge) are likely to have similar risk of scour under the TSP.

Tunnels

The shore-based measures proposed in the TSP would provide CSRM benefits for the tunnel portals of most vehicular tunnels in the Study Area. The tunnel portals (i.e., main openings where traffic enters the tunnel) of the Battery Park Underpass, the Hugh L. Carey (Brooklyn-Battery) Tunnel, Queens-Midtown Tunnel, and Holland Tunnel would be provided coastal storm risk management under the TSP. The portals of the Lincoln Tunnel would not benefit from the TSP, though they are comparatively less vulnerable than those of the other vehicular tunnels. The ventilation shafts for the Battery Park Underpass and the Queens-Midtown Tunnel would benefit from the flood risk ma provided under the TSP. The ventilation shafts for the remaining vehicular tunnels, the Hugh L. Carey Tunnel, the Holland Tunnel, and the Lincoln tunnel would not benefit from the TSP.

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Roads, Bridges, and Tunnels.

TSP Roads, Bridges, and Tunnels Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	0	0	-1	-1
O&M Assumptions	0	0	2	2	0	2	0	2	3

The shore-based measures proposed under the TSP include a large number of vehicular gates. The footprint, regular operation, and maintenance of such vehicular gates would conflict with surface roads in many neighborhoods throughout the Study Area, including Lower Manhattan, Red Hook, and Far Rockaway. By design, when deployed (either during operation or for regular maintenance) these vehicular gates would directly cross and obstruct surface roads and traffic, but are otherwise expected to have minimal impact when not in use. Despite the presence of these vehicular gates across surface roads, considering the benefit of the TSP, overall, surface roads in the Study Area would benefit under the TSP. Highways, bridges and tunnels within the Study

Area are not adversely affected by the footprint and operation of the shore-based measures and storm surge barriers proposed under the TSP. Within the Planning Regions where shore-based measures or storm surge barriers are planned (i.e., Lower Hudson/East River Region, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound, and Jamaica Bay) road infrastructure would benefit from the CSRM provided by the TSP. The TSP would have no impact on roads, bridges, or tunnels in the Capital District, Mid-Hudson, Lower Bay, or Raritan Regions.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Roads, Bridges, and Tunnels.

ALT 2 Roads, Bridges, and Tunnels Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	0	0	0	0	0	0	0	-1	-1
O&M Assumptions	0	0	2	2	2	2	2	2	2

Due to its alignment, Alternative 2 would require a minimal number of vehicular gates, with the majority of those specified designed as part of Risk Reduction Features. The regular operation of Alternative 2 would have net positive benefits to roads, bridges, and tunnels across all regions. Compared to the TSP, Alternative 2 would provide additional CSRM to roads, bridges, and tunnels in the Capital District, Mid-Hudson, Lower Bay, and Raritan Regions. Surface roads in the Long Island Sound region behind the proposed shore-based measures would also receive additional CSRM benefits when compared to the TSP. Additionally, due to the comparative lack of shore-based measures, only locations requiring the implementation of Risk Reduction Features would require vehicular gates. As such, there are significantly fewer locations where road infrastructure would be adversely impacted by Alternative 2 compared with the TSP. Additionally, all vehicular tunnels and related ventilation infrastructure would also benefit from reduced flood risk under this alternative, in contrast to the TSP which would not benefit the Lincoln Tunnel or ventilation shafts for the Hugh L. Carey Tunnel or the Holland Tunnel.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3A on Roads, Bridges, and Tunnels.

ALT 3A Roads, Bridges, and Tunnels Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	-1	-1
O&M Assumptions	0	0	2	2	0	2	0	1	2

The alignment of Alternative 3A requires a minimal number of vehicular gates, with the majority of those specified designed as part of Risk Reduction Features. The regular operation of Alternative 3A would have net positive benefits to roads, bridges, and tunnels across the Capital District, Mid-Hudson, Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound, and Jamaica Bay Regions. Similar to Alternative 2, Alternative 3A would provide additional CSRM to roads, bridges, and tunnels in the Capital District, Mid-Hudson and Long Island Sound Regions, though no additional CSRM benefits would be provided in the Lower Bay, and Raritan Regions when compared to the TSP. Adverse impacts of the proposed shore-based measure alignments in Alternative 3A would be less than under the TSP, as there would be fewer vehicular gates crossing surface roads. Similar to Alternative 2, all vehicular tunnels would receive the same level of flood risk management benefits, whereas the TSP would not benefit the Lincoln Tunnel or ventilation shafts for the Hugh L. Carey Tunnel or the Holland Tunnel.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 4 on Roads, Bridges, and Tunnels.

ALT 4 Roads, Bridges, and Tunnels Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	-1	0	-1	0	-1	-1
O&M Assumptions	0	0	1	1	0	2	0	2	2

The alignment of Alternative 4 would require a number of vehicular gates throughout the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound, and Jamaica Bay regions. The regular operation of Alternative 4 would have net positive benefits to roads, bridges, and tunnels across the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound, and Jamaica Bay Regions. Compared to the TSP, Alternative 4 would provide less CSRM benefits to roadway infrastructure. A much larger portion of the coastally adjacent surface streets and highways would not benefit from the CSRM proposed under Alternative 4. This includes low-lying portions of I-95 from Perth Amboy to Newark in New Jersey and portions of I-278 and the West Shore Expressway in Staten Island which would benefit under the TSP.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 5 on Roads, Bridges, and Tunnels.

ALT 5 Roads, Bridges, and Tunnels Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	-1	0	-1	0	0	0
O&M Assumptions	0	0	1	1	0	1	0	0	0

The alignment of Alternative 5 would requires a number of vehicular gates throughout the Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Regions. The regular operation of Alternative 5 would have net positive benefits to roads, bridges, and tunnels across the Lower Hudson/East River, Upper Bay/Arthur Kill, and Hackensack/Passaic Regions. Alternative 5 would benefit only a small portion of the roads, bridges, and tunnels in the Study Area when compared to the TSP. An even larger proportion of the coastally vulnerable surface streets and highways would not benefit from Alternative 4. Surface streets outside of Lower Manhattan, Jersey City, the Upper East Side, East Harlem, and portions of the Meadowlands would not benefit from Alternative 5. All highways outside of Manhattan that would benefit from the TSP would receive no CSRM benefits under Alternative 5. Additionally, the Queens-Midtown Tunnel and the Brooklyn portal of the Hugh L. Carey Tunnel would receive no CSRM benefit in Alternative 5, whereas they would directly benefit under the TSP.

6.2.2 Transit

Alternative 1: No Action Alternative (Future Without-Project Condition)

Transit agencies within the Study Area have made significant progress managing risk to transit assets in the Study Area. Particularly in the short term, transit infrastructure assets within the Study Area are already well prepared for future coastal flood risk, even without the project implemented. These measures include floodproofing and the installation of deployable flood control devices at underground tunnel openings, floodproofing of critical facilities, and elevating of infrastructure components within flood prone areas.

Alternative 3B: Tentatively Selected Plan

The TSP would also provide CSRM redundancies within the Study Area that will provide multiple lines of defense for many transit infrastructure assets. While these redundancies would provide incremental benefits to transit infrastructure assets in the Study Area, these benefits are not considered in the current economic analysis.

Rapid Transit

Notably, while the deployable flood control devices installed by NYC Department of Subways currently provide CSRM to subway openings with the projected extents of a Category 2 hurricane, there are at present no plans to inventory and mitigate additional openings that could become vulnerable with future RSLC. Under the TSP, any such additional subway openings would likely benefit from the CSRM provided by the project. The TSP would also provide redundant risk management for a significant portion of the approximately 3,500 openings already identified and fitted with deployable barriers by the MTA. This redundancy would provide an extra line of defense against flooding, particularly if several MTA flood control devices fail to properly deploy and may potentially obviate the need for deployment by NYC Department of Subways personnel altogether. Shore-based measures in the proximity of Coney Island and Willets Point would provide additional risk management for NYCT rail yards and maintenance facilities. Shore-based measures in Long Island City would also manage flood risk for NYCT tunnel portals and right of way. Similarly, the Jamaica Bay storm surge barrier would provide redundant protection to the NYCT Rockaway Line. Several MTA bus depots would also directly benefit from CSRM provided by shore-based measures and storm surge barriers proposed under the TSP.

While the majority of SIR facilities would not directly benefit from the TSP, a small portion of the SIR adjacent to Arthur Kill and Mill Creek, which remains vulnerable in the future without-project would benefit from the CSRM provided under the TSP. The storm surge barriers on Arthur Kill and Kill Van Kull would also provide redundant protection to Harrison maintenance facility (PATH). Similarly, shore-based measures in Jersey City would provide redundant risk management to PATH stations where deployable protection is already provided.

Commuter and Inter-city Rail

Under the TSP, some floodproofed assets along commuter rail lines would remain exposed to coastal flood risk, most notable of which is Metro North Railroad's Hudson Line, whose right of way would remain unprotected even though critical infrastructure within the right of way is elevated to reduce flood risk flooding with up to 4 feet of future RSLC. Existing design flood elevations for commuter rail assets in the Study Area are between 2.5 feet to 4 feet above the current 1% FEMA Base Flood Elevation, which is sufficiently elevated to ensure adequate CSRM through the end of century under the intermediate RSLC projection. Assuming the FEMA Base Flood Elevation increases directly with RSLC, under the high RSLC projection, the least elevated transit assets (elevated +2.5 feet above the current The FEMA Base Flood Elevation) would be exposed to the 1% coastal flood as soon as 2065, with all current CSRM measures (≤ 4 feet above current The FEMA Base Flood Elevation) providing inadequate risk management (i.e., exposed to flood risk more frequent than the 1% flood) by 2090. Many of these assets would also benefit from redundant CSRM under the TSP. Notably, New Jersey Transit and Amtrak rail lines adjacent to Newark Bay and the Hackensack and Passaic Rivers would benefit from the CSRM provided by the storm surge barriers on Arthur Kill and Kill Van Kull, particularly under higher future RSLC. These storm surge barriers would also provide redundant CSRM for the North River Tunnel. Shore-based measures in Long Island City would also provide redundant CSRM for the East River tunnel (used by Amtrak, LIRR), as well as the LIRR and Amtrak rail yards in Queens.

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Transit.

TSP Transit Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-2	0	0	0	0	-2	0
O&M Assumptions	0	0	2	2	0	2	0	2	2

The measures proposed in the TSP have the potential to conflict with existing rail rapid transit infrastructure and related flood mitigation infrastructure, particularly in the Lower Hudson/East River region. Where construction conflicts arise, coordination with relevant transit agencies would be required. The impacts of regular operation and maintenance of measures proposed in the TSP would be uniformly positive in affected Planning Regions (Lower Hudson/East River, Upper Bay, Hackensack/Passaic, Long Island Sound, and Jamaica Bay). Construction, operation, and maintenance of proposed measures would have no impact (neither positive nor negative) on the transit assets in the Capital, Mid-Hudson, Lower Bay, or Raritan Regions.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Transit.

ALT 2 Transit Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	2	2	1	2	1	2	2

The footprint of the alignment proposed under Alternative 2 has the potential to conflict with existing rail rapid transit infrastructure and related flood mitigation infrastructure within the Study Area. The regular operation of Alternative 2 would have net positive benefits to transit infrastructure across all regions. In contrast with the TSP, Alternative 2 would provide benefits to transit assets in the Capital, Mid-Hudson, Lower Bay, and Raritan regions. Notably, this would include additional risk management benefits for the entirety of the MNR Hudson Line and portions of its New Haven Line. Relative to the TSP, the SIR would also benefit from additional CSRM for the entirety of the Upper Bay/Arthur Kill Region. Additional NJ Transit commuter rail lines within the Raritan and Lower Bay Regions would also benefit from the additional CSRM relative to the TSP.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3A on Transit.

ALT 3A Transit Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures

Construction/Footprint	0	0	0	0	0	0	0	0	-1
O&M Assumptions	0	0	2	2	0	2	0	2	2

The footprint of the alignment proposed under Alternative 3A has to potential to conflict with transit assets within the Study Area. The regular operation of Alternative 3A would have net positive benefits to transit infrastructure in the Capital District, Mid-Hudson, Lower Hudson/East River, Upper Bay, Hackensack/Passaic, Long Island Sound, and Jamaica Bay Regions. CSRM benefits and impacts to transit infrastructure in the Planning Region under Alternative 3a would be largely consistent with those under Alternative 2, though there would not be any additional CSRM for NJ Transit assets south of the Raritan River relative to the TSP.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 4 on Transit.

ALT 4 Transit Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	-1	0	-1	0
O&M Assumptions	0	0	1	1	0	1	0	1	1

The footprint of the alignment proposed under Alternative 4 has the potential to conflict with existing rail rapid transit infrastructure and related flood mitigation infrastructure, particularly in the Lower Hudson/East River, Hackensack/Passaic, and Long Island Sound Regions. The regular operation of Alternative 4 would have net positive benefits to transit infrastructure in the Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound, and Jamaica Bay Regions. Under Alternative 4, NJ Transit infrastructure in the Upper Bay/Arthur Kill and Hackensack/Passaic regions would receive less CSRM benefits relative to the TSP and SIR infrastructure would receive no CSRM benefits. Redundant flood risk management benefits for PATH assets in the Hackensack/Passaic region would also be eliminated.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 5 on Transit.

ALT 5 Transit Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	0	0	0	0
O&M Assumptions	0	0	1	0	0	0	0	0	0

The footprint of the alignment proposed under Alternative 5 has the potential to conflict with existing rail rapid transit infrastructure and related flood mitigation infrastructure, particularly in the Lower Hudson/East River, Hackensack/Passaic, and Long Island Sound Regions. The regular operation of Alternative 5 would have net positive benefits to transit infrastructure in the Lower Hudson/East River Region. Alternative 5 would still provide additional redundant protection to PATH assets in Jersey City and to NYCT subway openings in Manhattan, though would not provide any additional benefits to transit assets. A significant number of transit assets in the Study Area would not receive coastal storm risk management benefits under this alternative.

6.2.3 Ports and Waterways

Alternative 1: No-Action Alternative (Future Without-Project Condition)

The Port Authority of NY and NJ has implemented The Port Master Plan 2050. This is a thirty-year comprehensive roadmap for the future that plans resiliency and growth of the 3,000 acres of port property (Port Master Plan 2019). This plan remains active under the future without-project condition. The NYSDOT and the Federal Transit Administration have planned to increase the resiliency of the Staten Island Ferry service by acquiring two larger vessels with capabilities of operating in a range of weather conditions along with the ability to be used for emergency evacuations. The existing terminals have also been upgraded to accommodate the new vessels and improve flood resilience (USACE 2018). The future without-project conditions in the New York and New Jersey Metropolitan area include vulnerable shorelines and increased annual damages from coastal flooding events, as sea level continues to rise. As is, the shorelines of all six of the Port Authority Container terminals are in the 1% The Federal Emergency Management Agency annual flood hazard zone, with a large threat of flooding (FEMA 2022). The Navigation section of this chapter includes supplemental information regarding existing and future without project con conditions for navigable waterways in the Study Area.

Alternative 3B: Tentatively Selected Plan

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3B on Ports and Waterways.

TSP Ports and Waterways Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	-1	0	-1	0	0	-1
O&M Assumptions	0	0	-2	-2	0	2	0	1	-1

With the economic advantages that come with increasing use of the New York metropolitan area's waterways as an asset into international trade and ease of public commuting, the fear of another damaging coastal storm event is not an impossible circumstance to consider. Alternative 3B includes an array of shore-based protective barriers and eight storm surge barriers. The construction of the storm surge barrier would have multiple gates that remain open in non-storm conditions to allow for navigation (USACE 2019).

Direct impacts of the TSP would include closures of the storm surge barriers which would prevent traffic in or out of the navigable channels that the gates protect. While frequency of closures would vary depending on the storm surge barrier, closures would be between one and three semidiurnal tide cycles long (two high and two low tides in a 24-hour period) depending on the length and severity of the storm. Additionally, shore-based measures on the waterfront such as bulkheads and levees could be placed directly over walkways and paths blocking the waterfront at ferry terminals.

Indirect impacts of the TSP plan would include possible delays in shipping times because of situational traffic and anchorage build-ups in the New York and New Jersey Harbor area after a large coastal storm or flooding event, due to gate closure. Container terminals have a strict schedule to keep, ensuring the flow of vessel traffic and keeping to tight schedules of the world trade vessel fleet. For New York City ferry terminals, shore-based measures at Battery Park City, Long Island City, Hunter's Point Terminal (deployable), Greenpoint (deployable), Coney Island (future landing), and Rockaway may be impacted by causing increased foot traffic and delays due to limited space and change of shoreline layout (NYC Ferry 2022). For New York Waterways ferry terminals, Liberty Harbor, Brookfield Place/ Battery Park City, Paulus Hook, Hoboken (New Jersey Transit) may be impacted by the elevated promenades, the floodwalls, and levees put in place as shore-based protective measures by altering foot traffic flow, increasing wait times due to more limited space on shorelines, or increasing traffic in the area during the construction phase (NY Waterway 2022)

Cumulative impacts to the Study Area with the TSP may include long term effects of annual gain and trade figures within the ports of New York and New Jersey. The Port of New York and New Jersey is currently the busiest on the East Coast and plans to continue to develop infrastructure to allow the port to continue increasing capacity for cargo trade (Port Master Plan 2019). With this comes concerns of how the shore-based measures of this alternative may have a negative impact on vessel traffic in the area and volumes of cargo being imported and exported. Impacts to ferries could include decrease in ridership due to any inconvenience of increased traffic or limited space when the shoreline measures are put in place.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Ports and Waterways.

ALT 2 Ports and Waterways Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	-2	-1	0	-1	-1
O&M Assumptions	0	0	1	2	-2	1	1	-1	1

Alternative 2 incorporates shore-based measures in combination with the Outer Harbor storm surge barrier connecting Sandy Hook, New Jersey to Rockaway Point on the Rockaway Peninsula, as well as the storm surge barrier at Throgs Neck. Numerous navigational storm surge barriers and auxiliary gates. At the Throgs Neck between the Bronx and Queens, the storm surge barrier structure would have a large impact on the navigation of tugs and barges that frequent the area. Storm surge barriers, navigable gates, and Risk Reduction Features within this alternative are located within the Hackensack/Passaic region, Jamaica Bay region, Lower Bay region, Lower Hudson/East River region, and Long Island Sound Region. The mentioned surge barriers would cause delay in traffic similar to that in Alternative 3B, however the barriers in Alternative 2 are in higher trafficked areas for container ships and other high frequency shipping traffic. Both the construction period and the operation and maintenance of these storm surge barriers would be a concern for the ports of New York and New Jersey. Risk of flooding is expected to be greatly managed in the Upper Bay/Arthur Kill region, where construction of the proposed shore-based measures would not be impactful to vessel traffic in the area.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3A on Ports and Waterways.

