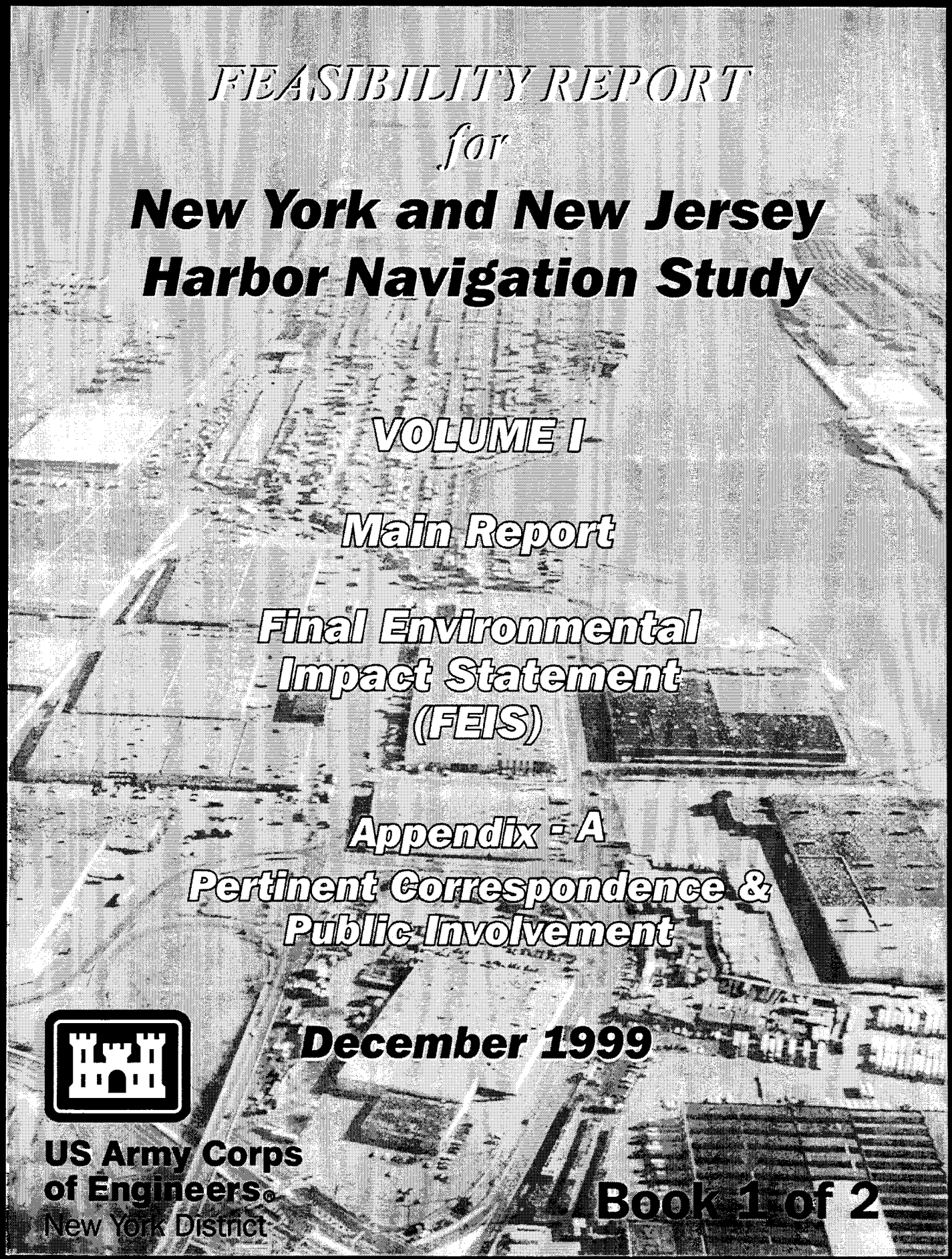


FEASIBILITY REPORT

for

New York and New Jersey Harbor Navigation Study

VOLUME I

Main Report

Final Environmental Impact Statement (FEIS)