ALT 3A Ports and Waterways Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	-2	-1	0	-1	-1
O&M Assumptions	0	0	1	2	-2	1	1	-1	1

Alternative 3A integrates shore-based measures with the storm surge barriers at Verrazano-Narrows, Arthur Kill, Throgs Neck, The Hackensack River, and Jamaica Bay. More specifically, there are navigational and auxiliary storm surge barriers located at the southern mouth of the Arthur Kill between Woodbridge, NJ, in Staten Island, at the Verrazano Narrows between Brooklyn and Staten Island, and at the Throgs Neck Bridge between the Bronx and Queens, at the Hackensack River in between Secaucus and Kearny, at the Newtown Creek in Brooklyn, and at Jamaica Bay between Rockaway beach and Floyd Bennett Field. The storm surge barriers at Perth Amboy, Newtown Creek, and Throgs Neck are in high trafficked areas for several ships, tugboats and barges, thus causing concern for the impact construction and operation or maintenance would have. There could be a great deal of reduced costal storm risk in several of the Planning Regions, however, where construction would minimally impact the general traffic pattern of ports and waterways.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 4 on Ports and Waterways.

ALT 4 Ports and Waterways Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	-1	0	0	-1
O&M Assumptions	0	0	1	1	0	2	0	1	-1

This alternative includes 18 separate features covering multiple bays, rivers, creeks, and numerous shoreline areas. Alternative 4 incorporates shore-based measures along with the storm surge barriers at Jamaica Bay, Newtown Creek, Gowanus Canal, Flushing Creek, and Hackensack River. These storm surge barrier structures at the mouth of Jamaica Bay, Gerritsen Creek, Sheepshead Bay, and Coney Island Creek are estimated to involve navigational and auxiliary gates with associated static barriers to connect to adjacent land. Jamaica Bay, while not trafficked by ships, is a large ferry terminal year-round for New York City Ferry. While it is more popular in the warmer months, the storm surge barrier proposed in Jamaica Bay could cause more traffic and inconvenience, by boat and foot, for those walking to and from the ferry landing. Gowanus Canal holds a large fuel terminal frequented by small ships and tugs and barges, in the case that these storm surge barriers close for a storm, it may prevent fueling or other vessel operations. In the Upper Bay/Arthur Kill region and the Hackensack/Passaic River region, risk of flooding would be managed more than construction would be an inconvenience.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 5 on Ports and Waterways.

ALT 5 Ports and Waterways Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	-1	0	0	0

O&M Assumptions	0	0	1	1	0	1	0	0	0

Alternative 5 presents a perimeter risk management concept which excludes storm surge barriers that traverse waterways or waterbodies. Shore-based measures would be implemented at the New Jersey Upper Bay and Hudson River shoreline, New York City West Side shoreline, East Harlem shoreline, and the Hackensack Perimeter Lower, Middle and Upper Areas. Induced Flooding-Mitigation Features and Risk Reduction Features are not part of this alternative. This alternative includes 14 features. While the construction and footprint of the alternative would have minimal impact, the reduced coastal storm risk would increase in the Lower Hudson/East River Region, the Upper Bay/Arthur Kill region, and in the Hackensack/Passaic River region.

6.2.4 Freight Rail

Alternative 1: No Action Alternative (Future Without-Project Condition)

Programs are in currently in place to increase capacity of freight rail and help to accommodate the growing demand of freight rail within the Study Area. Freight railways in the area are lacking the resiliency needed for a future without-project. Much of the freight railways are located on or adjacent to waterways within the Study Area and will continue to see the effects of both Global Climate Change and RSLC with increased storm surge and frequent heavy precipitation events that induce flooding.

Alternative 3B: Tentatively Selected Plan

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3B on Freight Rail.

TSP Freight Rail Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-2	-2	0	0	0	0	0
O&M Assumptions	0	0	-1	-1	0	0	0	1	1

There are no direct impacts to the Capital District Region, the Mid-Hudson Region, the Lower Bay region, the Hackensack/Passaic region, the Raritan region. A proposed levee and a proposed floodwall in the Jersey City waterfront area would be in the direct path of a Conrail track in five different locations. Similarly, in the Upper Bay/Arthur Kill region, near the New Jersey Transit, Jersey Avenue stop, there are Norfolk Southern owned tracks that would be crossed over by a proposed levee and seawall in four different locations and one location on a set of Conrail tracks, here. The direct crossing of tracks would have a negative direct impact during both the construction and operation phases of the NYNJHAT project, though initial construction of having to move the impacted tracks would prove to be an expensive project. The Arthur Kill storm surge barrier proposed within alternative 3B, may have a more indirect impact on the railways on the Bayonne side of the measure because of their proximity to the existing Conrail track, especially during the construction phase. In the Long Island Sound Region, existing railways would not be impacted by construction or operation of proposed measures but would be protected by them in the area behind LaGuardia Airport. Similarly, the Jamaica Bay region would not be negatively impacted by construction or operation of proposed measures, and instead protect the freight railways from future conditions.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 2 on Freight Rail.

ALT 2 Freight Rail Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	2	2	1	1	3	0	0

There are no direct impacts to the Capital District region, the Mid-Hudson region, Long Island Sound region, and the Jamaica Bay region from the measure proposed within this alternative. Within the Lower Hudson region and the Upper Bay region, there is a great deal of positive impact spanning the area of the New Jersey waterfront from Bayonne to Hoboken, whereas the freight rails present in the area would be more protected from the shore-based measures that are proposed in alternative 2. On a smaller scale, there would be some protection to the coast within the Lower Bay region and the existing tracks within the surrounding area. Within the Hackensack/Passaic region, there are portions of several freight tracks that will be slightly more protected from storm surge and other flooding, from this alternative. The Raritan region is impacted in the most positive way because of the freight rail yard in Perth Amboy, adjacent to the Raritan Bay that would be protected by the operation of the storm surge barrier without being impacted by its construction.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3A on Freight Rail.

ALT 3A Freight Rail Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	-1	-1
O&M Assumptions	0	0	2	3	1	2	3	0	0

The Capital District region sees no benefit or negative direct impacts from the measures proposed within this alternative. In the Mid-Hudson region, however, at areas directly adjacent to the waterfront at the bends of the Hudson River, there are existing freight tracks that would minorly benefit from this alternative because pieces of the track would be in managed risk areas. Similar to Alternative 2, in Alternative 3A would see a fairly significant change within the New Jersey waterfront because of a majority of freight tracks being in new managed risk areas, after construction. Within the Upper Bay region, the managed risk area continues along the waterfront in both New Jersey and the Red Hook Brooklyn area which would positively impact the heavy freight tracked area and either side of the track tunnel that goes across the upper New York Bay to easily transport goods from Greenville to Red Hook. In this region, the Newark Airport and surrounding freight tracks within Elizabeth would also have managed risk. The Lower Bay Region sees very little positive impact from the measures proposed within this alternative, but nonetheless pieces of freight tracks in the Long Branch area of New Jersey would benefit. While construction won't impact the Hackensack/Passaic region freight tracks, the area will see benefits with this alternative by making a good portion of the area lower risk for flooding. Similar to Alternative 2, the Raritan region will see a very significant benefit from this alternative by managed risk in the area of the freight yard in Perth Amboy. In the Long Island Sound region there are two instances where proposed measures have the potential to cross freight tracks near Thomaston and Douglaston. Within the Jamaica Bay Region there are proposed features that have the potential to cross freight rail tracks along West Road, and the Rockaway Freeway.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 4 on Freight Rail.

ALT 4 Freight Rail Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	-1	0	0	0	-1	0
O&M Assumptions	0	0	1	1	0	2	0	0	2

The Capital District region, the Mid-Hudson River region, the Lower Bay region, the Raritan region, and the Long Island Sound region have no negative or positive impacts associated from the proposed alternative. Within the Lower Hudson River region and Upper Bay region, there are proposed levees and floodwalls crossing tracks similarly to Alternative 3B on the New Jersey waterfront in Jersey City, and in Bayonne. While this would be an inconvenience during construction, the proposed measures within this plan would help to alleviate flooding within the area, and therefore protect the existing freight infrastructure in those areas. In this alternative, there are an array of shore-based measured within the Hackensack/Passaic region that would help the area from flooding and therefore help to protect the freight infrastructure, and while usually the construction would affect the existing tracks, these measures are mainly deployable and would be of no nuisance. Freight transport from John F. Kennedy Airport would be positively impacted by this alternative as the shore-based measures proposed would put the entirety of the airport at less of a risk for flooding.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 5 on Freight Rail.

ALT 5 Freight Rail Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	-1	0	0	0	0	0
O&M Assumptions	0	0	1	0	0	0	0	0	0

The Capital District region, the Mid-Hudson River region, the Lower Bay region, the Hackensack/Passaic region, the Raritan region, the Long Island Sound region, and the Jamaica Bay region have no negative or positive impacts associated with the measures proposed from this alternative. Within the Lower Hudson River region and Upper Bay region, there are proposed levees and floodwalls crossing tracks similarly to Alternative 3B on the New Jersey waterfront in Jersey City. While this would be an inconvenience during construction, the proposed measures within this plan would help to alleviate flooding within the area, and therefore protect the existing freight infrastructure in those areas, though there would be much less protection within the Upper New York Bay region.

6.2.5 Stormwater and Wastewater Infrastructure

Alternative 1: No Action Alternative (Future Without-Project Condition)

The future without-project condition continues the current trend of stormwater in the Study Area decreasing water quality after large flooding events and heavy precipitation. The U.S. EPA, as of March 29, 2021, required the City of New York to construct and operate two CSO retention tanks to control the discharge of contaminated solids after flooding and heavy rain into the Gowanus Canal (EPA 2021). This is an addition to the other retention tanks that the city already has in place in Paerdegat Basin and Flushing Bay. Aquatic pollution remains possible due to inefficiencies with wastewater treatment and disposal in a future without project.

Alternative 3B: Tentatively Selected Plan

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3B on Stormwater and Wastewater Infrastructure.

TSP Stormwater & Wastewater Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures

Construction/Footprint	0	0	-1	0	0	0	0	0	0
O&M Assumptions	0	0	1	1	0	0	0	1	1

Alternative 3B is expected to greatly manage coastal storm flood risk in much of the surrounding area behind shore-based features and storm surge barriers. While not all wastewater treatment facilities will be impacted, there are some that will be in managed risk areas. Passaic Valley Sewerage Comm, Secaucus MUA, Bergen County Utilities Authority, Linden Roselle SA, Port Richmond WPCF, Newtown Creek WPCP, Jamaica WPCP, and Cedarhurst WPCP will be relatively most impacted by Alternative 3B. With flooding by coastal storm surge reduced at these wastewater treatment facilities, the plants will be able to properly run and process solid waste as they should. Additionally, in managed risk areas are a few Tier 1 CSO and several Tier 2 and Tier 3 CSO, as well. The protection of CSO and WWTPs in low-risk areas with shore-based measures would prevent frequency of aquatic pollution.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 2 on Stormwater and Wastewater Infrastructure.

ALT 2 Stormwater & Wastewater Infrastructure Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	0	0	-1	0	0	0	0	0	0
O&M Assumptions	0	0	1	1	0	0	0	1	1

Similarly, to Alternative 3B, Alternative 2 is expected to greatly manage risk in much of the surrounding area behind shore-based features and storm surge barriers. Under this alternative, the Upper Bay/Arthur Kill region , Long Island Sound Region, and the Jamaica Bay region would have the greatest management of risk with construction not impacting the operations of stormwater and wastewater treatment and disposal. Within the Long Island Sound Region and the Jamaica Bay Region, there are at least five facilities that would be in managed rrisk areas after construction, causing a significant increase in the level of protection for these facilities.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3A on Stormwater and Wastewater Infrastructure.

ALT 3A Stormwater & Wastewater Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	3	2	1	1	0	3	3

Similarly, to Alternative 3B, Alternative 3A is expected to greatly reduce risk in much of the surrounding area behind shore-based features and storm surge barriers. Under this alternative, the Lower Hudson/East River region, the Jamaica Bay region, and the Long Island Sound region have the greatest management of risk to several wastewater facilities and combines sewage overflows without impact from construction.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 4 on Stormwater and Wastewater Infrastructure.

ALT 4 Stormwater & Wastewater Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	3	2	0	1	0	1	3

Similarly, to the other alternatives, alternative 4 is expected to greatly manage risk in much of the surrounding area behind shore-based features and storm surge barriers. The Jamaica Bay region and the Lower Hudson/East River Region would have the greatest management of risk to the local wastewater treatment facilities and combined sewage overflows without impact on operations during the construction phase.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 5 on Stormwater and Wastewater Infrastructure.

ALT 5 Stormwater & Wastewater Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	3	3	1	1	0	3	3

For Alternative 5, the Lower Hudson/East River region, Upper Bay/Arthur Kill region, Long Island Sound region, and Jamaica Bay region all have significant improvements of protection for wastewater treatment facilities and combined sewage overflows after construction would be complete because they all have at least five facilities located in reduced risk areas.

6.2.6 Energy Infrastructure

There are electrical substations, electrical power generating plants, petroleum pumping stations, natural gas connects, pipelines, power lines and other critical infrastructure located in the Study Area, as described in Chapter 2. Energy infrastructure is critical to residents. This infrastructure not only provides power for homes and businesses but also powers WWTPs and other critical infrastructures that cannot perform when there is a threat to the power lines or power generating plants. During prior storms, this infrastructure was vulnerable to flooding and other storm damage that impacted millions of people.

Alternative 1: No Action Alternative (Future Without-Project Condition)

Under Alternative 1, energy infrastructure in the Study Area would remain vulnerable to coastal storms and flooding which may cause power outages to New York and New Jersey for millions of people.

Alternative 3B: Tentatively Selected Plan

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3B on energy infrastructure.

TSP Energy Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	0	1	0	1	0	0	1

Under the TSP, energy infrastructure in the Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, and the Jamaica Bay Region would be provided the most benefit. Infrastructure in the Raritan Region and Lower Bay Regions of New Jersey will be the least protected. Petroleum pumping stations and electrical power generating plants in the Raritan and Lower Bay Regions of New Jersey will remain in the 1% FEMA floodplain and may remain be vulnerable under the TSP.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 2 on energy infrastructure.

ALT 2 Energy Infrastructure Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	0	0	0	1	1	0	0

Alternative 2 measures would leave sections of Long Island Sound Region and Capital region still vulnerable in the 1% FEMA floodplain. Most of the electrical generating units would benefit from the alternative (most in NJ). Natural gas storage and compressors in NJ would also benefit. Two petroleum pumping stations in Jamaica Bay Region are not located in the 1% floodplain but are close to the shoreline and would not directly benefit by Alternative 2. Electrical substations would benefit, but the gas stations along the shoreline of the Long Island Sound Region lie in the 1% FEMA floodplain and would remain vulnerable under Alternative 2. Alternative 2 measures would leave sections of Long Island Sound Region and Capital region still vulnerable in the 1% FEMA floodplain. Most of the electrical generating units would benefit from the alternative (most in NJ). Natural gas storage and compressors in NJ would also benefit. Two petroleum pumping stations in Jamaica Bay Region are not located in the 1% floodplain but are close to the shoreline and would not directly benefit by Alternative 2. Electrical substations would benefit, but the gas stations along the shoreline of the Long Island Sound Region lie in the 1% FEMA floodplain and would remain vulnerable under Alternative 2.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3A on energy infrastructure.

ALT 3A Energy Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	0	2	0	2	0	0	2

Energy infrastructure within 1% floodplain in the Lower Bay Region, Raritan Region and Long Island Sound Regions would remain at risk of costal storm damage, as they will not be directly impacted by Alternative 3A. However, all the power generation plants, and natural gas storage and compressor stations would benefit from the alternative. The four petroleum pumping stations in NJ and two in Queens are not in the 1% FEMA floodplain but close and would not benefit from the alternative. Four Staten Island gas stations that are in the 1% FEMA floodplain would remain vulnerable. Ten gas stations located in the New Jersey 1% floodplain would not be directly impacted and would remain vulnerable to flooding, as would the gas stations in the Lower Hudson Region. There is one electrical substation in NJ that is in the 1% FEMA floodplain that would not be protected under Alternative 3A.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 4 on energy infrastructure.

ALT 4 Energy Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	0	0	0	1	0	0	2

Infrastructure in the Upper Bay/Arthur Kill Region, Lower Bay Region, Lower Hudson Region, Long Island Sound Region, Capital Region would not be directly benefitted by Alternative 4 . Energy infrastructure in these areas, particularly in the 1% FEMA floodplain, would remain vulnerable to flooding during a coastal storm event.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 5 on energy infrastructure.

ALT 5 Energy Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	0	0	0	0	0	0	0

Alternative 5 would not provide substantial protective measures to more than 90% of infrastructure located in 1% FEMA floodplain. During coastal storms, energy infrastructure such as gas stations, electrical substations, petroleum pumping stations, and electrical generating plants would be vulnerable to flood damage and residents throughout all the Planning Regions could experience power loss.

6.2.7 Communications Infrastructure

There is communication infrastructure such as cellular towers and digital transmitters in the Study Area, as described in Chapter 2. While communications infrastructure lies predominantly outside the FEMA 1% floodplain, cellular towers may still be at risk during storm events. After Hurricane Sandy, many cell towers were down due to flood damage, leaving many residents without access to their cell phones which are vital in calling emergency responders.

Alternative 1: No Action Alternative (Future Without-Project Condition)

With no action, cellular towers may be damaged by future coastal storms. If cellular towers become damaged in a disaster, then emergency calls may be routed to the wrong location making it more difficult for first responders to get to people who need them. In addition, internet hubs in downtown Manhattan businesses may also be affected if lower Manhattan floods which can negatively impact the local and global economy.

Alternative 3B: Tentatively Selected Plan

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3B on communication infrastructure.

TSP Communications Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	1	1	0	1	0	0	1

Under the TSP energy infrastructure in the Hackensack/Passaic Region, Upper Bay/Arthur Kill Region, and the Jamaica Bay Region will be the most benefitted. Infrastructure in the Raritan Region and Lower Bay Regions of New Jersey will be least benefitted. Most of the communications infrastructure in the Study Area lies outside of the 1% FEMA floodplain and are not at high risk of flood damage during coastal storms. Due to new FCC regulations, many cellular towers have back-up generators to ensure emergency calls can be accurately routed during a disaster should any tower be affected during a storm or hurricane. Cellular towers along the shoreline of the Lower Bay Region of New Jersey will be at particular risk for damage. Three towers, in Monmouth Hills, Red Bank and Long Branch are outside of the 1% floodplain but only by a few blocks. Cellular towers and TV digital transmitters servicing lower Manhattan will be protected and out of the floodplain.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 2 on <resource name> communication infrastructure.