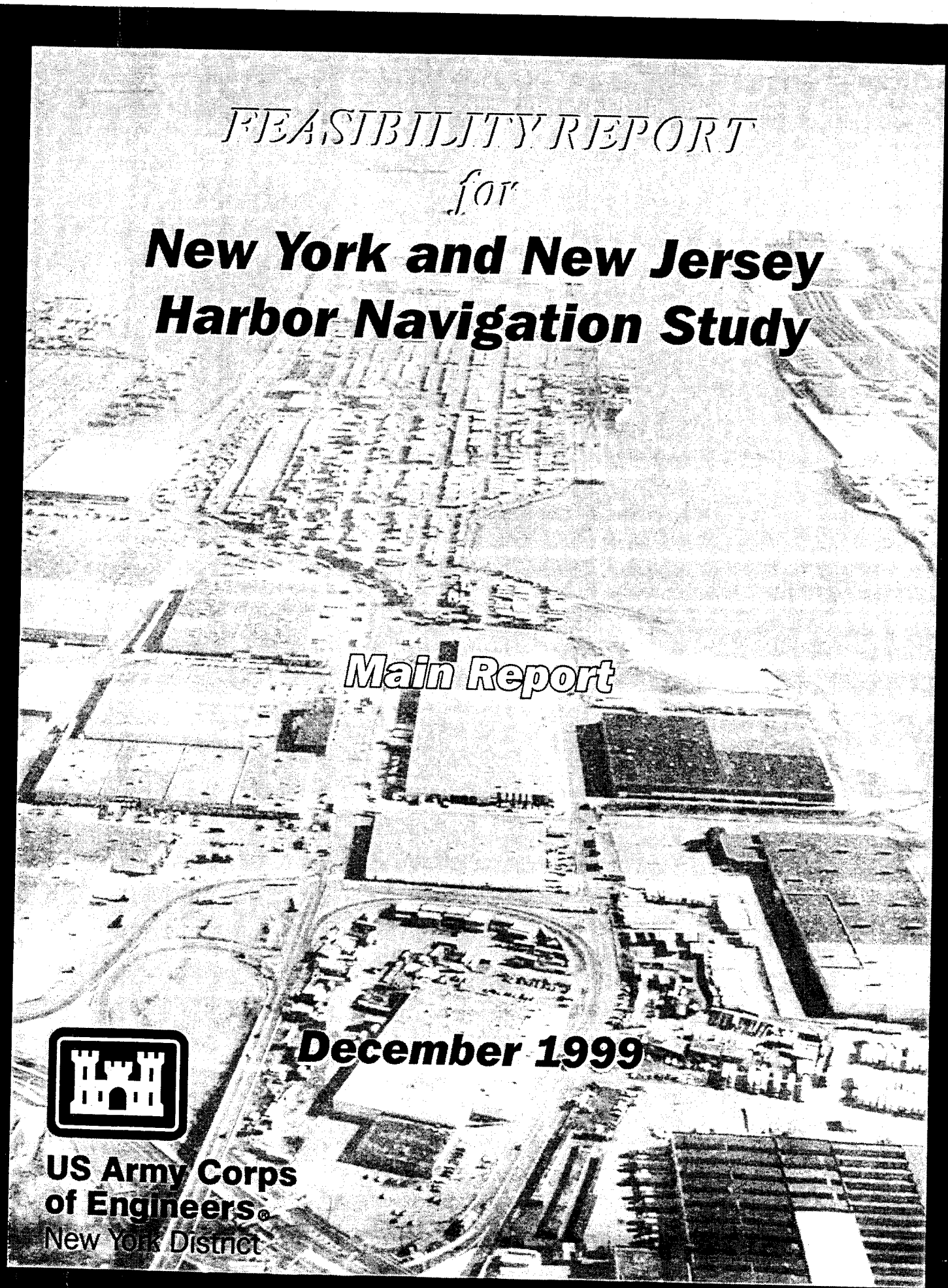
Appendix - A

Pertinent Correspondence & Public Involvement

December 1999

US Army Corps of Engineers®
New York District

Book 1 of 2



FEASIBILITY REPORT

for

New York and New Jersey Harbor Navigation Study

Main Report

December 1999

US Army Corps of Engineers®
New York District

SYLLABUS

The Feasibility Report / Environmental Impact Statement has been prepared to address the future navigation needs of New York and New Jersey Harbor. The report has been prepared by the New York District and coordinated with the non-Federal partners, the State of New York (assisted by the City of New York), the State of New Jersey and the Port Authority of New York and New Jersey. Various agencies and the public also participated in the study through a series of public and advisory group meetings.

This comprehensive navigation study of the Harbor investigated the feasibility of deepening all major channels to all marine terminals. The report considers the projected growth in world trade and the size of containerships in the world fleet and identifies the optimum navigation improvements to maximize maritime transportation cost savings. For formulation purposes, the Harbor was divided into pathways, each leading to the various terminals or anchorages in the Harbor.

- Pathway 1 — Kill Van Kull to Newark Bay to Elizabeth and South Elizabeth Channels
- Pathway 2 — Kill Van Kull to the Arthur Kill to Howland Hook
- Pathway 3 — Kill Van Kull to the Arthur Kill to Gulfport (at tanker design depth)
- Pathway 4 — Port Jersey Channel to Port Jersey and the former Military Ocean Terminal at Bayonne (MOTBY)
- Pathway 5 — Bay Ridge Channel to South Brooklyn
- Pathway 5A — Bay Ridge, Red Hook, Buttermilk Channels to Red Hook Marine Terminal
- Pathway 6 — Stapleton, Gravesend Bay and Red Hook Flats anchorages, for container vessels
- Pathway 7 — Stapleton, Gravesend Bay and Red Hook Flats anchorages, for tankers
- Pathway 8 — Claremont Channel to Claremont Terminal

Plans were developed to avoid and minimize environmental impacts where possible; mitigation will be provided as necessary. In addition to channel deepening, an off-shore container port and a canal extending the Port Jersey Channel across the Bayonne Peninsula were considered, but were dropped from the planning process, consistent with the desires of the non-Federal partners. Pathways 6 and 7 to the anchorages were deferred to a separate feasibility study. Pathway 5A to Red Hook was eliminated from plan formulation because the non-Federal partners have indicated that it would be converted to general cargo use by the year 2010. Pathway 3, developed to accommodate Suezmax tankers to the Gulfport Reach of the Arthur Kill Channel, and

Pathway 8 to Claremont Marine Terminal were determined not to be economically feasible and thus did not support a Federal interest.

The National Economic Development (NED) Plan is the District Engineer's Recommended Plan for project authorization and consists of deepening the following channels: Ambrose Channel, Anchorage Channel, Bay Ridge Channel, the Kill Van Kull, the Newark Bay Channels, Port Jersey Channel, and the Arthur Kill to Howland Hook. The channels will be deepened to 50 ft MLW except in areas of rock or otherwise hard material where they will be deepened to 52 ft MLW, with the exception of the Ambrose Channel, which will be deepened and maintained to 53 ft MLW. All channels will be maintained at 50 ft MLW with the exception of Ambrose Channel, which will be maintained at 53 ft MLW.

A preliminary, planning level construction schedule for the Recommended Plan is included in the report to provide an assessment of interest during construction, economic feasibility, and cumulative environmental effects. While the schedule indicates completion of the overall project by the year 2016, the New York District is working diligently with the Port Authority of New York and New Jersey, making every effort to expedite construction. The goals are to enable the project to accrue national economic benefits as soon as possible and to satisfy the non-Federal partners' desire for completion of the overall project as soon as possible, including a fifty foot channel to Port Newark and Elizabeth by end of year 2009.

The following pertinent data table summarizes the features of the Recommended Plan.

PERTINENT DATA

Description

The recommended plan is to deepen all channels in the Harbor providing containership access to the current or proposed container terminals.

Channel	Excavated Depth	Maintained Depth	Excavated Length
Ambrose Channel	53 ft	53 ft	63,600 ft
Anchorage Channel	50 ft	50 ft	19,000 ft
Kill Van Kull	52 ft	50 ft	31,800 ft
Newark Bay	52 ft	50 ft	14,000 ft
Elizabeth Channel	52 ft	50 ft	8,800 ft
South Elizabeth Channel	52 ft	50 ft	2,700 ft
Arthur Kill (to Howland Hook)	52 ft	50 ft	14,400 ft
Port Jersey Channel	52 ft	50 ft	10,000 ft
Bay Ridge Channel	50 ft	50 ft	18,000 ft

Volume of Initial Excavation (geologic volume)	
Rock	4,210,000 cy
Non-Rock (Suitable for HARS*)	25,920,000 cy
Non-Rock (Unsuitable for HARS)	8,170,000 cy
Total	38,300,000 cy
Channel Side Slopes	
Hard	1V:1H
Soft	1V:3H
Project Cost	
Initial	$1,781,234,000
Annual (Discounted at 6-7/8 %)	$165,895,000
Average Annual Benefits	$238,500,000
Benefit Cost Ratio	1.4
Cost Apportionment of the Fully Funded General Navigation Features	
Federal (42.0%)	$743,954,000
Non-Federal (58.0%)	$1,037,280,000

*HARS: Historic Area Remediation Site

(THIS PAGE INTENTIONALLY LEFT BLANK)

Table of Contents

INTRODUCTION **1**

STUDY AUTHORITY 1
SCOPE OF STUDY 1
Channels and Appurtenant Terminals *2*
Channel Depth *3*
Terminals *4*
Inland Infrastructure *4*
STUDY PARTICIPANTS AND COORDINATION 5
Desires of the Non-Federal Partners and Stakeholders *5*
PREVIOUS AND ONGOING STUDIES 6
New York Anchorages Study *9*
Study of the Arthur Kill South of the Gulfport Reach *10*
Dredged Material Management Plan (DMMP) for the Port of NY and NJ *10*
Port Authority of New York and New Jersey: Port Strategic Investment Options Analysis *11*
Strategic Plan for the Redevelopment of the Port of New York *11*
Cross Harbor Freight Movement Major Investment Study (MIS) *11*
FORMAT OF THE REPORT 12

EXISTING CONDITION **15**

GENERAL 15
CURRENT CARGO CAPACITY 15
PORT OPERATIONS 15
Container Operations in the Port *16*
Light Loading and Routing 16
Tidal Advantage 16
Impacts of Vessel Size 16
Vessel Alliances and Deregulation 16
Petroleum Operations in the Port *17*
TRANSPORTATION COSTS 17
TERMINAL DESCRIPTIONS 18
Port Newark/Elizabeth *18*
Site Description 18
Land-Side Access and Existing Infrastructure 18
Water-Side Access and Navigation Channels 19
Howland Hook *19*
Site Description 19
Land-Side Access and Existing Infrastructure 20
Water-Side Access and Navigation Channel 20
Port Jersey/Military Ocean Terminal at Bayonne *20*
Site Description 20
Land-Side Access and Existing Infrastructure 21
Water-Side Access and Navigation Channels 21
South Brooklyn *22*
Site Description 22
Land-Side Access and Existing Infrastructure 23
Water-Side Access and Navigation Channels 24
Red Hook *24*
Site Description 24
Land-Side Access and Existing Infrastructure 25

Table of Contents

Water-Side Access and Navigation Channels 25
Stapleton *25*
Site Description 25
Land-Side Access and Existing Infrastructure 26
Water-Side Access and Navigation Channels 26
TOSCO *26*
GATX *26*
Anchorages *26*
Terminal Summary *27*
REGIONAL TRANSPORTATION 27
Commercial Trucking *27*
Rail *28*
Growth and Development *28*
ENVIRONMENTAL SETTING 29
General *29*
Climate *29*
Hydraulics *30*
Geology *30*
Land Use *30*
Upland Habitat *30*
Marine Biota *31*
Avian Fauna *31*
Wetlands *31*
Water Quality *32*
Air Quality *32*
ARCHEOLOGICAL, HISTORICAL AND CULTURAL RESOURCES 32
SOCIO-ECONOMIC PROFILE 33
General *33*
Domestic Economic Hinterland *33*
31-County Metropolitan Area 34
260-Mile Radius 34
17-State Region 34
31-State Secondary Hinterland 34
Population *35*
Income *35*
Employment *35*

WITHOUT-PROJECT CONDITION 37

GENERAL 37
NON-FEDERAL PARTNERS' COMPREHENSIVE PORT IMPROVEMENT PLAN 37
Shortage of Throughput Capacity *37*
Productivity Increases *38*
Proposed New and Expanded Terminal Development in the CPIP *39*
South Brooklyn 39
Military Ocean Terminal at Bayonne (MOTBY) 40
Port Newark/Elizabeth Marine Terminals 40
Howland Hook Marine Terminal 40
Terminals Scheduled for Closure or Other Uses in the CPIP *40*
Red Hook Container Terminal 40
Claremont Terminal 41

Table of Contents

Oil Terminals 41
Summary of the Non-Federal Partners' CPIP *41*
WITHOUT-PROJECT CONDITION 41
CHANNEL /ANCHORAGE MAINTAINED DEPTHS 43
PROBLEM IDENTIFICATION 45
General *45*
Channels Leading to Existing Container Terminals *47*
Channels Leading to Oil Terminals on the Arthur Kill *47*
Anchorages *47*
NEEDS 47
Navigation Needs *47*
Environmental Needs *48*
Regional Needs *48*
OPPORTUNITIES 48

PLAN FORMULATION 49

FEDERAL PLANNING REQUIREMENTS 49
Principles and Guidelines *49*
National Economic Development (NED) Plan *50*
Locally Preferred Plan *50*
PLANNING OBJECTIVES AND CONSTRAINTS 50
Study Objectives *50*
Constraints *51*
Economic Constraints 51
Environmental Constraints 51
Regional and Social Constraints 51
Technical Constraints 51
Institutional Constraints 52
PLAN FORMULATION RATIONALE 52
General *52*
Economic Principles *53*