ALT 2 Communications Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	1	1	1	1	1	1	1

All cellular towers in the Study Area would be risk managed by Alternative 2 measures as well as all TV digital transmitters.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3A on communication infrastructure.

ALT 3A Communications Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	1	1	1	1	1	1	1

Under Alternative 3A, all cellular towers in the floodplain would benefit as well as TV digital transmitters and would not be directly impacted by coastal storm flooding.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 4 on communication infrastructure.

ALT 4 Communications Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	1	1	1	1	1	1	1

Much of the Hackensack/Passaic, Jamaica Bay, Lower Hudson and Long Island Regions would benefit under Alternative 4. Cellular towers would not be directly impacted by coastal storm flooding.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 5 on communication infrastructure.

ALT 5 Communications Infrastructure Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	1	1	1	1	1	0	0

Areas benefitted by Alternative 5 are similar to Alternative 4. Cellular towers and TV digital transmitters in the Raritan, Upper Bay and Lower Bay Regions would remain vulnerable to flood damage in future storm events. Sections of Hackensack/Passaic, Lower Hudson and Jamaica Bay Regions will be the most benefited under Alternative 5 measures.

6.2.8 Public Spaces

There would be direct impacts to public spaces from construction of the alternatives. It is an anticipated there could be both positive negative effects to aesthetics, available space, and access to waterways. These are anticipated to affect usage potentially negatively by the public. General impacts of the alternatives are presented in this Section. It is recognized that direct impacts to each individual park will vary depending on it's the scope of the alternative plan and existing park conditions.

Permanent direct impacts to parks would be caused by construction of floodwalls, seawalls, and bulkheads, which are all anticipated to impact the public's access to waterways in parks. The footprint of these structures varies by alternative but would typically run along or near the waterfront and would be at an increased elevation relative to the current shorefront, sometimes raising the entire height of the shoreline. This may temporarily or permanently impact user's ability to reach the waterfront, specifically for activities such as recreational boating, fishing, and other water sports.

The temporary construction impacts of floodwalls, seawalls, and bulkheads vary greatly by situation and depend on whether construction will be from the landward or waterward side. In-water construction is often avoided, meaning that construction of these elements in parks will most likely result in partial or comprehensive closures of public spaces. Some permanent and temporary impacts of these structures can be mitigated by installing them at lower heights. Elevated promenades are anticipated to have similar permanent direct impacts to public spaces, potentially altering accessibility to parks, as well as the aesthetic value of the waterfront. Levees take up considerable amounts of ground space and may also permanently impact the public's access to the waterfront, and potentially other sections of parks as well, often permanently altering access routes, and the landscape of public spaces. Berms and dunes will have less of a permanent impact on aesthetics, but often have a considerable unusable for activity footprint. Deployable barriers will have temporary negative impacts on parks during deployment, potentially closing off access to portions of the park for times before and after storm events. The raising of roads near or in parks is anticipated to permanently negatively impact access and aesthetics.

Permanent indirect effects of the installation of these features include the expectation to provide some level of flood protection to waterfront parks, as well as improve interior drainage during coastal storm events which is anticipated to have a positive effect on the use and clean-up of public spaces. Indirectly the cost of park maintenance after storm events is expected to decrease and the allowing the public to get back to using the space faster is a positive outcome.

Permanent cumulative effects of these features to public spaces are expected to be positive as many vulnerable spaces should be more sustainably maintained for public use with a decrease in sunny-day flooding, effects of RSLC, lower damage maintenance costs, and less closure times for public spaces overall.

Alternative 1: No Action Alternative (FWOP Condition)

Parks

While all the managing agencies discussed in Chapter 2 are working to mitigate coastal storm risk to public use spaces, in the No Action Alternative scenario, many shorefront parks are anticipated to be subject to increased sunny-day flooding, coastal storm surge, and other flood events. It is assumed this vulnerability remains under the No Action Alternative. RSLC and coastal storms could result in damage to public spaces, increased maintenance costs for regular upkeep, increased closure times after storm events, and ultimately decreased potential public space for users.

Bike Paths/Greenways

Since bike paths are key to connectedness for public spaces, and often run along waterways, there are anticipated negative impacts under the No Action Alternative scenario. If no coastal storm resiliency measures are put into place, it is expected that NYC shorefront Greenways will be subject to frequent and destructive coastal storm inundation, eventually making the greenways and spaces they connect no longer usable for the public. Waterfront biking trails in New Jersey are anticipated to have similar issues with coastal storm events as those within the NYC area. Other portions of New Jersey bike trails located in more upland and mountainous areas are anticipated to be subject to increased rainfall and erosion. Portions of the Empire State trail run along waterfronts, making those areas susceptible to inundation from storm events. Bike trails located in upland, and mountainous areas are expected to receive increased rainfall due to increased storm events, causing significant erosion and potential hazards to these public recreational spaces.

Community Garden

These designated green spaces are generally not designed to withstand the expected increase in frequency and severity of climate change and coastal storm events. Community gardens are expected to receive larger amounts of rainfall, overloading and destroying crops, rendering gardens barren which would take away a vital resource to communities.

Public Pools

These resources, like the rest of the built environment are expected to see the effects of future potential increases in RSLC, increased rainfall, and run-off. Public pools are affected by these events, which potentially cause structural damage, water pollution, and increased public closure/ maintenance times.

Athletic Fields

Athletic fields built near the shore or within the floodplain can expect impacts from future potential increases in RSLC. Inland fields are often a place where rainfall runoff collects, causing flooding, and damage to athletic fields.

Alternative 3B: Tentatively Selected Plan

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3B on Public Spaces.

TSP Public Spaces Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	-1	0	0	0	0	-1
O&M Assumptions	0	0	2	1	0	1	0	1	2

Alternative 3B as the selected plan is expected to have direct impacts to 37 park spaces as summarized below:

Table 53: Summary of Directly-Impacted Parks Associated with Alternative 3B.

Planning Region	Park	Proposed Structure
Jamaica Bay Region	Manhattan Beach Park	Large Floodwall
	Coney Island Beach and Boardwalk	Elevated Promenade

Planning Region	Park	Proposed Structure
	Coney Island Creek Park	Large Floodwall
		Seawall
	Coney Island Boat Basin/ Six Diamonds	Large Levee
	Calvert Vaux Park	Large Levee
	Belt Parkway/Shore Parkway	Medium Floodwall
		Deployable Flood Barrier
	Bensonhurst Park	Large Floodwall
	Shore Parkway	Large Levee
	Fresh Creek Nature Preserve	Revetment with Floodwall
		Low Floodwall
		Revetment with Floodwall
	Marine Park	Reinforced Dune
		Medium Levee
		storm surge barrier
		Medium Levee
	Rockaway Beach and Boardwalk	Reinforced Dune
	Jamaica Bay Park	Standard Floodwall
		Shallow Bulkhead
		Deployable Flood Barrier
		Low Berm
		High Floodwall
		High Berm
	Broad Channel Park	Road Raising
	Sunset Cove Park	High Berm
	Floyd Bennett Field	Reinforced Dune
		Floodwall
		Medium Levee
	Jacob Riis Park	Large Floodwall
		Medium Levee
	Breezy Point Park	Levee
		Reinforced Dune
	Park (Cross Bay Blvd. and W. 16 Rd. to W. 19 Rd.)	Bulkhead
Upper Bay/ Arthur Kill Region	North Shore Esplanade	Floodwall
	Freshkills Park	Floodwall
	Liberty State Park	Levee
	Tottenville Shore Park	storm surge barrier
	Red Hook Recreation Area	Levee
Lower Hudson/East River Region	Randall's Island Park	Floodwall

Planning Region	Park	Proposed Structure
	East River Esplanade	Elevated Promenade
	Transmitter Park	Levee
	The Battery	Floodwall
	Newtown Barge Playground	Floodwall
	Park (143 India Street)	Seawall
	Sherman Creek	Levee
	Battery Park City	Floodwall
	Gantry Plaza	Levee
	Greenport Landing	Seawall
	Percy E Sutton Playground	Floodwall
	Hunters Point	Seawall
	Highbridge Park	Floodwall
	Carl Shurz Park	Seawall

Alternative 3B integrates shore-based measures along the Arthur Kill, Kill Van Kull, Jamaica Bay, Newtown Creek, Gowanus Canal, and Flushing Creek storm surge barriers. The required shore-based measures include risk management of the New Jersey Upper Bay and Hudson River shoreline from Liberty State Park to Hoboken, New York City West Side shoreline from Brooklyn Bridge to Pier 78, East Harlem shoreline from Carl Schurz Park to Washington Heights, the Red Hook shoreline and the Long Island City-Astoria shoreline from Astoria Park to Ed Koch Queensboro Bridge. Risk Reduction Features are proposed along the shorelines of the Upper Bay, the Arthur Kill region, Jamaica Bay, and the Hackensack and Passaic Rivers. The most heavily impacted areas by the Risk Reduction Features are along Jamaica Bay, and the Lower Hudson/East River, specifically within the spaces outlined in the Table above. The impacts to public spaces in this area are substantial; however, will provide protection to many public spaces from projected coastal storm events. Induced flooding is expected to occur in portions of the East River and Harlem River and on the flood side of the Jamaica Bay storm surge as a result of the presence of the above stated storm surge barriers, thus, Induced Flooding-Mitigation Features are to be placed in some public spaces in this region, i.e., reinforced dunes, a floodwall, and a levee along the perimeter of Floyd Bennet Field. Overall Alternative 3B will directly impact 37 National, NYSDEC, NYC Parks, and NJDEP managed parks by the installation of features within their boundaries, while managing the coastal storm risk for an estimated 394 state and city park areas in the following Planning Regions: Lower Hudson/East River, Upper Bay/Arthur Kill, Hackensack/Passaic, Long Island Sound, Upper Bay/Arthur Kill and Jamaica Bay. Portions of Gateway National Park are also in the RRA. Other public spaces in the RRA including public pools, athletic fields, community gardens, and bike paths are all expected to be provided with protection from coastal storms. Those located outside the RRA are expected to maintain their vulnerability to RSLC.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 2 on Public Spaces.

ALT 2 Public Spaces Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	0	0	-1	-1
O&M Assumptions	0	0	1	0	0	0	0	1	1

Alternative 2 has the smallest footprint and the largest risk managed area. Its direct impacts to parks within the Study Area are summarized in the Table below:

Table 54: Summary of Directly Impacted Parks Associated with Alternative 2.

Planning Region	Park	Structure
Long Island Sound Region	Udalls Park	Large Levee
	Alley Pond Park	Large Levee
	Cross Island Parkway	Large Floodwall
		Large Levee
	Little Bay Park	Large Levee
		Floodwall
	Bicentennial Veterans Memorial Park	Floodwall
	Pelham Bay Park and Orchard Beach	Large Levee
		Seawall
Jamaica Bay Region	Fresh Creek Nature Preserve	Revetment with Floodwall
		Low Floodwall
		Revetment with Floodwall
	Rockaway Beach and Boardwalk	Reinforced Dune
	Jamaica Bay Park	Standard Floodwall
		Shallow Bulkhead
		Deployable Flood Barrier
		Low Berm
		High Floodwall
		High Berm
	Broad Channel Park	Road Raising
	Sunset Cove Park	High Berm
	Jacob Riis Park	Large Floodwall
		Medium Levee
	Park (Cross Bay Blvd. and W. 16 Rd. to W. 19 Rd.)	Bulkhead
Raritan Region	Sandy Hook	Reinforced Dune

Planning Region	Park	Structure
Upper Bay/Arthur Kill Region	North Shore Esplanade	Floodwall
	Freshkills Park	Floodwall
Lower Hudson/East River Region	Bushwick Inlet	Bulkhead
	Mill Pond Park	Bulkhead
	Hudson River Park	Low Flood Wall
		Deployable Flood Barrier

Alternative 2 incorporates shore-based measures in combination with the Outer Harbor storm surge barrier connecting Sandy Hook, New Jersey to Rockaway Point on the Rockaway Peninsula, as well as the storm surge barrier at Throgs Neck. The storm surge barrier in the vicinity of the Sandy Hook Unit of Gateway National Park is expected to impact the viewshed of the park, there will also be a reinforced dune within the footprint of the park, and their connection to the Rockaway Peninsula is expected to directly impact portions of the Jamaica Bay Unit of the Park. Risk Reduction Features are proposed along the shorelines of the Lower and Upper Bay, the Arthur Kill region, the Raritan River, Jamaica Bay, the Hackensack River and Passaic River, the Lower Hudson and East River for this alternative. Induced flooding is expected to occur in the western end of the Long Island Sound. This anticipated induced flooding will impact public access to Parks. The presence of the Throgs Neck storm surge barrier, necessitates Induced Flooding-Mitigation Features in this region, some of which will directly impact parks. For example, the installation of a large levee and floodwall in Little Bay Park. Overall Alternative Two will directly impact 19 National, NYSDEC, NYC Parks, and NJDEP managed parks by the installation of features within their boundaries. These impacts are within the Long Island Sound, Lower Hudson/East River, and Jamaica Bay Regions. Alternative 2 will manage coastal storm risk for an estimated 394 state and city park areas in all the Planning Regions excluding the Capital District Region. Portions of Gateway National Park are also in Alternative 2's RRA. Other public spaces in the RRA including public pools, athletic fields, community gardens, and bike paths are all expected to be provided with protection from coastal storms while those located outside the RRA are expected to maintain their vulnerability to RSLC.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 3A on Public Spaces.

ALT 3A Public Spaces Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	-1	0	0	-1	-2
O&M Assumptions	0	0	0	1	1	1	0	1	1

Identified direct impacts of Alternative 3A to Parks are summarized in the Table below:

Table 55: Summary of Directly Impacted Parks Associated with Alternative 3A.

Planning Region	Park	Structure
Long Island Sound Region	Udalls Park	Large Levee
	Alley Pond Park	Large Levee
	Cross Island Parkway	Large Floodwall
		Large Levee
	Little Bay Park	Large Levee
		Floodwall
	Bicentennial Veterans Memorial Park	Floodwall
	Pelham Bay Park and Orchard Beach	Large Levee
		Seawall
Lower Hudson/ East River Region	Hudson River Park	Low Floodwall
		Deployable Flood Barrier
	Bushwick Inlet	Bulkhead
	Mill Pond Park	Bulkhead
Jamaica Bay Region	Manhattan Beach Park	Large Floodwall
	Coney Island Beach and Boardwalk	Elevated Promenade
	Coney Island Creek Park	Large Floodwall
		Seawall
	Coney Island Boat Basin/ Six Diamonds	Large Levee
	Calvert Vaux Park	Large Levee
	Belt Parkway/Shore Parkway	Medium Floodwall
		Deployable Flood Barrier
	Bensonhurst Park	Large Floodwall
	Shore Parkway	Large Levee
	Fresh Creek Nature Preserve	Revetment with Floodwall
		Low Floodwall
		Revetment with Floodwall
	Marine Park	Reinforced Dune
		Medium Levee
		storm surge barrier
		Medium Levee
	Rockaway Beach and Boardwalk	Reinforced Dune
	Jamaica Bay Park	Standard Floodwall
		Shallow Bulkhead
		Deployable Flood Barrier
		Low Berm

Planning Region	Park	Structure
		High Floodwall
		High Berm
	Broad Channel Park	Road Raising
	Sunset Cove Park	High Berm
	Floyd Bennett Field	Reinforced Dune
		Floodwall
		Medium Levee
	Jacob Riis Park	Large Floodwall
		Medium Levee
	Breezy Point Park	Levee
		Reinforced Dune
	Park (Cross Bay Blvd. and W. 16 Rd. to W. 19 Rd.)	Bulkhead
Raritan Region	Great Kills Park	Large Levee
	Conference House Park	Large Levee
	Crescent Beach Park	Reinforced Dune
	Seaside Wildlife Nature Park	Large Floodwall
	Lemon Creek Park	Levee
	Wolfe's Pond Park	Reinforced Dune
		Large Levee
Upper Bay/Arthur Kill Region	North Shore Esplanade	Floodwall
	Freshkills Park	Floodwall
	Alice Austen Park	Floodwall
	Tottenville Shore Park	storm surge barrier

Alternative 3A integrates shore-based measures with the storm surge barriers at Verrazano-Narrows, Arthur Kill, Throgs Neck, and Jamaica Bay. Risk Reduction Features are proposed along the shorelines of the Upper Bay, the Arthur Kill region, Jamaica Bay, the Hackensack River and Passaic River, the Lower Hudson and East River. Induced flooding is expected to occur along the Lower Bay, the Raritan River and the western end of Long Island Sound as a result of the presence of storm surge barriers, Induced Flooding-Mitigation Features are proposed in these regions. Overall Alternative 3A will directly impact 37 National, NYSDEC, NYC Parks, and NJDEP managed parks by the installation of features within their boundaries, across three (Long Island Sound, Jamaica Bay, Lower Hudson/East River, Upper Bay/Arthur Kill, Raritan) Planning Regions. Alternative 3A's RRA covers an estimated 139 state and city park areas in the Upper Bay/Arthur Kill, Lower Bay, Hackensack/Passaic, Long Island Sound, and Jamaica Bay Regions. Sections of Gateway National Park are included in Alternative 3A's RRA. Other public spaces in the RRA including public pools, athletic fields, community gardens, and bike paths are all expected to be provided with protection from coastal storms while those located outside the RRA are expected to maintain their vulnerability to RSLC.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 4 on Public Spaces.

ALT 4 Public Spaces Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	-1	0	0	0	0	-2
O&M Assumptions	0	0	1	0	0	1	0	1	1

The direct impacts to parks from Alternative 4 are summarized in the Table below:

Table 56: Summary of Directly Impacted Parks Associated with Alternative 4.

Planning Region	Park	Structure
Lower Hudson/East River Region	East River Esplanade	Elevated Promenade
	Transmitter Park	Levee
	The Battery	Floodwall
	Newtown Barge Playground	Floodwall
	Park (143 India Street)	Seawall
	Battery Park City	Floodwall
	Gantry Plaza	Levee
	Greenport Landing	Seawall
	Percy E Sutton Playground	Floodwall
	Hunters Point	Seawall
	Highbridge Park	Floodwall
	Carl Shurz Park	Seawall
Jamaica Bay Region	Manhattan Beach Park	Large Floodwall
	Coney Island Beach and Boardwalk	Elevated Promenade
	Coney Island Creek Park	Large Floodwall
		Seawall
	Coney Island Boat Basin/ Six Diamonds	Large Levee
	Calvert Vaux Park	Large Levee
	Belt Parkway/Shore Parkway	Medium Floodwall
		Deployable Flood Barrier
	Bensonhurst Park	Large Floodwall
	Shore Parkway	Large Levee
	Fresh Creek Nature Preserve	Revetment with Floodwall
		Low Floodwall
		Revetment with Floodwall
	Marine Park	Reinforced Dune
		Medium Levee
		Storm Surge Barrier
		Medium Levee

	Rockaway Beach ad Boardwalk	Reinforced Dune
	Jamaica Bay Park	Standard Floodwall
		Shallow Bulkhead
		Deployable Flood Barrier
		Low Berm
		High Floodwall
		High Berm
	Broad Channel Park	Road Raising
	Sunset Cove Park	High Berm
	Floyd Bennett Field	Reinforced Dune
		Floodwall
		Medium Levee
	Jacob Riis Park	Large Floodwall
		Medium Levee
	Breezy Point Park	Levee
		Reinforced Dune
	Park (Cross Bay Blvd. and W. 16 Rd. to W. 19 Rd.)	Bulkhead
Upper Bay/ Arthur Kill Region	Liberty State Park	Levee
	Red Hook Recreation Area	Levee

Alternative 4 incorporates shore-based measures along with the storm surge barriers at Jamaica Bay, Newtown Creek, Gowanus Canal, Flushing Creek, and Hackensack River. These shore-based measures are located at the New Jersey Upper Bay and along the Hudson River shoreline from Liberty State Park to Hoboken, New York City West Side shoreline from Brooklyn Bridge to Pier 78, Long Island City shoreline, the Red Hook shoreline and the East Harlem Shoreline from Carl Schurz Park to Washington Heights. To mitigate the residual flood risk, Risk Reduction Features are proposed along the shorelines of Jamaica Bay, interacting with many public spaces. Induced flooding is expected to occur in Newark Bay and portions of the Arthur Kill and Kill van Kull, and on the flood side of the Jamaica Bay storm surge barrier, and thus, Induced Flooding-Mitigation Features are suggested to be placed in these regions. Within the Jamaica Bay Region, Alternative 4 will directly impact 32 National, NYSDEC, NYC Parks, and NJDEP managed parks by the installation of features within their boundaries, Alternative 4 will reduce coastal storm risk for an estimated 376 state and city park areas in the Lower Hudson/East River, Hackensack/Passaic, Long Island Sound, Upper Bay/Arthur Kill, and Jamaica Bay Planning Regions. Portions of Gateway National Park are also in the RRA. Other public spaces in the RRA including public pools, athletic fields, community gardens, and bike paths are all expected to be provided with protection from coastal storms while those located outside the RRA are expected to maintain their vulnerability to RSLC.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with Alternative 5 on Public Spaces.

ALT 5 Public Spaces Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	-1	0	0	0	0	0
O&M Assumptions	0	0	2	0	0	0	0	0	0

The direct impacts to Alternative 5 are summarized below:

Planning Region	Park	Structure
Lower Hudson River/East River	East River Esplanade	Elevated Promenade
	The Battery	Floodwall
	Battery Park City	Floodwall
	Percy E Sutton Playground	Floodwall
	Highbridge Park	Floodwall
	Carl Shurz Park	Seawall
Upper Bay/Arthur Kill Region	Liberty State Park	Levee

Alternative 5 utilizes a perimeter approach which excludes storm surge barriers. Shore-based measures are projected to be implemented at the New Jersey Upper Bay and Hudson River shoreline, New York City West Side shoreline, East Harlem shoreline, and the Hackensack Perimeter Lower, Middle and Upper Areas. Due to the absence of storm surge barriers, Induced Flooding-Mitigation Features and Risk Reduction Features are not part of this alternative, so there are only 7 identified direct impacts to parks. Alternative 5's RRA incudes an estimated 60 state and city park areas, and portions of Gateway National Park. Other public spaces in the RRA including public pools, athletic fields, community gardens, and bike paths are all expected to be provided with protection from coastal storms while those located outside the RRA are expected to maintain their vulnerability to RSLC.

6.2.9 Aviation

Alternative 1: No Action Alternative (Future Without-Project Condition)

Under Alternative 1, in which no action is undertaken (i.e., the future without-project condition), much of the aviation infrastructure in the Study Area would remain exposed to coastal flood risk. LGA is a notable exception, as recently completed CSRM projects at LGA is expected to provide CSRM benefits in the future without-project condition. The remaining major airports (JFK, EWR), as well as the regional airports and heliports in the region are likely to remain exposed to coastal flood risk, which is expected to become increasingly more frequent and severe with expected RSLC.

Alternative 3B: Tentatively Selected Plan

The TSP would provide significant benefits to aviation infrastructure and assets located within the Study Area. The value of protecting infrastructure assets and avoiding the consequences of direct damage to the major airports in the Study Area is currently considered in the economic analysis, though the value of indirect benefits (e.g., avoiding socioeconomic costs and revenue losses associated with coastal flood-related shutdowns) is not included in the economic analysis at this time. Risk management benefits for regional airports and heliports are not included in the economic analysis at this time.

Major Airports

Only two of the three major airports in the Study Area are expected to benefit from the CSRM provided under the TSP. LaGuardia Airport would not gain any additional CSRM under the TSP, though it would benefit in the future from CSRM measures already implemented by PANYNJ. Between the shore-based measures and storm surge barrier proposed for the Jamaica Bay Region, the TSP is expected to provide significant CSRM for JFK International Airport. Similarly, the shore-based measures and storm surge barriers on Arthur Kill and Kill Van Kull in the Upper Bay/Arthur Kill region would provide effective CSRM for Newark Liberty International Airport. While the CSRM provided by the TSP would result in significant benefits to PANYNJ, the avoidance of coastal flood-related shutdowns and resultant delays for passengers and cargo also represents significant indirect regional and national economic benefit.

Regional Airports and Heliports

The shore-based measures and storm surge barriers on Arthur Kill and Kill Van Kull would also provide CSRM benefits to the regional airports in the Study Area, Linden Municipal Airport and Teterboro Airport. Similarly, the Little Ferry Seaplane Base and heliports within the Hackensack/Passaic Region would also benefit from these shore-based measures and storm surge barriers. Teterboro Airport would also benefit from more frequent operation of the Meadowlands tide gate proposed in the TSP. Benefits to these facilities are not considered in the economic analysis at this time. The New York Skyports Seaplane Base (located off 23rd Street on the East Side of Manhattan) would remain vulnerable in the TSP. Similarly, many of the coastally vulnerable heliports within the Study Area, particularly those in Manhattan, would remain vulnerable under the TSP. The Jamaica Bay storm surge barrier would provide protection to NYPD's aviation unit in Floyd Bennett Field. Coastally vulnerable heliports in adjacent regions (e.g., Palisades General Hospital Heliport, Haverstraw Heliport) would remain unprotected in the TSP.

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the TSP (Alternative 3B) on Aviation.

TSP Aviation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	0	0	0	0
O&M Assumptions	0	0	-2	3	0	3	0	0	3

The footprint and regular operation of measures proposed in the TSP have the potential to conflict with heliports in Manhattan and Jersey City (within the Lower Hudson/East River region) as they are on the outside of the planned shore-based measures and would likely have limited accessibility during construction and operation. Construction is not anticipated to significantly affect aviation infrastructure in the remaining regions during construction. Operation impacts in the Upper Bay/Arthur Kill and Jamaica Bay regions would be positive, as regular operation would result in a management of flood risk and related operational disruptions. The TSP would have no impact on aviation infrastructure in the Capital, Mid-Hudson, Lower Bay, Raritan, or Long Island Sound Regions.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Aviation.

ALT 2 Aviation Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	2	3	0	2	0	2	3

The footprint of the alignment proposed under Alternative 2 would not conflict with aviation infrastructure within the Study Area. In comparison with the TSP, Alternative 2 would also provide additional CSRM benefits for coastally adjacent heliports across all Planning Regions, with minimal impacts on operations. The New York Skyports Sea Plane base would also benefit from additional CSRM compared to the TSP. CSRM benefits for the remaining aviation assets would be the same as under the TSP, though LGA would also benefit from additional redundant CSRM.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3A on Aviation.

ALT 3A Aviation Impact Rating by Measure	**Capital District Region Measures**	**Mid-Hudson Region Measures**	**Lower Hudson/East River Region Measures**	**Upper Bay/Arthur Kill Region Measures**	**Lower Bay Region Measures**	**Hackensack/Passaic Region Measures**	**Raritan Region Measures**	**Long Island Sound Region Measures**	**Jamaica Bay Region Measures**
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	2	3	0	2	0	2	3

The footprint of the alignment proposed under Alternative 3A would not conflict with aviation infrastructure within the Study Area. Similar to Alternative 2, in comparison with the TSP, Alternative 3A would provide additional CSRM benefits for coastally adjacent heliports and the New York Skyports Sea Plane Base. CSRM benefits for the remaining aviation assets would be the same as under the TSP.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 4 on Aviation.

ALT 4 Aviation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	0	0	0	0
O&M Assumptions	0	0	-2	0	0	2	0	0	3

Similar to the TSP, the footprint and regular operation of measures proposed in Alternative 4 have the potential to conflict with heliports in Manhattan and Jersey City (within the Lower Hudson/East River region) as they are on the outside of the planned shore-based measures and would likely have limited accessibility during construction and operation. Compared to the TSP, Alternative 4 would provide a similar level of CSRM for aviation infrastructure in the Lower Hudson/East River, Jamacia Bay (JFK), and Hackensack/Passaic (Teterboro) regions, though would provide less protection to aviation infrastructure within the Lower Bay/Arthur Kill region. Notably, EWR and Linden Municipal Airport would not benefit from CSRM under Alternative 4.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 5 on Aviation.

ALT 5 Aviation Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	0	0	0	0
O&M Assumptions	0	0	-2	0	0	2	0	0	0

Similarly, to the TSP, the footprint and regular operation of measures proposed in Alternative 5 have the potential to conflict with heliports in Manhattan and Jersey City (within the Lower Hudson/East River region) as they are on the outside of the planned shore-based measures and would likely have limited accessibility during construction and operation. Alternative 5 would provide little to no CSRM benefits to aviation infrastructure in the Study Area because there are no measures proposed within the Upper Bay/Arthur Kill region, the

Hackensack/Passaic region, or the Jamaica Bay region within this alternative. JFK, EWR, Teterboro Airport, Linden Municipal Airport, the New York Skyports Sea Plane Base, and all coastally vulnerable heliports in the Study Area would not benefit from CSRM under Alternative 5.

6.2.10 Schools

Alternative 1: No-Action Alternative (Future Without-Project Condition)

There are 3,309 public and 871 private schools in the Study Area according to the 2020-2021 Common Core of Data created by the National Center for Education Statistics' (NCES) Education Demographic and Geographic Estimates (EDGE) program. Under the future without-project condition, it is expected that many schools and childcare centers in the Study Area will continue to face coastal flooding during major storm events. After Hurricane Sandy, damage to schools lead not only to structural damage to school buildings but to major disruptions in education which could have long term effects on student development and performance. Not only would there be an interruption in education services if a school is forced to close, while repairs are done, students would be forced to go to another school causing stress from large classroom size, new environments. Furthermore, students with disabilities could be displaced from their regular school placements during the emergency situation and the new school may not be able to meet all of the student’s individualized education program (IEP) recommendations. This could cause long term stress and negative educational impacts on students as well as their families.

School closures not only affect student well-being but for younger children, their parents may need to take time out of work to stay home with their children or to bring them to a different district. This could cause economic hardship.

Alternative 3B: Tentatively Selected Plan

Alternative 3B is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3B on Schools.

TSP Schools Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	2	1	0	0	0	0	1

Schools are more densely packed in the Lower Hudson/East River Region and the Long Island Sound Regions. Schools in these areas are also surrounded by the Federal Emergency Management Agency 1% Floodplain and are vulnerable to flood damage from storm surge and hurricanes. The Lower Hudson/East River Region would have flood mitigation measures under Alternative 3B that would mitigate flood risk to 118 Manhattan public schools below the W34th St. Floodwall. There is also a series of seawalls and elevated promenades that runs along the western side of Manhattan and would benefit schools from E88 to W165. There are over 20 schools in the 1%Floodplain that would be behind these measures. There would also be floodwalls and seawalls on the western side of Queens and northern Brooklyn under this alternative, however there are only two schools in that area. The largest storm surge barrier managed risk area of the Lower Hudson Region is around the Jersey City area, however there are only 14 public schools in the managed risk area of this region. There are four public schools in the storm surge barrier managed risk area of Red Hook, Brooklyn in the Arthur Kill Region and no schools in the Risk Reduction Feature risk managed area under this alternative. Schools in The Rockaways, Coney Island and Brighton Beach would benefit under this alternative from reinforced dunes, seawalls and floodwalls.

Alternative 2

Alternative 2 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 2 on Schools.

ALT 2 Schools Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	1	1	2	0	0	1	2

Alternative 2 has a greater focus on Jamaica Bay and Lower Bay Regions than Alternative 3B. There is 131 public schools and 37 private schools in the Lower Bay Region that could benefit from this alternative as they would lie behind a storm surge barrier There are 509 public and 166 private schools in the Jamaica Bay region. Under Alternative 2 there would be a reinforced dune that would protect the 23 schools currently in the FEMA 1% floodplain in the Rockaways. Most schools in this region are not in the floodplain but would be protected by Alternative 2 storm surge barrier from Rockaway Point to Sandy Hook.

Alternative 3A

Alternative 3A is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 3A on Schools.

ALT 3A Schools Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	0	0	0	0	0	0	0
O&M Assumptions	0	0	1	2	2	2	0	1	2

Alternative 3A would provide similar measures to the Rockaways, Lower Manhattan, and Staten Island as Alternative 2. Alternative 3A would provide greater benefits to the Passaic Region than Alt 2 or 3B, however, in that region there is a low concentration of schools in the floodplain and no schools in the reduced risk area.

Alternative 4

Alternative 4 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 4 on Schools.

ALT 4 Schools Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-1	0	0	0	0	0	-1
O&M Assumptions	0	0	2	1	0	1	0	1	2

Alternative 4 provides benefits primarily to the Jamaica Bay, Upper Bay, Lower Hudson and Hackensack/Passaic Regions. Unlike Alternatives 2 and 3A, there is no CSRM features to the Lower Bay Region, this leaves many schools vulnerable to flood damage. As in Alternative 3A, the protection measures for the Hackensack/Passaic region do not impact schools as much as other structures. However, in this alternative most of the floodplain in the Jamaica Bay Region benefits which includes over 80 schools in the floodplain in Brooklyn and Queens.

Alternative 5

Alternative 5 is anticipated to have the following impacts associated with the construction footprint and operations and maintenances assumptions:

Summary of Construction Footprint and Operations and Maintenance Impacts Associated with the Alternative 5 on Schools.

ALT 5 Schools Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	1	0	-1	0	0	0	0
O&M Assumptions	0	0	2	0	0	0	0	0	0

Alternative 5 measures are located in the Lower Hudson/East River and the Hackensack/Passaic Region. Benefits in the Lower Hudson Region are similar to those in Alternative 3B to Lower Manhattan but without the floodwall on the eastern side of the island. Although there would be a similar size floodwall on the Eastern side of Upper Manhattan, like in Alternative 3B, however there are few schools that would be behind this floodwall as it doesn't extend as far south as the wall in Alternative 3B which would benefit over 20 schools in the floodplain between E88 and E125th st. Alternatively, there are only two schools in the FEMA 1% Floodplain that would be behind the floodwall in Alternative 5. There are no schools directly in the risk management area of Hackensack/Passaic Region. Schools in the Jamaica Bay, Lower Bay and Long Island Sound Regions would not receive benefits under Alternative 5 measures, many of which are in the FEMA 1% Floodplain and are vulnerable to flood damage. Schools in Jersey City would receive the same benefits under Alternative 5 as in Alternative 4 and 3B.

6.2.11 Aesthetics

The measures included in the alternative plans could disrupt or enhance existing viewscapes, depending on location and scale. Construction of structural measures may affect scenic byways, diminish or lose existing residential views, and/or obstruct access to historic coastal sites (USACE 2019). Aesthetic valuation, a judgement of value based on appearance of an object and emotional responses, of the public is described in this Section, but was not used to determine aesthetic impact rating.

Aerial photographs and field observations were analyzed for each Planning Region of visual effect, that will later be considered in determining the build alternative. This includes project visibility and viewsheds from neighbors and travelers as well the influence of topography, vegetation, and structures. An inventory of existing landscape character, viewers and visual quality is the baseline for this documentation. Characterization of visual quality of landscape compositions based on intrinsic characteristics of natural, and existing roadway features; stakeholder values, public interest, real estate and scenic designations may be altered by the implementation of the proposed structural measures but will greatly manage the impact from coastal storms. Generally, implementing the alternatives could provide direct benefits by reducing the severity of damage to coastal sites and residences.

In support of the aesthetic viewshed analysis, USACE undertook a preliminary identification of known cultural resources that could be visually affected by the project in accordance with the New Jersey Historic Preservation Office's (2004) Guidelines for the Preparation of Cultural Resource Management Archaeological Reports; New York Archeological Council's (NYAC) Standards for Cultural Resources Investigations and the Curation of Archeological Collections in New York State; New York State Office of Parks, Recreation, and Historic Preservation's (2005) State, Historic Preservation Office Phase I Archaeological Report Format Requirements; and the Secretary of the Interior's Standards and Guidelines for Archaeological Documentation (48FR44734-37), and the USACE NYNJHATS OSE Report (2022). Visual analysis, as a component of the NEPA and Section 106 analyses, includes a broad look at the potential impacts to historic properties. By definition, a visual effect occurs whenever a proposed undertaking will be visible from an historic property. The mere existence of a visual effect does not automatically imply that the effect is adverse. An adverse visual effect occurs only when the addition of a new element to a landscape is found to diminish those aspects of a property's significance and integrity, such as its historic setting, which make it eligible for the State and National Registers of Historic Places (S/NRHPs).

Adverse visual effects are generally of two types, aesthetic or obstructive. An adverse aesthetic effect transpires when an undertaking's visual effect has a negative impact upon the perceived beauty or artistic values of an historic structure or landscape, thereby diminishing the appreciation, experience, or understanding of the resource. Common examples of adverse aesthetic impacts include the diminution or elimination of open space, or the introduction of a visual element that is incompatible, out of scale, in great contrast, or out of character with the historic resource or its associated setting. An adverse obstructive effect occurs when the proposed undertaking blocks any part of an historic property or eliminates scenic views historically visible from the property.