SCREENING OF STUDY ALTERNATIVES 55

SCREENING OF PRELIMINARY PLANS 55
No Action Plan *55*
Non-Structural Plans *55*
Structural Plans *56*
Design Criteria 56
General 56
Design Vessel Parameters 57
Channel Design 58
Bayonne-Newark Bay Canal 59
Off-Shore Island Port 61
Channel Deepening Plans 62
EVALUATION OF CHANNEL DEEPENING ALTERNATIVES 62
Tanker Channel Deepening Alternative *62*
Anchorage Deepening Alternative *63*
Container Vessel Channel Deepening Alternatives *63*
Preliminary Quantities and Costs 64
General 64

Table of Contents

Estimated Dredged Material Quantities 64
Unit Costs 65
Utility Relocations 66
Mitigation Costs 67
Land-side Infrastructure Costs 68
NED Investment Costs 68
Annual Costs 69
Costs by Pathway 69
Benefits Model 69
Port Outlook 70
Expected Fleet Distribution 71
Ship Transportation Cost Savings 73
Benefits by Pathway 75
Channel Deepening Economics 76
SUMMARY OF PRELIMINARY PLANS SCREENING 79

IDENTIFICATION OF THE NED PLAN 81

ALTERNATIVES ANALYSIS 81
THE NED PLAN 82

RECOMMENDED PLAN 83

OVERVIEW 83
DESCRIPTION OF THE RECOMMENDED PLAN 83
Ambrose Channel 83
Anchorage Channel 83
Port Jersey Channel 85
Kill Van Kull 85
Newark Bay Channels 86
Arthur Kill Channel 87
Bay Ridge Channel 87

DESIGN OF THE RECOMMENDED PLAN 89

OVERVIEW 89
DESCRIPTION 89
BASIS OF DESIGN 89
General 89
Geotechnical Investigations 90
Geotechnical Analyses 90
Surveying and Mapping 91
Structural Studies 91
Ship Simulation Modeling 92
DREDGED MATERIAL PLACEMENT 92
REAL ESTATE REQUIREMENTS 96

ENVIRONMENTAL ANALYSIS OF THE RECOMMENDED PLAN 99

OVERVIEW 99
COMPREHENSIVE PORT IMPROVEMENT PLAN EIS (CPIP-EIS) 99
PHYSICAL RESOURCES 100
General 100
Hydraulics 100

Table of Contents

Sedimentation *100*
Water Quality *101*
Air Quality *101*
HTRW Consequences *102*
BIOLOGICAL RESOURCES 103
General *103*
Aquatic Resources *103*
Wildlife Resources *104*
THREATENED AND ENDANGERED SPECIES 104
ESSENTIAL FISH HABITAT 106
UPLAND IMPACTS 106
CULTURAL RESOURCES 106
Prehistoric Resources *107*
Historic Resources *107*
IMPACTS ASSOCIATED WITH ROCK BLASTING 108
SOCIOECONOMIC RESOURCES 108
SECONDARY IMPACTS 108
Side Slope Stability *108*
Biological Exposure Potential *109*
Noise, Odor, and Aesthetics *109*
Recreation *109*
CUMULATIVE IMPACTS 110
Relationships to Other Projects *110*
Habitat Disturbance *110*
Contamination *110*
IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES 110
MITIGATION 111

ECONOMIC ANALYSIS OF THE RECOMMENDED PLAN 113

OVERVIEW 113
GENERAL 113
COST ESTIMATES 113
First Costs *113*
Annual Costs *114*
Interest During Construction 114
Operation and Maintenance (O&M) Costs 115
Summary of Annual Costs 115
BENEFITS 116
General *116*
Benefits During Construction *116*
Summary of Annual Benefits *116*
FEASIBILITY 117

COORDINATION AND PUBLIC INVOLVEMENT 119

REQUIRED COORDINATION 119
EXECUTIVE COMMITTEE 120
TECHNICAL WORK GROUPS 121
ADVISORY GROUP MEETINGS 121
PUBLIC MEETINGS 121

Table of Contents

NEWSLETTERS AND PROJECT LIBRARIES 121

PROJECT IMPLEMENTATION 123

OVERVIEW 123
GENERAL 123
PROJECT COOPERATIVE AGREEMENT 123
COST APPORTIONMENT 126
Design Cost Sharing 127
CONSTRUCTION SCHEDULE 127
FINANCIAL ANALYSIS 129

CONCLUSIONS 131

RECOMMENDATION 135

Table of Contents

List of Tables

Table #		*Page #*
1	Baseline Channel Depths	3
2	Prior Pertinent Authorizations – NY & NJ Harbor	6
3	Current Container Terminal Capacity	15
4	NY & NJ Harbor Anchorage Use	27
5	Terminal Descriptions – Existing Condition	27
6	Summary of Non-Federal Partners' Comprehensive Port Development Plan	41
7	Terminal Descriptions – Without-Project Condition	42
8	Navigation Channels and Anchorages in NY & NJ Harbor	44
9	Estimated Geologic Dredged Material Quantities	65
10	Channel Deepening Alternatives – Unit Costs	66
11	Preliminary Area of Environmental Impact	68
12	Construction Costs, Investment Costs, and Annual Costs by Pathway	70
13	Expected Fleet Distribution	72
14	Pathway Annual Benefits	76
15	Economic Summary by Pathway	77
16	Economic Summary of Pathway 1 as Last-Added Element to Pathway 4	78
17	Economic Summary of Pathway 2 as Last-Added Element to Pathway 1	78
18	Economic Summary by Alternative for Second-Added Feature	81
19	Economic Summary by Alternative for Comprehensive Plan Alternatives	82
20	Recommended Plan - Pertinent Data	84
21	Littoral Zone Impacts of Newark Bay Channels	87
22	The Recommended Plan	89
23	Dredged Material Pay Quantities	93
24	Placement Options for Project Dredged Material	95
25	LERR Required	96
26	Recommended Plan – First Costs	114
27	Recommended Plan – Summary of Annual Costs	115
28	Recommended Plan – Summary of Annual Benefits	117
29	Recommended Plan – Summary of Annual Benefits and Costs	117
30	Newspapers and Journals Sent the Notice of Public Scoping Meetings	119
31	Date and Location of Public Scoping Meetings	120
32	Main Libraries for Harbor Navigation Study Documents	122
33	Cost Apportionment – Federal and Non-Federal Responsibilities	127