In keeping with USACE guidance, the APE for visual impacts on historic properties for the project cultural resource study is defined as those areas within one mile of proposed facilities which are within the potential viewshed (based on topography) of each alternative. NYSDEC defines Visual Impact as:

*when the mitigating effects of perspective do not reduce the visibility of an object to insignificant levels. Beauty plays no role in this concept. A visual impact may also be considered in the context of contrast. For instance, all other things being equal, a blue object seen against an orange background has greater visual impact than a blue object seen against the same colored blue background. Again, beauty plays no role in this concep*t [NYSDEC 2000:10-11].

Background research for the project included a review of existing cultural resource reports, management plans, archaeological site files, historic maps, and nominations to the National Register of Historic Places (NRHP). The analysis takes into consideration the resource's geographical distance and the effect of topography on whether the Alternative is visible from historic resources. A visibility analysis that takes the built environment and vegetation into account are beyond the scope of the Tier 1 Study. Additional discussion and evaluation of the visual impacts from each Alternative is available in the Cultural Resource Appendix.

Alternative 1: No Action Alternative (Future Without-Project Condition)

The No Action Alternative would involve no action as a result of this Study. Because factors associated with climate change will persist an increase in the frequency and strength of storms, the risk of coastal inundation will rise and over time, the natural morphological processes of erosion and siltation will occur (USACE 2019). Under the no action alternative, erosion, subsidence, and flooding in the Study Area are anticipated to continue to occur and will have an adverse impact on coastal viewsheds. Alternative 1 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Recreation and Natural Areas. Loss of coastal views and permanent changes to aesthetics can be observed by loss of recreational habitat. In sediment-starved wetland areas where accretion cannot keep pace with effects from coastal storms, wetland losses can be expected as wetlands convert to open water. Loss of wetlands can drastically change the landscape, reduce recreational area (birding, hiking), and visually alter the estuarine and coastal habitat in the Study Area.

Alternative 3B: Tentatively Selected Plan

Alternative 3B includes eight storm surge barriers with which have multiple gates that remain open in no-storm conditions to allow for navigation and tidal exchange. Alternative 3B is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Table 1: Summary of construction footprint and operations and maintenance impacts associated with Alternative 3B on Aesthetics.

TSP Aesthetics Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-2	-2	-2	-2	-2	-2	-3
O&M Assumptions	0	0	0	0	0	0	0	0	-1

Natural and Recreational Areas. The construction of these gates would have direct permanent impacts to estuarine wetlands on the Rockaway peninsula and around Gerritsen Creek and a small riverine section in Pierson Park, in Tarrytown, NY. There would also be possible impacts to freshwater emergent wetlands in Jersey City, freshwater forested/shrub wetlands in Pelham Bay Park, estuarine wetlands along Flushing Bay, in Pelham Bay Park in Stony Point, New York and several freshwater ponds in Stony Point, New York.

Existing Shoreline and Infrastructure. This alternative has the potential for adverse effects to historic properties within the Gateway National Recreation Area, the Pelham Bay Park Historic District, the Greenpoint Historic District, the Gowanus Canal Historic District and other historic properties. Alternative 3B is likely to have aesthetic impacts associated with a changed viewscape and some coastal views may be impacted, diminished, or lost due to the construction of this alternative.

Measures proposed for Alternative 3B will involve the construction of structures that have a potential to indirectly affect historic properties, most prominently by altering the visible environment (i.e., setting) of those resources. For this Study, the visual impact Study Area (Indirect APE) includes those places within one mile (1.6 km) of proposed facilities for the alternative that are in the potential viewshed (based on topography). The total area within one mile of Alternative 3B is 189.4 sq miles (490.5 sq km), within which project measures are potentially visible from 130.2 sq miles (337.2 sq km). This Visual Impact Area, or Zone of Visual Influence (ZVI), encompasses parts of northeast New Jersey, all New York City counties, and northwest Nassau County on Long Island. As of this writing, spatial data is available only for resources in New York, so this preliminary visual impact analysis for Alternative 3B only addresses historic properties in the New York ZVI. The largest ZVI Study Area occurs in New York.

Preliminary Viewshed Analysis: New York. Of the two states where Alternative 3B measures will be constructed, the largest visual effect will be in New York. The total area within one mile of Alternative 3A structures in New York is 127.7 sq miles (330.7 sq km), 67.4 percent of the total area within a mile in both states. Within that area in New York, alternative structures will be potentially visible from 100.7 sq miles (260.8 sq km), 78.8 percent of the total area within a mile of the project in New York. According to the NYSHPO data, this area where the alternative will potentially be visible contains: 12,302 NR-listed aboveground individual properties; 51 NR-listed historic districts; 3,316 NR-eligible aboveground individual properties; 47 NR-eligible districts; and 11 cemeteries (Table 57).

Table 57: Summary of historic properties in New York within one mile of TSP.
Historic properties within that area from which project structures will potentially be visible.

Historic property type	Total within one mile	Total in topographic viewshed within one mile
NR-listed individual building	14,843	12,302
NR-listed historic district	56	51
NR-eligible individual building	4,157	3,316
NR-eligible historic district	50	47
Cemetery	20	11

Preliminary Viewshed Analysis: New Jersey. The total area within one mile of Alternative 3B measures in New Jersey is 61.7 sq miles (159.8 sq km), 32.6 percent of the total area within a mile in both project states. In the New Jersey area, Alternative 3B structures will potentially be visible from 29.5 sq miles (76.4 sq km), 47.8 percent of the total terrain within a mile of the project in that state. A preliminary visual impact analysis of historic properties in New Jersey is not presented in this Tier I Draft EIS because cultural resources spatial data from the state unavailable as of this writing. The New Jersey visual impact analysis is anticipated to be included in the next phase of cultural resources and environmental investigations for the Study.

Alternative 2

Alternative 2 contains the Sandy-Hook Breezy Point storm surge barrier, which is the largest under consideration with a potential length of over 30 miles (including shore-based measures tying into high ground). The construction of the storm surge barrier, which would have multiple gates, and could act as new visual “landmark,” would have direct impacts to estuarine wetlands on Sandy Hook, Rockaway peninsulas, Throgs Neck peninsula and estuarine and freshwater forested/shrub wetlands in Pelham Bay Park. Alternative 2 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 2 on Aesthetics.

ALT 2 Aesthetics Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-2	-2	-3	-2	-2	-2	-3
O&M Assumptions	0	0	-1	-1	-2	-1	-1	-1	-2

Natural and Recreational Areas. Loss of estuarine wetlands in these areas will have adverse impacts on the coastal viewsheds and affect recreational opportunities in Important Bird Areas in Jamaica Bay, Pelham Bay Park and Sandy Hook/Gateway National Recreation Area (Audubon 2007). This Alternative would require coordination with the New York State Office of Parks, Recreation and Historic Preservation, Department of Interior and the Advisory Council on Historic Preservation due to the high probability of altering viewscape of historic monuments. Any construction on NPS lands by other entities, including other Federal agencies, would require NPS agreement and acceptability. Alternative 2 is likely to have aesthetic impacts associated with a changed viewscape and some coastal views may be impacted, diminished or lost due to the construction of this alternative (USACE 2019).

Existing Shoreline and Infrastructure. Measures proposed for Alternative 2 will involve the construction of structures that have a potential to indirectly affect historic properties, most prominently by altering the visible environment (i.e., setting) of those resources. For this Study, the visual impact Study Area (Indirect APE) includes those places within one mile (1.6 km) of proposed facilities for Alternative 2 that are in the potential viewshed (based on topography) . The total area within one mile of Alternative 2 is 268.13 sq miles (694.5 sq km), within which project measures are potentially visible from 189.29 sq miles (490.3 sq km). This Visual Impact Area, or Zone of Visual Influence (ZVI), encompasses parts of northeast New Jersey, all New York City counties, and northwest Nassau County on Long Island. As of this writing, spatial data is available only for resources in New York, so this preliminary visual impact analysis for Alternative 2 only addresses historic properties in the New York ZVI. The largest ZVI Study Area occurs in New York.

Preliminary Viewshed Analysis: New York. Of the two states where Alternative 2 measures will be constructed, the largest visual effect will be in New York. The total area within one mile of Alternative 2 structures in New York is 165.87 sq miles (729.6 sq km), 61.9 percent of the total area within a mile in both states. Within that area in New York, alternative structures will be potentially visible from 126.5 sq miles (327.6 sq km), 76.2 percent of the total area within a mile of the project in New York. According to the NYSHPO data, this area where the alternative will potentially be visible contains: 8,193 NR-listed aboveground individual properties; 47 NR-listed historic districts; 2,280 NR-eligible aboveground individual properties; 48 NR-eligible districts; and 12 cemeteries (Table 58).

Table 58: Summary of historic properties in New York within one mile of Alternative 2 structures, and the total historic properties within that area from which project structures will potentially be visible

Historic property type	Total within one mile	Total in topographic viewshed within one mile

NR-listed individual building	11,948	8,193
NR-listed historic district	50	47
NR-eligible individual building	3,715	2,280
NR-eligible historic district	51	48
Cemetery	22	12

Note: After data from the NYSHPO.

Preliminary Viewshed Analysis: New Jersey. The total area within one mile of Alternative 2 measures in New Jersey is 102.3 sq miles (265 sq km), 38.1 percent of the total area within a mile in both project states. In the New Jersey area, Alternative 2 structures will potentially be visible from 62.8 sq miles (162.7 sq km), 61.4 percent of the total terrain within a mile of the project in that state. A preliminary visual impact analysis of historic properties in New Jersey is not presented in this Tier I Draft EIS because cultural resources spatial data from the state unavailable as of this writing. The New Jersey visual impact analysis is anticipated to be included in the next phase of cultural resources and environmental investigations for the NYNJHAT Study.

Alternative 3A

Alternative 3A includes five storm surge barriers, which will have multiple gates that remain open in non-storm conditions to allow for navigation and tidal exchange. Alternative 3A is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 3A on Aesthetics.

ALT 3A Aesthetics Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-2	-2	-2	-2	-2	-2	-3
O&M Assumptions	0	0	-1	-1	-1	0	0	-1	-1

Natural and Recreational Areas. This would permanently replace the open bottom habitat with a hard structure. This modification would have direct permanent impacts to estuarine wetlands on the Rockaway peninsula and Gerritsen Creek. There may also be impacts to estuarine wetlands on the Throgs Neck peninsula and estuarine and freshwater forested/shrub wetlands in Pelham Bay Park. Furthermore, these changes may affect Import Bird Areas and may affect viewscapes for recreationists.

Existing Shoreline and Infrastructure. This Alternative could impact current historic viewsheds and would require coordination with New York State Office of Park, Recreation and Historic Preservation, the Department of Interior and the Advisory Council on Historic Preservation. Alternative 3A is likely to have aesthetics associated with a changed viewscape and some coastal views may be impacted, diminished or lost due to the construction of this alternative.

Measures proposed for Alternative 3A will involve the construction of structures that have a potential to indirectly affect historic properties, most prominently by altering the visible environment (i.e., setting) of those resources. For this Study, the visual impact Study Area (Indirect APE) includes those places within one mile (1.6 km) of proposed facilities for the alternative that are in the potential viewshed (based on topography). The total area within one mile of Alternative 3A is 293.2 sq miles (759.4 sq km), within which project measures are potentially visible from 208.63 sq miles (540.3 sq km). This Visual Impact Area, or Zone of Visual Influence (ZVI), encompasses parts of northeast New Jersey, all New York City counties, and northwest Nassau County on Long Island. As of this writing, spatial data is available only for resources in New York, so this preliminary visual impact analysis for Alternative 3A only addresses historic properties in the New York ZVI. The largest ZVI Study Area occurs in New York.

Preliminary Viewshed Analysis: New York. Of the two states where Alternative 3A measures will be constructed, the largest visual effect will be in New York. The total area within one mile of Alternative 3A structures in New York is 195.13 sq miles (505.4 sq km), 66.6 percent of the total area within a mile in both states. Within that area in New York, alternative structures will be potentially visible from 152.26 sq miles (394.4 sq km), 78 percent of the total area within a mile of the project in New York. According to the NYSHPO data, this area where the alternative will potentially be visible contains: 9,016 NR-listed aboveground individual properties; 48 NR-listed historic districts; 2,459 NR-eligible aboveground individual properties; 51 NR-eligible districts; and 12 cemeteries (Table 59.

Table 59: Summary of historic properties in New York within one mile of Alternative 3A structures, and the total historic properties within that area from which project structures will potentially be visible

Historic property type	Total within one mile	Total in topographic viewshed within one mile
NR-listed individual building	12,046	9,016
NR-listed historic district	51	48
NR-eligible individual building	3,862	2,459
NR-eligible historic district	54	51
Cemetery	25	12

Note: After data from the NYSHPO.

Preliminary Viewshed Analysis: New Jersey. The total area within one mile of Alternative 3A measures in New Jersey is 98.1 sq miles (254.1 sq km), 33.4 percent of the total area within a mile in both project states. In the New Jersey area, Alternative 3A structures will potentially be visible from 56.4 sq miles (146.1 sq km), 57.5 percent of the total terrain within a mile of the project in that state. A preliminary visual impact analysis of historic properties in New Jersey is not presented in this Tier I Draft EIS because cultural resources spatial data from the state unavailable as of this writing. The New Jersey impact analysis is anticipated to be included in the next phase of cultural resources and environmental investigations for the NYNJHAT Study.

Alternative 4

Alternative 4 includes seven storm surge barriers which have multiple gates that remain open in non-storm conditions to allow for navigation and tidal exchange. Alternative 4 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 4 on Aesthetics.

ALT 4 Aesthetics Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-2	-2	-2	-2	-2	-2	-3
O&M Assumptions	0	0	0	0	-1	0	-1	-1	-2

Natural and Recreational Areas. Loss of coastal views and permanent changes to aesthetics can be observed by loss of recreational habitat. In sediment-starved wetland areas where accretion cannot keep pace with effects from coastal storms, wetland losses can be expected as wetlands convert to open water. Loss of wetlands can drastically change the landscape, reduce recreational area (birding, hiking), and visually alter the estuarine and coastal habitat in the Study Area.

Existing Shoreline and Infrastructure. Measures proposed for Alternative 4 will involve the construction of structures that have a potential to indirectly affect historic properties, most prominently by altering the visible environment (i.e., setting) of those resources within the Gateway National Recreation Area, the Pelham Bay Park Historic District, the Greenpoint Historic District, the Gowanus Canal Historic District. Several measures are within the Hudson River Valley National Heritage Area, consisting of heritage sites along the Hudson River in partnership with the NPS to interpret and preserve cultural and natural resources along the Hudson River Valley. . For this Study, the visual impact Study Area (Indirect APE) includes those places within one mile (1.6 km) of proposed facilities for the alternative that are in the potential viewshed (based on topography). The total area within one mile of Alternative 4 is 181.9 sq miles (471.1 sq km), within which project measures are potentially visible from 144.7 sq miles (374.8 sq km). This Visual Impact Area, or Zone of Visual Influence (ZVI), encompasses parts of northeast New Jersey, all New York City counties, and northwest Nassau County on Long Island. As of this writing, spatial data is available only for resources in New York, so this preliminary visual impact analysis for Alternative 4 only addresses historic properties in the New York ZVI. The largest ZVI Study Area occurs in New York. Alternative 4 is likely to have aesthetic impacts associated with a changed viewscape and some coastal views may be impacted, diminished or lost due to the construction of this alternative

Preliminary Viewshed Analysis: New York. Of the two states where Alternative 4 measures will be constructed, the largest visual effect will be in New York. The total area within one mile of Alternative 4 structures in New York is 115.4 sq miles (298.9 sq km), 63.4 percent of the total area within a mile in both states. Within that area in New York, alternative structures will be potentially visible from 98.8 sq miles (255.9 sq km), 85.6 percent of the total area within a mile of the project in New York. According to the NYSHPO data, this area where the alternative will potentially be visible contains: 12,085 NR-listed aboveground individual properties; 51 NR-listed historic districts; 3,005 NR-eligible aboveground individual properties; 46 NR-eligible districts; and 14 cemeteries (Table 60).

Table 60: Summary of historic properties in New York within one mile of Alternative 4 structures, and the total historic properties within that area from which project structures will potentially be visible

Historic property type	Total within one mile	Total in topographic viewshed within one mile
NR-listed individual building	14,242	12,085
NR-listed historic district	51	51
NR-eligible individual building	3,518	3,005
NR-eligible historic district	47	46
Cemetery	19	14

Note: After data from the NYSHPO.

Preliminary Viewshed Analysis: New Jersey. The total area within one mile of Alternative 4 measures in New Jersey is 66.5 sq miles (172.2 sq km), 36.6 percent of the total area within a mile in both project states. In the New Jersey area, Alternative 4 structures will potentially be visible from 45.95 sq miles (119 sq km), 69.1 percent of the total terrain within a mile of the project in that state. A preliminary visual impact analysis of historic properties in New Jersey is not presented in this Tier I Draft EIS because cultural resources spatial data from the state unavailable as of this writing. The New Jersey visual impact analysis is anticipated to be included in the next phase of cultural resources and environmental investigations for the NYNJHAT Study.

Alternative 5

Because Alternative 5 contains only shore-based measure's, no effects on water elevations are expected. Alternative 5 includes floodwalls along the coast to manage the risk of storm surge as well as frequent flooding. Thus, Alternative 5 could have significant adverse impacts to aesthetics, particularly viewscape. Aesthetic impacts may also impact real estate values for coastal properties where existing views would be diminished or lost. Alternative 5 is anticipated to have the following impacts associated with the construction footprint and expected operations and maintenance activities:

Summary of construction footprint and operations and maintenance impacts associated with Alternative 5 on Aesthetics.

ALT 5 Aesthetics Impact Rating by Measure	Capital District Region Measures	Mid-Hudson Region Measures	Lower Hudson/East River Region Measures	Upper Bay/Arthur Kill Region Measures	Lower Bay Region Measures	Hackensack/Passaic Region Measures	Raritan Region Measures	Long Island Sound Region Measures	Jamaica Bay Region Measures
Construction/Footprint	0	0	-2	-2	-3	-2	-2	0	0
O&M Assumptions	0	0	0	0	0	0	0	0	0

Natural and Recreational Areas. There may be direct permanent or temporary impacts to freshwater emergent wetlands in Jersey City, as well as estuarine wetlands and several freshwater ponds in Stony Point. Within in the Hackensack Meadowlands there may be direct permanent or temporary impacts to estuarine wetlands, freshwater emergent wetlands, freshwater forested/shrub wetlands, and riverine areas.

Existing Shoreline and Infrastructure. Measures proposed for Alternative 5 will involve the construction of structures that have a potential to indirectly affect historic properties, most prominently by altering the visible environment (i.e., setting) of those resources which includes the Holland Tunnel National Historic Landmark, Castle Clinton National Monument, the Hudson River bulkhead, and other historic properties. For this Study, the visual impact Study Area (Indirect APE) includes those places within one mile (1.6 km) of proposed facilities for the alternative that are in the potential viewshed (based on topography). The total area within one mile of Alternative 5 is 49.4 sq miles (127.9 sq km), within which project measures are potentially visible from 144.7 sq miles (35.4 sq km). This Visual Impact Area, or Zone of Visual Influence (ZVI), encompasses parts of northeast New Jersey, all New York City counties, and northwest Nassau County on Long Island. As of this writing, spatial data is available only for resources in New York, so this preliminary visual impact analysis for Alternative 4 only addresses historic properties in the New York ZVI. The largest ZVI Study Area occurs in New York. Alternative 5 is likely to have aesthetic impacts associated with a changed viewscape and some coastal views may be impacted, diminished or lost due to the construction of this alternative.

Preliminary Viewshed Analysis: New York. The visual effect of Alternative 5 measures will be roughly equivalent in New York and New Jersey. The measures will be visible across a larger area in New Jersey, but across a larger portion of the area within a mile of measures in New York. The total area within one mile of Alternative 5 structures in New York is 22.1 sq miles (57.2 sq km), 44.7 percent of the total area within a mile in both states. Within that area in New York, alternative structures will be potentially visible from 16.7 sq miles (43.3 sq km), 75.5 percent of the total area within a mile of the project in New York. According to the NYSHPO data, this area where the alternative will potentially be visible contains: 8,382 NR-listed aboveground individual properties; 33 NR-listed historic districts; 2,096 NR-eligible aboveground individual properties; 21 NR-eligible districts; and six cemeteries (Table 61).

Table 61: Summary of historic properties in New York within one mile of Alternative 5 structures.
The total historic properties within that area from which project structures will potentially be visible.

Historic property type	Total within one mile	Total in topographic viewshed within one mile
NR-listed individual building	10,900	8,382
NR-listed historic district	34	33
NR-eligible individual building	2,523	2,096
NR-eligible historic district	21	21
Cemetery	9	6

Note: After data from the NYSHPO.

Preliminary Viewshed Analysis: New Jersey. The total area within one mile of Alternative 5 measures in New Jersey is 27.3 sq miles (70.7 sq km), 53.3 percent of the total area within a mile in both project states. In the New Jersey area, Alternative 5 structures will potentially be visible from 18.7 sq miles (48.4 sq km), 68.4 percent of the total terrain within a mile of the project in that state. A preliminary visual impact analysis of historic properties in New Jersey is not presented in this Tier I Draft EIS because cultural resources spatial data from the state unavailable as of this analysis and is anticipated to be included in the next phase of cultural resources and environmental investigations for the NYNJHAT Study.

6.3 CUMULATIVE IMPACTS*

Cumulative effects are defined for NEPA as "the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." These impacts represent the cumulative effects that can result from individually minor but collectively significant actions taking place over time in a particular habitat.

Sources of human-induced mortality, injury, harassment of wildlife, and changes to the natural environment in the Study Area that are reasonably certain to occur in the future include interactions in state-regulated and recreational fishing activities, vessel collisions, ingestion of plastic debris, pollution, deforestation, coastal development, global climate change, and catastrophic events. The full magnitude of these consequences is not completely known. However, best information available was utilized in the assessment of cumulative effects.

For this Tier 1 impact assessment, the following cumulative impacts were considered:

State Water Fisheries

This Section describes state water fisheries for those species that are applicable. Impacts to sea turtles, shortnose sturgeon, and Atlantic sturgeon are discussed below.

Fishing activities are considered one of the most significant causes of serious injury or death for sea turtles. Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). Fishing gear in state waters, including bottom trawls, gillnets, trap/pot gear, and pound nets, interacts with sea turtles each year. NMFS is working with state agencies to address the bycatch of sea turtles in state water fisheries within the action area of this consultation where information exists to show that these fisheries capture sea turtles. Action has been taken by some states to reduce or remove the likelihood of sea turtle bycatch and/or the likelihood of serious injury or mortality in one or more gear types. However, given that state managed commercial and recreational fisheries along the U.S. Atlantic coast are reasonably certain to occur within the action area in the foreseeable future, additional interactions of sea turtles with these fisheries are anticipated. There is insufficient information to quantify the number of sea turtle interactions with state water fisheries as well as the number of sea turtles injured or killed as a result of these interactions. While actions have been taken to reduce sea turtle bycatch in some state water fisheries, the overall effect of these actions is not fully known, and the future effects of state water fisheries on sea turtles are presently difficult to quantify due to data and monitoring limitations.

Information on interactions with shortnose and Atlantic sturgeon with state fisheries operating in the action area is not available, and it is not clear to what extent these future activities will affect listed species differently than the current activities.

Habitat Loss

Loss of habitat by conversion of forests, grassland and coastal habitats to commercial, residential, and industrial development has contributed to species loss. Future development and habitat loss is expected to occur and effect the listed species over the temporal scale of the NYNJ HAT Study (i.e., over the next 50 years).

The listed bat species depend upon trees for roosting within the native range (USFWS 2022b) and future development could contribute to habitat loss within the Study Area. The northern long-eared bat is sometimes found in structures such as buildings, barns, sheds, under eaves, so it is possible these bats would utilize man-made structures if trees were not available. Bats could possibly leave their existing habitat in search of other wooded or forested locations as future development continues.

Shoreline development will inevitably impact shorebirds that utilize marshes and beach habitat for nesting, breeding, and foraging each year. Impacts are unpredictable and depend upon habitat protections and future development along beachfronts in the Study Area.

Monarch butterfly populations have declined due to habitat loss over the past two decades (Federal Register 2020) and future development in meadows or fields where wildflowers and milkweed grow could continue to impact the species. Milkweed is the sole food source for monarch butterfly larvae and reproduction is dependent on its presence in the spring and summer northern habitats. Monarch butterflies also utilize habitat along coastal beaches with dunes and future development along beaches could impact the species (NYSDEC 2022b). Seabeach amaranth is a flowering plant that occurs on barrier islands, inlets and over wash areas (Federal Register 1990) that could also be impacted by coastal development. Beach slope is a critical factor for the growth of seabeach amaranth and changes to existing slopes could degrade or reduce the habitat available to the species.

Vessel Interactions

NMFS's Sea Turtle Stranding and Salvage Network (STSSN) data indicate that vessel interactions are responsible for a number of sea turtle strandings within the action area each year. In the U.S. Atlantic from 1997-2005, 14.9% of all stranded loggerheads were documented as having sustained some type of propeller or collision injuries (NMFS and USFWS 2007). The incidence of propeller wounds rose from approximately 10% in the late 1980s to a record high of 20.5% in 2004 (STSSN database). Such collisions are reasonably certain to continue. Collisions with boats can stun, injure, or kill sea turtles, and many live-captured and stranded sea turtles have obvious propeller or collision marks (Dwyer *et al.* 2003). However, it is not always clear whether the collision occurred pre-or postmortem. NMFS believes that vessel interactions with sea turtles will continue in the future.

An estimate of the number of sea turtles that will likely be killed by vessels is not available at this time. Similarly, the risk that vessel operations in the action area pose to Atlantic sturgeon cannot be assessed. While vessel strikes have been documented in several rivers, the extent that interactions occur in the marine environment is not fully known.

Pollution and Contaminants

Human activities in the action area causing pollution are reasonably certain to continue in the future, as are impacts from them on birds, mammals, insects, plants, fish, and sea turtles. However, the level of impacts cannot be projected. Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contamination may have effects on listed species' reproduction and survival. The extent of these effects is dependent upon the type of contaminant and the chemical concentration in a given habitat.

Excessive turbidity due to coastal development and/or construction sites could influence the foraging ability of many animals that utilize the aquatic environment (*e.g.,* birds, fish, mammals, reptiles). Marine debris (*e.g.*, discarded fishing line or lines from boats, plastics) also has the potential to entangle animals or to be consumed by them. For example, sea turtles, birds, and marine mammals commonly ingest plastic or mistake debris for food which sometimes leads to asphyxiation.

State NPDES Permits

Actions carried out or regulated within the action area also include the regulation of dredged material discharges through CWA Section 401-certification and point and non-point source pollution through the National Pollutant Discharge Elimination System. New York has been delegated authority to issue NPDES permits by the EPA. These permits authorize the discharge of pollutants in the action area. Permittees include municipalities for sewage treatment plants and other industrial users.

Global Climate Change

Global climate change is expected to continue and could impact a variety of species and habitats in the Study Area. Given the rate of change associated with climate impacts (i.e., on a decadal to century scale), it is likely that climate related impacts will influence the status of any listed species over the temporal scale of the NYNJ HAT Study (i.e., over the next 50 years) or that the abundance, distribution, or behavior of those species in the Study Area will significantly change as a result of climate change impacts.

There are numerous impacts associated with climate change and the effects within the Study Area are difficult to predict. Sea-level rise will continue to impact coastal habitats such as marshes, inlets, barrier islands, coastal meadows, and sand dunes which provide habitat for seabeach amaranth and the monarch butterfly. According to the NYS 2100 Commission Report (2013), RSLC in New York City and Long Island is projected to be as many as six feet within the next 90 years (USACE 2013). Coastal storms will cause flooding at increased heights and over larger areas than in the past as RSLCs. It is also projected that frequency and intensity of coastal storms will increase (NPCC 2013). As tropical storms continue to increase in severity, forested inland habitat that is utilized by ESA-listed species of bats in the Study Area will be impacted. Beach erosion is another concern and contributes to habitat loss for shorebirds that depend upon nesting locations each year. These impacts are unpredictable and will vary in severity over the temporal scale.

Seasonal restrictions and BMPs will be employed for all bird species to ensure that compliance with the ESA, MTBA and Bald and Golden Eagle Protection Act are achieved during construction and operation and maintenance of the NYNJ HAT Study.

Other Construction Projects in the Study Area

Other permitted and pending projects located within the Study Area have been authorized by permits issued under the USACE's Permits Program for the Clean Water Act Section 404 and Section 10 of the Rivers and Harbors Act of 1899. Some of these applicants have already completed some dredging; others have not begun or scheduled the work. Some examples of dredging projects in the NY/NJ Harbor include the Harbor Deepening Project, East Rockaway Inlet maintenance, Jamaica Bay Federal Navigation Channel maintenance, and maintenance of several other USACE navigation channel maintenance projects in the Harbor (USACE 2022). Other than the Port Authority and USACE projects, the permitted and pending work typically represents maintenance around pier areas and includes dredging, pier rehabilitation, and pier maintenance, rehabilitation of wave breaks, bridge abutment rehabilitation, and wharf reinforcements. Numerous sand and aggregate borrow areas also lie off the coasts of New Jersey and New York. These areas are dredged periodically and used for beach nourishment a nd CSRM. Some examples of other coastal stprojects include the Passaic River Tidal Protection Area, the Sea Bright to Manasquan Project, the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay project, and others.

In addition to dredging, beach nourishment, and navigation projects, several other in-water and restoration projects exist in the region. For example, the Hudson River Estuary Program includes the development of a habitat restoration plan and provides funding and planning assistance for restoration projects (USACE 2020a). Restoration efforts include the improvement of water quality and wetlands, as well as bird, shellfish, and other sensitive species habitat in the Port District of New York and New Jersey (USACE 2020a). Additional restoration projects in the region include the New York Rising Community Reconstruction Program, implemented in 2013 with over 3,000 projects across the state addressing critical infrastructure, drainage improvements, and shoreline protection (USACE 2020b). Environmental mitigation and restoration related to the Tappan Zee Bridge replacement project on the Hudson River include wetland restoration and management, oyster restoration, and stormwater treatment construction projects (USACE 2020b). In addition, the NYCDEP is undertaking large infrastructure improvement projects at several of its wastewater treatment facilities including at Wards Island in Manhattan and Coney Island in southern Brooklyn. The cumulative impact of these projects in improving overall water quality in the Harbor should represent a net benefit but would be evaluated in more detail and for specific waterbodies in the Tier 2 EIS.

Short-term cumulative impacts are related to Project activities and in-water construction associated with other permitted projects that are ongoing concurrently within the Harbor area. These short-term cumulative impacts would be a combination of disturbances associated with each project. Cumulative construction impacts are the combined effect on wildlife and the natural environment related to temporary effects such as increased turbidity, habitat disturbance, and/or discharge in the Study Area. Impacts related to construction would be minimized as practicable using BMPs.

Long-term cumulative impacts would be limited to localized changes in water column depth, bathymetric contours, hydrodynamics, and sedimentation rates, such as those potential impacts associated with the operation and maintenance of the existing or proposed deepened channels, any deepening or operations and maintenance proposed by private entities, and the berth deepening being proposed by the Port Authority of New York and New Jersey, as well as sand borrow and beach nourishment activities and other restoration projects ongoing or planned for the region. However, cumulative restoration activities related to habitat improvement or CSRM are expected to generate cumulative benefits to the Study Area by reducing water quality impacts from potential flooding and improve quality of habitats and wetlands.

Specifically, in response to cumulative impacts on fishes, mobile life stages are expected to find acceptable habitat elsewhere within the Harbor beyond the temporary and localized dredging plumes. Early life stages that are pelagic and planktonic will be carried through areas of dredging by tidal currents resulting in little effect on them. The life stages that would be most susceptible to the deepening dredging are demersal eggs and larvae. Eggs are demersal and adhesive for a short period following fertilization; larvae are largely passive drifters with limited capabilities to move within the water column. The magnitude of cumulative impacts from this and other projects would be directly related to work occurring in specific habitat and spawning grounds.

Other Storm Risk Management Projects in the Study Area

It is recognized that large parts of the NYNJHAT Study Area are highly developed. Over the course of the NYNJHAT Study, separate new projects and developments have been or may be planned, and may go into construction in the future. As described in Chapters 2 and 3, approximately 50 different planned and in-development storm risk management projects could potentially cumulatively impact the proposed NYNJHAT Study Area. For these separate CSRM related studies and projects, which have not been assumed to be in place as part of the NYNJHAT Study No Action Alternative, continued coordination will be needed to further refine and optimize the reaches and proposed alignments between those studies and projects and what may be advanced as part of the NYNJHAT Study. A brief list of key projects that will need further coordination is provided in this Section. It is recognized that this list will require review and updates in subsequence phases of the Study.

- NJDEP Rebuild by Design – Hudson River, NY
- NJDEP Rebuild by Design – Meadowlands, NJ
- NYC East Side Coastal Resiliency Project, NY
- NYC Lower Manhattan Coastal Resiliency Project, NY
- Port Monmouth Coastal Strom Risk Management Project, NJ
- South Shore of Staten Island Coastal Strom Risk Management Project, NY
- USACE Coney Island Coastal Storm Risk Reduction Project, NY

7 ENVIRONMENTAL COMPLIANCE*

Compliance with the following laws, regulations, and Executive Orders (Tables 35 and 36), as applicable, is required for environmental acceptability of the project alternatives, which includes but is not limited to the following:

Table 62: Regulatory compliance status.

Title of Law	U.S. Code	Compliance Status
Abandoned Shipwreck Act of 1987	43 United States Code (U.S.C.) 2101	In Progress
American Indian Religious Freedom Act of 1978	Public Law No. 95-341, 42 U.S.C. 1996	In Progress
Anadromous Fish Conservation Act of 1974	16 U.S.C. 757 a et seq.	In Progress
Archaeological and Historic Preservation Act of 1974	Public Law 93-291 and 16 U.S.C.469-469c	In Progress
Archaeological Resources Protection Act of 1979	16 U.S.C. 470aa–470mm	In Progress
Bald and Golden Eagle Protection Act of 1962, as amended	16 U.S.C. 668	In Progress
Clean Air Act of 1972, as amended	42 U.S.C. 7401 et seq.	In Progress
Clean Water Act of 1972, as amended	33 U.S.C. 1251 et seq.	In Progress
Coastal Barrier Resources Act of 1982	Public Law 114-314	In Progress
Coastal Zone Management Act of 1972, as amended	16 U.S.C. 1451 et seq.	In Progress
Comprehensive Environmental Response, Compensation and Liability act of 1980	42 U.S.C. 9601	N/A
Emergency Wetlands Resources Act	16 U.S.C. 3901-3932	In Progress
Endangered Species Act of 1973	16 U.S.C. 1531	In Progress
Estuary Protection Act of 1968	16 U.S.C. 1221 et seq.	In Progress
Fish and Wildlife Coordination Act of 1958, as amended	16 U.S.C. 661	In Progress
Flood Control Act of 1970	33 U.S.C. 549	In Progress
Hudson River Valley National Heritage Area	Title IX of Public Law 104-333 (1996), as amended by Section 324 of Public Law 105-83 (1997)	In Progress
Land and Water Conservation Act	16 U.S.C. 460	In Progress
Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Amendment	16 U.S.C. 1801	In Progress
Marine Mammal Protection Act of 1972, as amended	16 U.S.C. 1361	In Progress
Marine Protection, Research, and Sanctuaries Act of 1972	33 U.S.C. 1401	In Progress
Migratory Bird Conservation Act of 1928, as amended	16 U.S.C. 715	In Progress
Migratory Bird Treaty Act of 1918, as amended	16 U.S.C. 703	In Progress
National Environmental Policy Act of 1969, as amended	42 U.S.C. 4321 et seq.	In Progress
National Historic Preservation Act of 1966, as amended	54 U.S.C. Section 300101	In Progress

Title of Law	U.S. Code	Compliance Status
Native American Graves Protection and Repatriation Act of 1990	25 U.S.C. 3001	In Progress
Noise Control Act of 1972, as amended	42 U.S.C. 4901	In Progress
Resource Conservation and Recovery Act of 1976	42 U.S.C. 6901 et seq.	N/A
Rivers and Harbors Act of 1888, Section 11	33 U.S.C. 608	In Progress
Rivers and Harbors Act of 1899	33 U.S.C. 401 et seq.	In Progress
Safe Drinking Water Act of 1974, as amended	42 U.S.C. 300	N/A
Submerged Lands Act of 1953	43 U.S.C. 1301 et seq	In Progress
Toxic Substances Control Act of 1976	15 U.S.C. 2601	N/A

Table 63: Executive Order compliance status.