Table of Contents

List of Figures

(following Figure 1, all figures are located at the end of the text with the exception of Figures 20 and 24, on pages 46 and 71, respectively)

Figure #

1 Location of Study Area
2 Location Map – Existing Condition
3 Port Newark/Elizabeth Marine Terminals – Existing Condition
4 Port Newark/Elizabeth Marine Terminals – Aerial View
5 Howland Hook Marine Terminal – Existing Condition
6 Howland Hook Marine Terminal – Aerial View
7 Port Jersey & MOTBY Marine Terminals – Existing Condition
8 Port Jersey & MOTBY Marine Terminals – Aerial View
9 South Brooklyn Marine Terminal – Existing Condition
10 South Brooklyn Marine Terminal – Aerial View
11 Red Hook Container Terminal – Existing Condition
12 Red Hook Container Terminal – Aerial View
13 Stapleton Site – Existing Condition
14 Existing Rail freight Lines
15 Domestic Economic Hinterland
16 Commodity Flow To and From the NYC Metro Region
17 Port Newark/Elizabeth Marine Terminals – Without-Project Condition
18 South Brooklyn Marine Terminal – Without-Project Condition
19 Port Jersey & MOTBY Marine Terminals – Without Project Condition
20 Evolution of Container Ships
21 Design Vessel Parameters
22 Bayonne-Newark Bay Canal
23 Offshore Island Port – Concept
24 Forecast Container Terminal Demand
25 The NED Plan
26 Recommended Plan – Index Sheet
27 Recommended Plan – Ambrose Channel
28 Recommended Plan – Anchorage Channel
29 Recommended Plan – Port Jersey Channel
30 Recommended Plan – Kill Van Kull
31 Recommended Plan – Newark Bay
32 Recommended Plan – Arthur Kill
33 Recommended Plan – Bay Ridge Channel

Table of Contents

Final Environmental Impact Statement (FEIS)

Appendix A – Pertinent Correspondence and Public Involvement

Appendix B – (Not Used)

List of Additional Appendices

Appendix C: Plan Formulation

Appendix D: Economics

Appendix E: Channel Design

Appendix F: Geotechnical

Appendix G: Structural

Appendix H: Costs

Appendix I: Real Estate

Table of Contents

List of Volumes

Volume I (Book 1 of 2)

Main Report
Final Environmental Impact Statement (FEIS)

Volume I (Book 2 of 2)

FEIS Appendices
Appendix A: Pertinent Correspondence and Public Involvement
Appendix B: (Not Used)

Volume II

Appendix C: Plan Formulation
Appendix D: Economics
Appendix E: Channel Design
Appendix F: Geotechnical
Appendix G: Structural
Appendix H: Costs
Appendix I: Real Estate

Glossary

Authorized Depth.....The excavated depth. In areas of rock or hard bottoms this depth is 2 feet deeper than maintained depth.

Base Year.....The first year of the project period of analysis. The base year for this report is 2010.

Berth.....The water area, at the waterfront edge of a wharf, reserved for a vessel. The term is sometimes used to refer to the dock or wharf structure.

Break-Bulk Cargo.....General cargo, conventionally stevedored and stowed (palleted or sling), as opposed to bulk or containerized cargo.

Bulk Cargo.....Usually a homogenous raw material shipped in shipload lots, *e.g.* scrap metal, grain, chemicals, petroleum products. Usually differentiated by dry and liquid bulk.

Containerized Cargo.....Cargo transported in boxes (containers) that are constructed with varying dimensions and to withstand transportation stresses.

Draft.....The depth of a vessel in the water.

Draft, Sailing.....The draft of a vessel taking in to account environmental and physical factors (*e.g.*, squat, trim, salinity).

Draft, Static.....The dead weight, design draft of a vessel.

Equimarginal Analysis.....A foot-by-foot of channel depth analysis of commodity flows, based on forecast fleet distributions, predicted vessel loading, terminal capacities, etc.

Excavated Depth.....This is the target, or minimum, depth of initial construction dredging. To provide added safety clearance, this depth is 2 ft deeper than maintained depth in areas of rock and hard bottom.

Float Bridge.....(Rail) A barge fitted with railroad tracks used for the transportation of rail cars across a waterway.

Glossary

Geologic Volume.....The volume of in situ material to be dredged.

Gross Volume.....The volume of dredge material including the maximum permitted overdredge depth of 2 additional feet.

Harbor .....Short for "New York and New Jersey Harbor"; this refers to the waterways in the analysis. However, it may be used interchangeably with the Port.

Hinterland .....Interior origins and destinations for commodities passing through the Port.

Land-side Improvements .....Improvements occurring on a terminal or facility adjacent to the waterway (as opposed to inland – away from the water).

Lift .....The movement of one container to or from a containership.

Macroeconomic Analysis.....The economics of aggregate income, output and employment.

Maintained Depth.....The depth of a channel maintained by operation and maintenance dredging.

Neo-bulk .....Used to refer to processed or manufactured goods that move by ship-lot lots, such as automobiles or lumber.

Overdredge Depth.....The maximum additional depth of a channel beyond excavated depth allowed by permit to account for dredging equipment inaccuracy. In order to assure that the excavated depth is achieved, contractors tend to dredge beyond the excavated depth. This additional depth is routinely permitted to vary up to an additional 2 feet from the excavated depth, depending on the type of dredged material and dredging method used. The contractor is not paid for this additional volume.

Glossary

Pay Volume.....The volume of dredge material used to compute the construction cost estimate. This volume varies from geologic volumes in the division between rock and non-rock material by considering equipment inaccuracies.

Port.....Short for "The Port of New York and New Jersey", this refers to the land-side facilities, operations, etc. in the analysis. However, it may be used interchangeably with the Harbor.

Post-Panamax Vessel.....Refers to a vessel too large to navigate the Panama Canal. The beam width is greater than 113 ft (34.5 m).

Shoaling.....In terms of dredging, the deposition of sediments in a channel following dredging.

TEU.....Twenty-foot Equivalent Unit. In the current analysis, the ratio of TEU's to lifts is 1.7 to 1.

Ultimate Cost.....The term ultimate cost refers to the sum of Federal and non-Federal project costs.

Water-side Improvements.....Improvements occurring in the water (*e.g.*, channel deepening, widening, etc.).

(THIS PAGE INTENTIONALLY LEFT BLANK)

INTRODUCTION

Study Authority

1. The New York District, U.S. Army Corps of Engineers (the District) has been authorized to conduct a feasibility study to evaluate Federal participation in navigation improvements in New York and New Jersey Harbor (the Harbor). The feasibility study was authorized by Section 435 of the Water Resources Development Act of 1996, which reads:

> *The Secretary shall conduct a comprehensive study of navigation needs at the Port of New York-New Jersey (including the South Brooklyn Marine and Red Hook Container Terminals, Staten Island, and adjacent areas) to address improvements, including deepening of existing channels to depths of 50 feet or greater, that are required to provide economically efficient and environmentally sound navigation to meet current and future requirements.*

2. Figure 1 depicts the location of the study area, the existing terminals, and the channels that are the subject of this study.

Scope of Study

3. The purpose of the New York and New Jersey Harbor Navigation Feasibility Study is to identify, screen, evaluate, and recommend a plan for channel improvements throughout the Port of New York and New Jersey (the Port). Channel improvement (*e.g.*, construction, deepening, widening, realignment, etc.) is an action that can be taken to meet the changing trend toward larger cargo vessels in the world's fleet. The investigation considers the following channels: Ambrose, Anchorage, Bay Ridge, Red Hook, Buttermilk, the Kill Van Kull, Claremont, Port Jersey, Newark Bay (including the Elizabeth and South Elizabeth Channels), and the Arthur Kill to Gulfport, as well as the anchorage areas at Stapleton, Red Hook Flats, and Gravesend Bay. Alternatives were selected for detailed study on the basis of estimated costs and benefits of the proposed navigation improvements. Project justification is based on macroeconomics whereby growth in trade is forecasted on the basis of projected worldwide population and income growth. Benefits are derived from transportation cost savings associated with the ability to efficiently use larger vessels in the deeper channels and not increased commerce movement through the Port. Benefits used to justify alternatives considered in this study are constrained by existing and foreseeable near-term terminal capacity, allowing for some reasonable increases in efficiency.

4. A Final Environmental Impact Statement (FEIS) was prepared according to the National Environmental Policy Act (NEPA). The FEIS presents project alternatives, documented baseline conditions, and identifies direct, indirect, and cumulative impacts

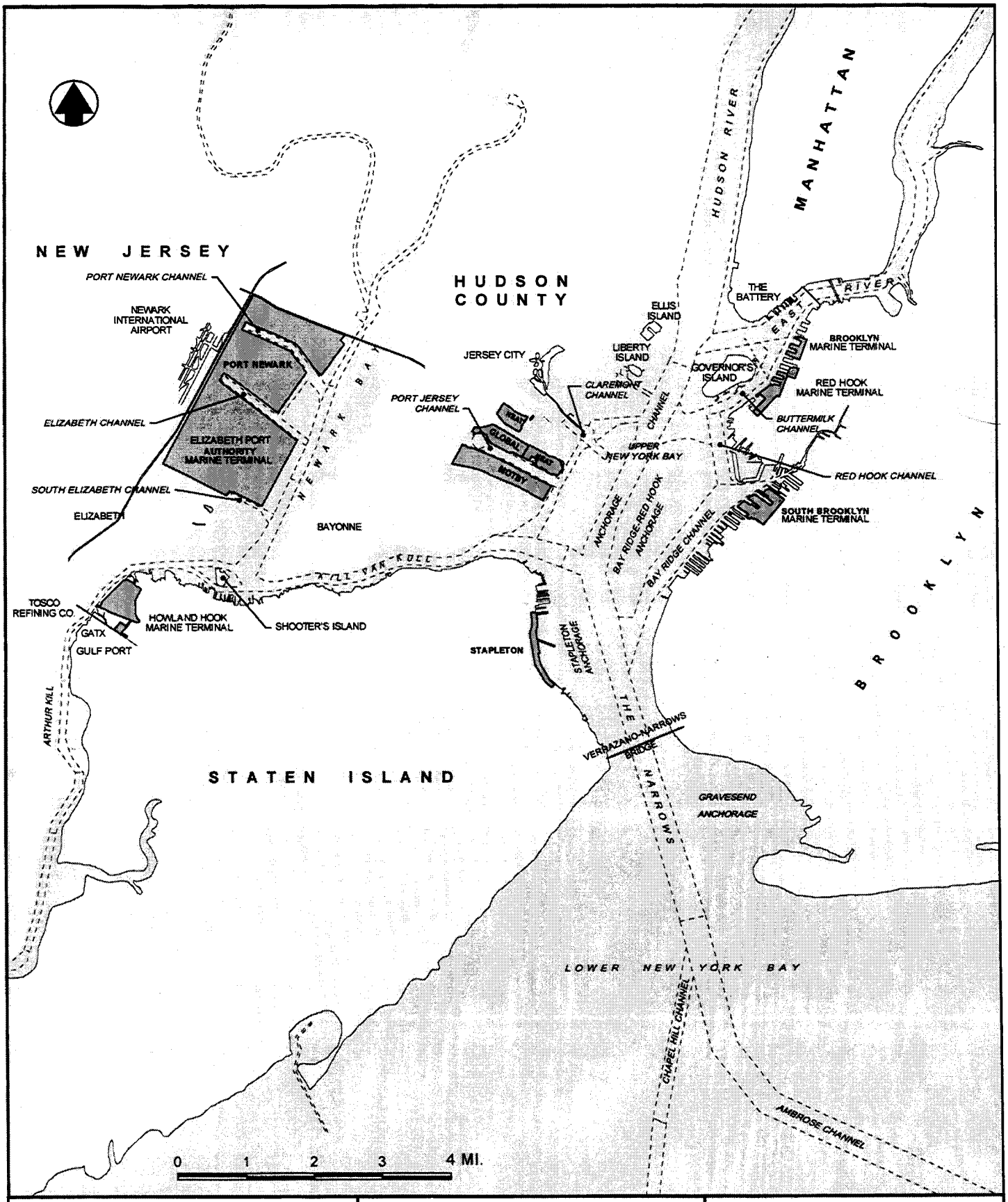
that are expected to result from plan implementation. For those impacts determined to be unavoidable, a mitigation plan is prepared. The FEIS, however, is limited only to the impacts associated with deepening the Harbor.