Title of Executive Order	Executive Order Number	Compliance Status
Consultation and Coordination with Indian Tribal Governments	13175	In Progress
Environmental Justice – Federal Actions to Address Environmental Justice and Minority and Low-income Populations	12898	In Progress
Environmental Justice 40	14008	In Progress
Facilitation of Cooperative Conservation	13352	In Progress
Floodplain Management	11988	In Progress
Federal Compliance with Pollution Control Standards	12088	In Progress
Federal Compliance with Right-to-Know Laws and Pollution Prevention	12856	N/A
Invasive Species	13112	In Progress
Marine Protected Areas	13158	In Progress
Offshore Oil Spill Pollution	12123	N/A
Protection and Enhancement of Environmental Quality	11514/11991	In Progress
Protection and Enhancement of the Cultural Environment	11593	
Protection of Wetlands	11990	In Progress
Protection of Children from Environmental Health and Safety Risks	13045	In Progress
Planning for Federal Sustainability in the Next Decade (2015)	13693	In Progress
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	In Progress

7.1.1 Environmental Commitments

The following summarizes environmental commitments and compliance including but not limited to those discussed in more detail below. The conceptual mitigation, compensatory mitigation, and BMPs under consideration for the TSP are also included in this Chapter.

Clean Air Act

Section 118 of the Clean Air Act states that any Federal action that may result in discharge of air pollutants must comply with Federal, State, interstate, and local requirements respecting control and abatement of air pollution. Section 176(c) of the Act requires that Federal actions conform to an implementation plan after is has been approved or promulgated under Section 110 of the Act. The NYNJHAT project area is located in counties that are part of the New York, Northern New Jersey, Long Island, and Connecticut ozone nonattainment area. This area has been designated with the following attainment status with respect to the NAAQS for ozone: 'moderate' nonattainment for the 2015 8-hour ozone standard, 'serious' nonattainment for the 2008 8-hour ozone standard. In addition, a number of the counties have been designated a 'maintenance' area for the 2006 particulate matter less than 2.5 microns ($PM_{2.5}$) standard, and a 'maintenance' area for the 1971 carbon monoxide (CO) standard (40 CFR §81.331). The project area is also part of a larger Ozone Transport Region. Oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) are precursors for ozone, while sulfur dioxide (SO_2) is a precursor pollutant for PM2.5. The NYNJHAT project area is in attainment of the NAAQS for all other criteria pollutants. The relevant threshold levels for the current nonattainment status of the project area are the following:[9] 50 tons per year (tpy) of NO_x or VOCs in a serious O_3 nonattainment area, 100 tpy of $PM_{2.5}$, SO_2, NO_x, VOCs, and ammonia in a $PM_{2.5}$ maintenance area, and 100 tpy of CO in a CO maintenance area. Emissions from construction of the NYNJHAT TSP will be below all of these de minimis levels on a yearly basis; and therefore, is not anticipated to trigger General Conformity Review. A Tier 1 Clean Air Act assessment was prepared for the TSP, provided in Appendix A6.

Clean Water Act, 33 U.S.C. 1251, et seq.

Section 401 of the Clean Water Act (CWA) requires every applicant for a Federal license or permit for any activity that may result in a discharge into navigable waters to obtain a State Water Quality Certificate or a waiver that the proposed activity will comply with the state water quality standards. NYSDEC and NJDEP issue Section 401 Water Quality Certificates for activities within each respective State (in New Jersey via the Waterfront Development Permits and CAFRA Permits processes).

Section 402 of the CWA prohibits the discharge of pollutants to the waters of the United States from any point source unless the discharge follows a National Pollutant Discharge Elimination System (NPDES) Permit (SPDES in New York and NJPDES in New Jersey). Storm water discharges associated with any activity that involves earth disturbances that exceed one acre also require a NPDES permit.

Section 404 of the CWA regulates the discharge of dredge or fill materials into the waters of the Unites States, including wetlands, at specific disposal sites. The selection and use of disposal sites must be in accordance with guidelines development by the U.S. EPA in conjunction with the Secretary of the Army and published in 40 CFR Part 230 (also known as the 404(b)(1) guidelines). Under Section 404(b)(1) USACE shall examine practicable alternatives to the proposed discharge and permit only the Least Environmentally Damaging Practicable Alternative (LEDPA). Both Section 404 and 33 C.F.R. 336(c)(4) and 320.4(b) require USACE avoid, minimize, and mitigate impacts to wetlands. A Tier 1 CWA assessment was prepared for the TSP, provided in Appendix A5.

Coastal Zone Management Act, 16 U.S.C. 1451, et seq.

To implement CZMA and to establish procedures for compliance with the Act's Federal consistency provisions, NOAA promulgated regulations (15 C.F.R. Part 930), which state that a federal agency may use NEPA documents as a vehicle for CZMA consistency determination. The NYSDOS Office of Planning and Management administers and maintains New York State mapped CZMA boundaries present within New York State, and the NJDEP Division of Land Use Regulation administers and maintains New Jersey State mapped CAFRA boundaries present within the State of New Jersey. Additionally, the New Jersey Waterfront

[9] https://www.epa.gov/general-conformity/de-minimis-tables

Development Law (N.J.S.A 12:5-3) sets forth additional provisions that include tidally influenced municipalities throughout the State of New Jersey that are also subject to CZMA. The TSP includes measures that fall within Federal and/or state mapped CZMA zones; and therefore, a Tier 1 CZMA assessment was prepared for the TSP, provided in Appendix A4.

Endangered Species Act, 16 U.S.C. 1531, et seq. (USFWS and NOAA-NMFS)

Consultation with the USFWS and/or NOAA-NMFS is required when a Federal action may affect a Federally-listed species or designated critical habitat. Many terrestrial and aquatic threatened, endangered, as well as candidate, species are present within the NYNJHAT Study Area. The TSP is likely to have adverse effects on threatened and endangered species; and therefore, a Tier 1 Biological Assessment was prepared for the TSP, provided in Appendix A1 (USFWS) and A2 (NOAA-NMFS).

Fish and Wildlife Coordination Act Report

In 2019, the USACE New York District and the USFWS initiated a scope of work for the preparation of a Planning Aid Letter (PAL). Later that year, the NYNJHAT Study was indefinitely postponed, due to a lack of Federal funding for Fiscal Year (FY) 2020 and 2021. The USACE New York District received Federal funding for FY 2022, and give the schedule timeline, requested the USFWS advance to the preparation of a Fish and Wildlife Coordination Act Report (FWCAR) instead of a PAL. In August 2022, the USACE New York District and the USFWS initiated a scope of work for the preparation of a FWCAR pursuant to the Fish and Wildlife Coordination Act 48 Stat. 401, as amended; 16 U.S.C 661 et seq., to provide information of fish and wildlife resources, including listed species under the ESA, and trust resources within the NYNJHAT Study Area. The FWCAR will be coordinated with the U.S. EPA, NYSDEC, NJDEP, and other agencies/organizations as appropriate, regarding the project area resources, potential project related impacts, and the means and measures that should be adopted to prevent the loss of or damage to fish and wildlife resources, as well as recommendations to avoid, minimize, or compensate for impacts resulting from the Tentatively Selected Plan and other Study Alternatives. The USACE New York District anticipates a Draft FWCAR by the end of November 2022, and a Final FWCAR thereafter following a review and comment period. This Draft Integrated FR/Tier 1 EIS will be updated with the FWCAR findings and recommendations for issuance of the Final Integrated FR/Tier 1 EIS.

Floodplain Management (E.O. 11988)

Executive Order 11988 *Floodplain Management* implementing procedures include an eight-step process for determining potential impacts to floodplains. These steps, as outlined by 44 CFR 9.6 and under USACE ER 1165-2-26 *Implementation of Executive Order 11988 on Flood Plain Management*, are summarized as follows:

- Determine if the proposed action is in the base floodplain (1% chance of annual flood, also known as the 1% floodplain)
- If the action is in the base floodplain, involve the public in the decision making process
- Identify and evaluate practicable alternatives to locating the action in the base floodplain
- Identify beneficial and adverse impacts of the proposed action
- Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values
- Reevaluate the alternatives
- If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the public of findings
- Implement the proposed action

The alternative plans were assessed under the eight-step process. All Alternatives have measures that are located within and/or near a base floodplain, of which are presented and evaluated within this Integrated FR/Tier 1 EIS. Avoidance of base floodplains in CSRM studies is largely unavoidable as storm-related flooding inundates the 1% and 0.2% floodplain areas, and upland areas depending on location and severity of the storm. As the Study Area is heavily urban, many areas within or near the 1% floodplain are developed communities in New Jersey (such as Hoboken, Jersey City, Newark) and New York (including Seagate, Coney Island, Rockaway). Potential beneficial and adverse impacts of the TSP are discussed in this report, which has been made available for public review and input. Public meetings will be held during the public comment period to present and discuss findings to stakeholders within the NYNJHAT Study Area. Public and Agency feedback will be incorporated into the Final Integrated FR/Tier 1 EIS. Additionally, The FEMA is a participating agency for the NYNJHAT Study and USACE has coordinated with The FEMA throughout the Study's progress including during scoping, the interim report release, and during Cooperating and Participating Agency coordination meetings which recently included an engineering presentation on the Study Alternatives and a presentation on the TSP selection process and TSP (refer to Appendix H for additional information on Public and Agency Coordination). USACE will continue to coordinate with The FEMA in subsequent phases of the Study to minimize threats to life and property, and to preserve natural and beneficial floodplain values, as applicable. As this is a Tier 1 level report, there will be additional opportunities for the public and Agencies to review the future proposed plan and provide feedback during the Tier 2 EIS(s).

National Park Service Lands, Public Law 92-592, 1972

CSRM plans that fall within the boundaries of or impact the resources of the NPS Lands, i.e. Gateway National Recreation Area, must be mutually acceptable to the Department of the Interior and the Department of the Army. The authorizing legislation (Public Law 92-592, 1972) for GNRA recognized the potential need for water resource development projects within USACE mission to be undertaken within its boundaries by establishing that that there must be agreement between the two agencies. The authorizing language states that "The authority of the Secretary of the Army to undertake or contribute to water resource developments, including shore erosion control, beach protection, and navigation improvements (including the deepening of the shipping channel from the Atlantic Ocean to the New York harbor) on land and/or waters within the recreation area shall be exercised in accordance with plans which are mutually acceptable to the Secretary of the Interior and the Secretary of the Army."

National Environmental Policy Act of 1969. 42 U.S.C. §4321 et seq.

Environmental data for the NYNJHAT Study has been compiled and this Integrated FR/Tier 1 EIS has been prepared and coordinated for public, state, and Federal agency review. NEPA compliance will continue to be implemented throughout subsequent phases of the Study, including the remainder of the Tier 1 and the Tier 2 EIS(s).

National Historic Preservation Act of 1966 (INTER ALIA)

The TSP is in compliance with Section 106 of the National Historic Preservation Act, as amended. As part of the requirements and consultation process contained within the National Historic Preservation Act implementing regulations of 36 CFR 800, this project is also in compliance through ongoing consultation with the Archaeological and Historic Preservation Act, as amended, Archeological Resources Protection Act, American Indian Religious Freedom Act, Executive Order 11593, 13007, and 13175, the Presidential Memo of 1994 on Government to Government Relations, New York State Office of Parks, Recreation and Historic Preservation(OPRHP) Section 14.09 of the New York State Historic Preservation Act and the New Jersey Register of Historic Places Act, (Laws of 1970, Chapter 268)and New Jersey Public Law 2004,Chapter 1. Consultation with the New York State Historic Preservation Office (NYSHPO), NYC Landmarks Preservation Commission (LPC), the New Jersey Historic Preservation Office (NJHPO), NJDEP, and NYSDEC, in partnership with MOCEJ, the Secretary of the Interior (SOI) in consultation with NPS Interior Region 1 Office, the Delaware Nation, the Stockbridge Munsee Community Band of Mohican Indians, and the Delaware Tribe of Indians (federally-recognized tribes), and other interested parties was initiated on May 23, 2022. Coordination on the potential for adverse effects with the interested parties and the appropriate federally recognized tribes is ongoing and will be finalized prior to implementation of the proposed action. The proposed action will be in compliance with the goals of this Act upon completion of coordination as stated above.

The TSP has the potential to have an adverse impact on historic properties, however, additional investigation is required to determine what resources will be impacted. A Programmatic Agreement (see Appendix A8) which stipulates the actions the USACE will take with regard to cultural resources as the Project proceeds. The Programmatic Agreement will be used to ensure that the USACE satisfies its responsibilities under Section 106 of the NHPA and other applicable laws and regulations. The Draft PA will be provided to the USACE New York District, New York and New Jersey State Historic Preservation Offices, New York City Landmarks Preservation Commission, Federally Recognized Tribes, and Interested parties for their review and participation. Both cultural resource surveys, and additional analysis of the impacts to the viewshed will be carried out in compliance with Stipulations I-V in the PA.

Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. et seq.

The Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265), as amended, establishes procedures for the identification of essential fish habitat and required interagency coordination to further the conservation of Federally-managed fisheries. The implementing regulations require Federal agencies that authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake, an activity that could adversely affect essential fish habitat is subject to the consultation provisions of the Act and identified consultation requirements. The TSP is likely to have adverse effects on essential fish habitat; and therefore, a Tier 1 essential fish habitat assessment was prepared for the TSP, provided in Appendix A3.

Marine Mammal Protection Act of 1972, 16 U.S.C. 1631, et seq.

The MMPA prohibits the “take” of marine mammals within a federally authorized project area. The TSP includes measures that would be constructed in water with the potential to affect marine mammals and aquatic life within the estuary; and therefore, USACE will continue to coordinate with the USFWS and NOAA-NMFS, both of which are Cooperating Agencies on this Study, to determine the level of effect and determine is a permit to authorize incidental take will be required for the TSP.

Migratory Bird Treaty Act, 16 U.S.C. 715-715s, and E.O. 13186 Responsibilities of Federal Agencies to Protect Migratory Birds

A “take” of a migratory bird protected under the MBTA. Section 704 of the MBTA states that the Secretary of the Interior is authorized and directed to determine if, and by what means, the take of migratory birds should be allowed and to adopt suitable regulations permitting and governing “takes”. Disturbance of a nest of a migratory bird requires a permit issued by the USFWS pursuant to Title 50 of the Code of Federal Regulations. Construction of the TSP measures has the potential to “take” migratory birds, eggs, nests, or young during construction that may involve mechanized land clearing. USACE will coordinate with the USFWS, NYSDEC, and NJDEP to determine the appropriate construction windows that avoid “takes” and establish best management practices to be implemented during construction and operations and maintenance activities of the TSP measures.

Rivers and Harbors Act, 33 U.S.C. 401, et seq.

The Rivers and Harbors Act prohibits the construction of any bridge, dam, dike, or causeway over and/or in navigable waters of the United States without Congressional approval. The USCG administers Section 9 of the Act, and issues bridge crossing permits over navigable waters, in addition to requiring the necessary lighting aids to navigation to approve any temporary or permanent closures or restrictions of navigation channels. It is anticipated that the storm surge barriers would require a permit from the USCG to be constructed, and therefore, USACE will continue to coordinate with the USCG, a Cooperating Agency on the NYNJHAT Study, in subsequent phases of the Study.

7.2 CONCEPTUAL MITIGATION PLAN

Mitigation, as defined by the Council on Environmental Quality (40 CFR § 1508.20), includes (a) avoiding the impact by not taking a certain action or parts of an action; (b) minimizing the impact by limiting the degree of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating or restoring the effected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; (e) compensating for the impact by replacing or providing substitute resources or environments. This Section summarizes the conceptual mitigation measures and compensatory mitigation and monitoring considered in this Tier 1 assessment, to be further developed in subsequent phases of the Study (Final Integrated FR/Tier 1 EIS and Tier 2 EIS(s), and in coordination with the appropriate Federal, State, and Local Agencies during each Study phase.

7.2.1 Conceptual Mitigation

The potential mitigation measures and BMPs under consideration in this Draft Integrated FR/Tier 1 EIS to avoid, minimize, reduce, or rectify potential adverse environmental impacts of the TSP are summarized in Table 37. This Section will be further refined for the Final Integrated FR/Tier 1 EIS and Tier 2 EIS(s) as additional details are available and following additional coordination and consultation with resource regulatory Agencies.

Table 64: Summary of conceptual mitigation measures under consideration.

RESOURCE CATEGORY	POTENTIAL CONCEPTUAL MITIGATION DESCRIPTION
Wildlife and Vegetation	Erosion and sediment control BMPs, vegetation restoration and compensation, invasive species BMPs, tree/shrub clearing restriction windows, replanting with native vegetation, pre-construction vegetation surveys
Special Status Species	Environmental window restrictions for construction and maintenance activities, terrestrial aquatic species and vegetation surveys, continued coordination with respective regulatory Agencies
Special Status Areas	Erosion and sediment control BMPs, wetland restoration and compensation, continued coordination with respective regulatory Agencies
Physical Resources	Erosion and sediment control BMPs, disturbed areas restored to pre-construction land use,
Hydrological Resources	Erosion and sediment control BMPs, water quality certificate recommendations/BMPs
Air Quality, Clean Air Act, and Greenhouse Gas	Air emissions from construction of the NYNJHAT TSP are anticipated to be below all de minimis levels on a yearly basis; and therefore, is not anticipated to trigger General Conformity Review.
Cultural Resources	In continued coordination with NYSHPO, NJHPO, LPC, NPS and other stakeholders, avoid/minimize adverse effects to Cultural Resources in accordance with stipulations of the Programmatic Agreement.
HTRW	Avoidance and minimization of impacts to HTRW sites, implementation of BMPs when working near HTRW sites. Coordination with Federal, State, and Local agencies as needed.
Navigation	Continued coordination with USCG to avoid/minimize impacts to navigation.
Noise and Vibration	Construction timeframes will be coordinated with local ordinance. noise and vibration monitoring during construction.
Environmental Justice	Construction timeframes will be coordinated with local ordinances, noise and vibration monitoring/surveys during construction. Additional mitigation may be tailored to the community concerns.

7.2.2 Conceptual Compensatory Mitigation and Monitoring

A Conceptual Mitigation and Monitoring Plan was developed for this Integrated Feasibility Report/Tier 1 EIS (Appendix A10). The plan describes potential environmental impacts, pursuant to NEPA, based on the current level of design and assumptions. The Conceptual Mitigation and Monitoring Plan covers impacts identified during the Tier 1 EIS analysis and only addresses the compensatory mitigation method. The other forms of mitigation exercised prior to considering compensatory mitigation (e.g., avoidance, minimization, reduction of impact) are discussed in the previous Section, and throughout this report. The plan identifies and describes the mitigation activities proposed and the estimated cost of the effort. The general purpose of the plan is to provide a systematic approach for improving resource management outcomes and a structured process for recommending decisions, with an emphasis on uncertainty to improve management. In addition, the plan establishes the framework for effective monitoring, assessment of monitoring data and decision making for implementation of adaptive management activities in the project area.