5. There is a realization on the part of the Port stakeholders that terminal capacity will be insufficient to handle the future quantity of container cargo handling services demanded. This increased quantity demanded is projected to stem from growth in worldwide population and income and is independent of any plans for further deepening of the Harbor's channels. Wishing to maximize their market share, the non-Federal partners have presented a vision of facility expansions described later in this report that is not considered as part of the Without-Project Condition used in the benefit analysis. In the past, such Port improvement plans have been evaluated individually. A Memorandum of Understanding (MOU) among the appropriate regulatory agencies and project sponsors to agree to prepare a Comprehensive Port Improvement Plan (CPIP) to address such expansions has been developed. A copy of the MOU is provided in Appendix B-1.8 of the FEIS. The version provided contains the signatures of the parties as of the printing of this report. The CPIP's accompanying EIS will be the vehicle to address the environmental impacts related to further expansion of the Port's terminals.

Channels and Appurtenant Terminals

6. The study area was divided into "pathways" (*i.e.*, a series of channels or channel segments) leading to the existing and proposed Port facilities in order to facilitate the formulation and analyses of alternatives. Alternatives considered involved each of the pathways at various depths and in various combinations with one another. Approved or planned terminal modifications or expansions were taken into consideration and a determination was made as to whether they should be included in the analysis or not, based on data provided by the Port Authority of New York and New Jersey (PANYNJ), the states of New York and New Jersey, and the City of New York. The designated pathways, all of which have Ambrose Channel and sections of the Anchorage Channel as common elements, are:

- Pathway 1 Kill Van Kull to Newark Bay to Elizabeth and South Elizabeth Channels;
- Pathway 2 Kill Van Kull to the Arthur Kill to Howland Hook;
- Pathway 3 Kill Van Kull to the Arthur Kill to Gulfport (at tanker design depth);
- Pathway 4 Port Jersey Channel to Port Jersey and the former Military Ocean Terminal at Bayonne (MOTBY);
- Pathway 5 Bay Ridge Channel to South Brooklyn;
- Pathway 5A Bay Ridge, Red Hook, Buttermilk Channels to Red Hook Marine Terminal;



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY FEASIBILITY REPORT

FIGURE 1

LOCATION OF STUDY AREA

- Pathway 6 Stapleton, Gravesend Bay, and Red Hook Flats anchorages, for container vessels;
- Pathway 7 Stapleton, Gravesend Bay, and Red Hook Flats anchorages, for tankers;
- Pathway 8 Claremont Channel to Claremont Terminal.

7. In addition to the listed Pathways, two other structural alternatives were considered. One was the Bayonne-Newark Bay Canal, which would have extended the Port Jersey Channel through the Bayonne Peninsula to Newark Bay. The other was an off-shore structure that would have served as both a marine terminal and a dredged material placement facility. Both of these ideas were dismissed early in the planning process at the direction of the non-Federal partners.

Channel Depth

8. A majority of the channels under consideration as part of this study already are, or soon will be Federally-maintained navigation channels. For the purpose of formulating further Harbor deepening, the previously authorized depths, where supported as necessary by favorable reports, have been considered as the baseline (*i.e.*, without-project conditions) for this study. Table 1 summarizes the baseline depths used in the formulation process.

TABLE 1
Baseline Channel Depths

Channel Name		Depth (ft MLW)
Ambrose		45[1]
Anchorage		45[1]
Bay Ridge		40
Kill Van Kull		45[2]
Newark Bay		45[2]
Arthur Kill (to Howland Hook)		41[3]
Arthur Kill (from Howland Hook to Gulfport)		40[3]
Port Jersey		41[4]
Claremont		15-30+[5]
New Jersey Pierhead		20
Anchorages	Stapleton	33-70+
	Gravesend Bay	47
	Red Hook Flats	35-45

1 Authorized to 55 ft but is subject to a favorable report not pursued.
2 Channel is currently 40 ft. Construction has been initiated on the 45ft channel.
3 Channel is currently 35 ft. Construction to 41/40ft has been authorized. Awaiting construction appropriations.
4 Channel is not currently a federal channel. Federalization and deepening of the channel has been authorized. Awaiting construction appropriations.
5 Channel is not a federal channel and is not federally maintained.