Note that the Conceptual Mitigation and Monitoring Plan will be revised for the Final Integrated FR/Tier 1 EIS to include the NYBEM, and additionally as needed as specific design details are made available following site-specific impact analyses conducted under the future Tier 2 EIS(s). In addition, the plan will be refined pending the results of the functional assessments for potential mitigation site(s) and the cost effectiveness/incremental cost analyses and updated as necessary in the Tier 2 EIS(s).

8 PUBLIC COORDINATION AND VIEWS

Coordination with stakeholders has been a critical component of the NYNJHAT Study. Since early 2017 the USACE New York District has held several workshops and meetings with Cooperating/Participating Agencies and other Federal, State, and local stakeholders to share information on the Study scope, purpose, and formulation of alternatives, as well as to exchange ideas and information on natural and marine resources within the Study Area. Refer to Chapter 1, Appendix A11, and Appendix H for additional information.

8.1 PUBLIC AND AGENCY COORDINATION SUMMARY

8.1.1 8.1.1 Public Scoping Meetings

The NEPA scoping period for the NYNJHAT Study originally spanned 45 days from July 6th – August 20, 2018, but, due to numerous requests from the public, was extended by 77 days for total of 122 days scoping period. The extended period was open until November 5, 2018. During the NEPA scoping public comment period, comments were submitted to a project email address, mailed by hard copy, or provided in person at one or more of the Scoping Meetings that were held during the scoping period. Scoping information received after this date continued to be compiled and considered as the Study progressed, and are included in this draft report and as part of the administrative record. Originally, there were five NEPA scoping meetings scheduled for this Study. Pursuant to the request of congressional representatives, USACE held four additional meetings for a total of nine scoping public meetings. Meeting locations were chosen to be easily accessible by transit, able to accommodate large groups, and dispersed throughout the large Study Area, such that interested stakeholders could reasonably travel to at least one meeting. General comment trends included the following topics: scoping process, storm surge and RSLC, environmental impacts, navigation impacts, cost and construction, overall Study process, and induced flooding. A discussion of general comment trends and well as the NYNJHAT Study scoping comments and responses are included in Appendix H.

8.1.2 Public Interim Report Meetings

To further provide the public with NYNJHAT Study information prior to release of this Draft Integrated FR/Tier 1 EIS Report, an Interim Report was released on February 19, 2019 that identified the preliminary economic, environmental, engineering and other studies performed to date of the above referenced alternatives. Eight public meetings were held following the release of the Interim Report. General comment trends on the Interim Report including the following topics: general meeting information or concerns, storm surge and RSLC, environmental impacts, navigation impacts, cost of construction and operation, engineering, sedimentation rate change and water quality, flooding, and overall Study questions or concerns. Refer to Appendix H for additional information.

8.1.3 Cooperating and Participating Agency Coordination Meetings

The USACE New York District hosted several Cooperating and Participating Agency meetings in order to facilitate open communication, share Study progress, status updates, and data as it became available, including an Engineering presentation on the Study Alternatives, a presentation on the NYBEM development since the workshops were held in 2019, and a presentation on the Tentatively Selected Plan. Recent meetings took place on February 17th, June 9th, August 3rd (hosted by the New Jersey Back Bays CSRM Study team), and August 11th. Additionally, the USACE New York District provided e-mail Study status updates on January 31st, May 6th, July 14th, August 8th, and August 26th between Agency coordination meetings. As part of the continuing coordination for the Study, the USACE New York District offered shapefiles of the NYNJHATS Alternatives to all Cooperating and Participating Agencies in preparation for future consultation and coordination. Cooperating/Participating Agencies were engaged to provide data, input, and comments or recommendations on the TSP and Study Alternatives and analysis, in advance of the comments that would be provided as part of an official review of this Draft Integrated FR/Tier 1 EIS. Scoping and Interim Report Comment Letters received from the Cooperating/Participating Agencies are provided in Appendix H.

8.1.4 Cultural Resource Coordination Meeting

On May 23, 2022, the USACE New York District held a Cultural Resource briefing with over 40 invited stakeholders (See Appendix A8). The briefing provided an update to the existing and new Stakeholders on the scope of the Study, the conceptual alternatives that are under evaluation and the type of solutions that may be tentatively selected to address the considerable coastal storm risk that still faces the vast Study Area. The goal was to collaboratively develop a common understanding of cultural resources at risk from increased coastal storm damages as a result of RSLC within the project area. The briefing also outlined how at-risk cultural resources will be taken into consideration throughout the Study's analysis and as the District developed measures and actions to manage risk to these resources. In support of this goal, USACE requested stakeholder participation, as interested parties' feedback assisted the USACE team with the TSP selection process and the analysis included in this interim report.

8.1.5 Agency Consultation

The USACE New York District has been actively coordinating with the Cooperating and Participating Agencies on the NYNJHAT Study and will initiate consultation following the release of this Draft FR/Tier 1 EIS. Since early 2017 USACE has held many workshops and meetings with Cooperating Agencies and other stakeholders to share information on the Study scope, purpose, and formulation of alternatives, as well as to exchange ideas and information on natural and marine resources within the Study Area. In 2019, four New York Bight Ecological Model (NYBEM) workshops were held on January 3rd, March 11th, June 6th, and November 14th. These meetings informed development of the NYBEM model, which was set up to be used as a tool for assessing direct and indirect effects of agency actions on regional ecosystems, including NYNJHATS.

In February 2020, NYNJHATS paused until October 2021 due to a lack of Federal funding. Following Study resumption, the USACE New York District held several Cooperating Agency meetings in order to facilitate open communication, share Study progress, status updates, and data as it became available, including an Engineering presentation on the Study Alternatives, a presentation on the NYBEM development since the workshops were held in 2019, and a presentation on the TSP. These meetings took place on February 17th, June 9th, August 3rd, August 11th. Additionally, the USACE New York District provided e-mail Study status updates on January 31st, May 6th, July 14th, August 8th, and August 26th between Agency coordination meetings. As part of the continuing coordination for the Study, the USACE New York District offered shapefiles of the NYNJHATS Alternative alignments to all Cooperating and Participating Agencies in preparation for future consultation and coordination. Refer to Appendix A11 and G for additional information. In addition to the environmental consequences assessment included in this document, appendices for the ESA (Appendix A1 and A2), EFH (Appendix A3), Coastal Zone Management Act (Appendix A4), Clean Water Act (Appendix A5), Clean Air Act (Appendix A6), Coastal Barrier Resources Act (Appendix A7), Cultural Resources (Appendix A8), Hazardous, Toxic, and Radioactive Waste (Appendix A9), and Other Social Effects and Environmental Justice (Appendix A12) have been prepared for Agency review and comments.

8.1.6 Tribal Consultation

As part of consideration of effects, the USACE New York District has been actively consulting with interested parties under the Archaeological Resources Protection Act (ARPA), the American Indian Religious Freedom Act (AIRFA), Section 106 of the National Historic Preservation Act (NHPA) and NEPA. Consultation has been initiated via letter and by webinar and is ongoing between the USACE New York District and federally recognized tribes. Letters notifying the tribes of the USACE New York District's initial the consideration of effects and of the USACE New York District's intent to development of a Programmatic Agreement to address potential adverse effect to cultural resources were sent on May 09, 2022. At the May 23 meeting the Stockbridge Munsee Community Band of Mohican Indians expressed interest in participating in the PA. Consultation letters requesting concurrence of the USACE New York District's determination of adverse effects and requesting comment on the PA will be sent to the NYSHPO, NJHPO, NYCLPC, NPS, the Delaware Nation, the Stockbridge Munsee, and the Delaware Tribe of Indians (Appendix A8). Consultation is ongoing and will be finalized prior to implementation of the proposed action.

8.1.7 State of New York- State Historic Preservation Officer

The USACE New York District initiated consultation with the New York State Historic Preservation Officer under Section 106 of the National Historic Preservation Act and NEPA on May 09, 2022. As part of the initial notification, the USACE New York District presented the preliminary APE, the consideration of effects, and declared it's intent to develop a Programmatic Agreement to address potential adverse effects to cultural resources through the development of a Programmatic Agreement (refer to Appendix A8). Consultation is ongoing and will be finalized prior to implementation of the proposed action.

8.1.8 State of New Jersey- Historic Preservation Officer

The USACE New York District initiated consultation with the New Jersey State Historic Preservation Officer under Section 106 of the National Historic Preservation Act and NEPA on May 09, 2022. As part of the initial notification the USACE New York District presented the preliminary APE, the consideration of effects, and declared its intent to develop a Programmatic Agreement to address potential adverse effects to cultural resources through the development of a Programmatic Agreement (refer to Appendix A8). Consultation is ongoing and will be finalized prior to implementation of the proposed action.

8.1.9 New York City Landmark Preservation Commission

As part of the initial notification of the preliminary APE, the consideration of effects and the development of a Programmatic Agreement, consultation with the New York State Historic Preservation Officer was initiated on May 09, 2022 (refer to Appendix A8). Consultation is ongoing and will be finalized prior to implementation of the proposed action.

8.1.10 National Park Service

The National Parks Service has elected to be a Cooperating Agency on the study and the USACE New York District has been actively coordinating with staff from the Gateway National Recreation Area and Department of the Interior Region 1 since early 2017. The USACE New York District initiated consultation with the NPS under Section 106 of the National Historic Preservation Act and NEPA on May 09, 2022. As part of the initial notification the USACE New York District presented the preliminary APE, the consideration of effects, and declared its intent to develop a Programmatic Agreement to address potential adverse effects to cultural resources through the development of a Programmatic Agreement (refer to Appendix A8). Consultation is ongoing and will be finalized prior to implementation of the proposed action.

8.2 SUBMITTED ALTERNATIVES, INFORMATION, AND ANALYSES

In accordance with NEPA Implementing Regulations (40 CFR 1502.17) a summary of submitted alternatives, information, and analyses shall be included in the Tier 1 EIS, submitted by State, Tribal, and local governments as well as other public commenters during the scoping process for consideration by the lead and Cooperating Agencies in the development of the Tier 1 EIS.

While no Alternative plan was formally submitted for additional consideration during the scoping period, the USACE New York District received information and feedback from local stakeholders on the existing Study Alternatives following the scoping period including assessments of construction duration estimates in comparison to other storm surge barriers such as the St. Petersburg, Maeslant, and Eastern Scheldt barriers, barrier height in relation to sea level, costs to construct, benefits, Alternative comparison, and modeling simulations (SSWG 2019 and Bowman et al 2019). Stakeholders have also requested USACE develop one or more new Alternatives to the Study that consists entirely of nonstructural measures, and/or primarily of nonstructural measures, with an emphasis on buyouts and setbacks to address adaptation, RSLC, storm surge and climate change related impacts (NPCA 2020). USACE understands local stakeholders have interest for nonstructural and natural and nature-based feature measures be incorporated in the NYNJHAT Study Alternatives. While the Alternative's structural measures are the primary focus currently in the Draft Integrated FR/Tier 1 EIS, nonstructural and natural and nature-based features are part of Alternatives 2, 3A, 3B, 4, and 5, and will be further assessed for the Final Integrated FR/Tier 1 EIS.

8.3 AREAS OF CONTROVERSY

Below is a summary of a few topics of controversy encountered in the NYNJHAT Study.

Storm Surge Barriers

While storm surge barriers have been constructed and operated in other locations around the world since at least the 1980s (e.g. in the Netherlands, London, Venice, Stamford, CT, Providence, RI, etc.), less is known about the long-term environmental effects of storm surge barriers placement within the Hudson River Estuary as compared to the other structural measures being assessed in each Alternative, such as floodwalls and levees. As of the date of the release of this Draft Integrated FR/Tier 1 EIS, modeling of the storm surge barriers in the open gate position (NYBEM and AdH) was performed to better understand construction and footprint related impacts of the storm surge barriers effects to existing conditions. Studies proposed to be undertaken by stakeholders to assess the effects of storm surge barriers on the Hudson River Estuary also aim to better understand the long-term environmental effects, including the potential for open storm surge barrier gates to alter water flow conditions that would cause physical changes in the estuary and closed storm surge barrier gates restricting tidal exchange; however, these studies are still underway (Orton 2020). In preparation for release of the Final Integrated FR/Tier 1 EIS, USACE plans to model closed and open gate scenario(s) to better understand the effects of both conditions on the estuary.

The two Alternatives that appear to be more controversial than others include Alternative 2 (harbor-wide barrier) and Alternative 3A (multiple barriers) due to their proximity and potential effects to the Hudson River, although concerns have been expressed for all storm surge barrier Alternatives, while sometimes favoring Alternative 5 as it does not contain in-water measures such as storm surge barriers. Concerns include the potential effects to the Hudson River's tidal flow, contaminant and sediment transport, the migration patterns of fish species (including Atlantic sturgeon, herring, shad, and eel), and include requests to further assess storm surge, RSLC, and preservation of the Hudson River Ecosystem (Riverkeeper 2018).

A petition with several signatories was received from the Natural Resource Defense Council (NRDC), requesting the USACE New York District avoid offshore storm surge barriers that would potentially close off New York Harbor from the Atlantic Ocean (such as Alternative 2) due to concerns for sewage, contaminants, and other pollution that may accumulate and threaten marine life (including Atlantic sturgeon). Instead, the petition requested the USACE New York District consider shore-based measures (e.g. dunes, dikes, levees) as well as wetland restoration (NRDC 2020).

Alternatively, favor for storm surge barriers in combination with shore-based measures have been communicated by local stakeholders, particularly Alternative 2 (harbor-wide barrier), citing in one letter Alternative 2 potential to reduce coastal storm risk for 95% of the area and in combination with shore-based measures to address both RSLC and high-frequency flooding (SSWG 2019).

Environmental Justice and Other Social Effects

Public engagement and comments received have informed that the study required a more comprehensive Environmental Justice and Other Social Effects analysis to fully understand the impacts and benefits to communities as a result of implementing Alternatives considered in this Study. During recent USACE projects, including completion of the 50-foot Harbor Deepening Project and the HDCI Feasibility Study/Environmental Assessment Report, local stakeholder concerns for construction related noise, vibration, and air quality impacts to environmental justice communities were communicated to USACE, bringing a heightened awareness to construction activities occurring in and near these communities, particularly the neighborhoods along the Kill Van Kull on the north shore of Staten Island, given the proximity to necessary navigation channel bedrock drilling and blasting needed for navigation channel construction. As a result of the public and local stakeholders request for a more comprehensive environmental justice analysis and in lieu of recent experience, the USACE New York District requested the support of subject matter experts from ERDC to research and assess the potential adverse and beneficial effects to environmental justice communities as well as other social effects to communities within the broader NYNJHAT Study Area. That analysis is included in this Draft Integrated FR/Tier 1 EIS for public and Agency review, in consideration of this potential topic of controversy. Refer to Appendix A12 for additional information.

Proximity to Known Contamination Sites and USACE Remedial Action Policy

The Study Area is a highly urban environment with a long history of industrial activity that has contributed to a degraded environment for a broad range of environmental receptors. While it is a priority to avoid known contaminated sites, it may not be possible along all portions of the TSP, or any Alternative assessed under the NYNJHAT Study. For sites with HTRW issues that lie in the project footprint and that cannot be avoided, the non-federal sponsor would be required to ensure that they are fully remediated prior to the NYNJHAT Alternative being constructed. This remediation would also be at 100% Non-Federal cost. This can be a timely and costly process, that has the potential to cause schedule delays and funding lapses. Planning for future remediation needs and ensuring its cleanup to an acceptable level prior to construction of any USACE project is a known concern of the non-Federal sponsor. In order the mitigate for these concerns, the USACE New York District prepared a HTRW Survey (Appendix A9) to help identify potential known contaminated sites of concern early in the planning process. Additionally, the USACE New York District will continue to coordinate with the Non-Federal Sponsor, as well as the applicable Federal (USEPA), State (New York and New Jersey), and Local (relevant municipalities) to implement best management practices and to avoid and/or minimize the potential cost and schedule impacts as much as possible. During the Tier 2 phase, updated HTRW survey(s) will be completed and during the Preconstruction Engineering and Design phase, HTRW samples will be collected along the alignment, at 100% Non-Federal cost. The updated survey(s), sampling, and analysis will inform the future requirements of remediation in advance of construction of any Alternative advanced as a result of the study.

9 RECOMMENDATIONS

In making the following recommendations, I have given consideration to all significant aspects in the overall public interest, including environmental, social and economic effects, engineering feasibility and compatibility of the project with the policies, desires, and capabilities of New York State, the State of New Jersey, and other non-Federal interests.

I recommend that the selected plan for coastal storm risk management in the New York-New Jersey Harbor and Tributaries region, as fully detailed in this integrated feasibility report and Tier I EIS, be authorized for construction as a federal project, subject to such modifications as may be prescribed by the Chief of Engineers. The Tentatively Selected Plan consists of a suite of CSRM measures that function as a system including: primary structural components consisting of storm surge barriers at the entrance to Jamaica Bay, Arthur Kill, and Kill Van Kull to provide CSRM on a multi-basin basis, three primary structural components involving storm surge barriers on the individual water bodies of Gowanus Canal, Newtown Creek and Flushing Creek located in Brooklyn and Queens, and three primary structural shore-based measures in Jersey City, the lower west side of Manhattan, and East Harlem. In addition to the primary storm surge barriers and shore-based measures, there are also nonstructural measures, natural and nature-based features, land and water based measures to mitigate for any anticipated induced flooding from the project (known as Induced Flooding Features), and small scale measures that can be implemented quickly to address high frequency flooding at the most vulnerable potions of the study area (known as Residual Risk Features). As this is an Integrated Feasibility Report/Tier 1 Environmental Impact Statement with a conceptual level of design, compensatory mitigation and adaptive management will be further refined in subsequent phases of the study and in coordination with the appropriate federal, state, and local agencies.

The Tentatively Selected Plan has an estimated project first cost of $52,627,325,000 (Fiscal Year 2022 price level) and an annualized cost of $2,551,663,000 (based on 2.25% discount rate). The annualized cost includes planning, engineering and design, construction management, interest during construction, and operation and maintenance, including contingencies. The Tentatively Selected Plan provides an estimated $3,707,484,000 in annualized net benefits, and has a benefit-cost ratio of 2.5. The plan would be cost shared as 65 percent Federal ($34,207,761,000) and 35 percent Non-Federal ($18,419,564,000).

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of highest review levels within the Executive Branch. Consequently, the recommendations may be modified by the Chief of Engineers before they are transmitted to the Congress as proposals for authorization and implementing funding. However, prior to transmittal to Congress, the partner, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

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