Terminals

9. The study considers the cargo throughput capacity for container terminals and oil terminals that exist, are to be expanded, or will be developed within the Port. The relevant container terminals are: Port Newark and the Elizabeth Port Authority Marine Terminal (together known as Port Newark/Elizabeth Marine Terminal) in New Jersey; Howland Hook Marine Terminal in Staten Island, New York; Port Jersey Peninsula, New Jersey, including both the Global Marine Terminal and the Northeast Auto Terminal (NEAT); the proposed conversion of the Military Ocean Terminal at Bayonne (MOTBY), New Jersey; and a proposed redevelopment of marine terminal facilities in South Brooklyn, New York, (from 29th Street to 65th Street). The Red Hook Container Terminal in the Red Hook section of Brooklyn is included in the Existing Condition Analysis, however, the non-Federal partners have indicated that the terminal will be phased out of container operations by approximately the year 2010 when its operations move to South Brooklyn. The non-Federal partners have also indicated there is no present intention to develop the Stapleton area on Staten Island as a container terminal due to the relatively high development costs and the lack of suitable land-side transportation infrastructure. There are two relevant petroleum facilities, TOSCO and GATX. These existing facilities are located along the Gulfport Reach of the Arthur Kill.

Inland Infrastructure

10. It is important to determine whether or not the inland infrastructure (*i.e.*, highways, arterial roadways, railroads and off-port intermodal terminals) will be adequate to accommodate the cargo loaded and unloaded from vessels calling on the Port in the future. The total cargo throughput of the Port depends not only on the throughput of the marine terminals but also on the throughput capacity of this inland infrastructure. For example, a lack of adequate inland infrastructure could constrain the amount of cargo transferred through the Port, and thus could constrain the realization of project benefits. In addition to considerations of inland infrastructure, the present evaluation addresses terminal infrastructure (*i.e.*, berths, cranes, gates, etc.) associated with the proposed deeper channels and the larger vessels they would serve.

11. The project is not expected to induce commerce into the area beyond that which is forecast to occur without project implementation. Accordingly, it is anticipated that the intermodal transportation network capacity will keep pace with the projected Port growth. Thus, the inland transportation infrastructure will not constrain the realization of the potential benefits nor will improvements to it represent project costs. The inland transportation network is expected to grow independent of Harbor deepening, therefore, no additional analysis of inland infrastructure capacity was warranted.

Study Participants and Coordination

12. The New York District Engineer is responsible for conducting the overall study in cooperation with the New York and New Jersey Harbor Navigation Study Executive Committee comprised of representatives from the non-Federal partners (the State of New York, assisted by the City of New York, the State of New Jersey, and the Port Authority of New York and New Jersey). The non-Federal partners collectively are contributing one-half the Feasibility Study costs in cash or in-kind services. Agreed to in-kind services include providing engineering, cost, and environmental information about planned land-side terminals and improvements, as well as berthing areas, and the upland environmental analysis.

13. There are a number of agencies involved in the study process. The U.S. Environmental Protection Agency (EPA), the Federal Highway Administration, and National Marine Fisheries Service are serving as cooperating agencies in the National Environmental Policy Act (NEPA) process. As part of a public outreach program, the District formed an advisory group comprised of business and labor interests as well as citizens' groups. The District briefed the group at important points including the public scoping and the completion of the Alternative Formulation Briefing (AFB). Due to the complexity of the study and its fast pace, the District formed several workgroups to assist the District in completing this study. Participants of each workgroup came from each of the partners' organizations or the various resource agencies. The four major workgroups are in the following technical areas: Environmental, Engineering, Economics, and Infrastructure/Formulation. Ongoing meetings kept the workgroups abreast of the study progress. The workgroups input was invaluable in providing technical information, voicing environmental concerns, and ultimately in helping to steer the formulation process.

14. Materials developed in support of the study are available to the public at six libraries in the study region. Newsletters have summarized progress and provided additional information to the public. Newsletters and a study fact sheet are available at the District's World Wide Web site (www.nan.usace.army.mil).

Desires of the Non-Federal Partners and Stakeholders

15. The legislation authorizing the study is quite broad. The study has been limited to areas where requests for improvement have been voiced by the non-Federal partners during the reconnaissance phase and where such requests have a plausible basis in terms of engineering, environmental impact and economic return. In addition, other study authorities were considered in scoping the extent of this investigation.

Previous and Ongoing Studies

16. Though this study is the first comprehensive Port-wide study of the New York and New Jersey Harbor, a number of reports have been previously prepared by the Army Corps of Engineers concerning the need for navigation channel and anchorage improvements in the study area. Some of the recommended projects have been authorized by Congress. Some of the authorized projects are complete, some are on hold, and still others are underway. Table 2 lists the authorizations and reports most pertinent to the Harbor. A complete listing is provided in the Plan Formulation Appendix.

TABLE 2
Prior Pertinent Authorizations
New York and New Jersey Harbor

Approving Legislation or Authority for Project Construction	Remarks
Ambrose & Anchorage Channels	
River and Harbor Act 3 March 1899	Authorized construction of a channel 35 ft deep, to be ultimately deepened to 40 ft and 2000 ft wide from the Narrows to the sea through East (Ambrose) Channel.
River and Harbor Act 8 August 1917	Authorized extending project of 1899 to include improvement of Anchorage Channel in Upper Bay to the same dimensions as Ambrose.
River and Harbor Act 26 August 1937	Authorized modification of existing Ambrose and Anchorage Channels to provide a channel 2000 feet wide, suitably widened at bends, 45 feet deep from the Atlantic Ocean to West 40th Street Manhattan, thence 48 feet to West 59th Street.
Section 201(b) of the Water Resources Development Act of 1986	Authorized deepening Ambrose Channel to a depth of 55 ft MLW, 770 ft wide; and deepening Anchorage Channel to a depth of 55 ft MLW, 660 ft wide, subject to a favorable report by the Chief of Engineers.
Kill Van Kull and Arthur Kill to Gulfport Reach	
River and Harbor Act 23 August 1874	Original project for a "channel between Staten Island and New Jersey", 150 feet wide, 16 feet deep.
River and Harbor Act 13 June 1902	Recommended a channel between New York and New Jersey passing south of Shooter's Island, 21 feet deep and 300 feet wide except at turns where width would be 400 feet.
River and Harbor Act 25 June 1910	Authorized channel north of Shooter's Island 1 mile long, 300 feet wide, 16 feet deep.
River and Harbor Act 22 September 1922	The original project for "New York and New Jersey Channels", provided for a channel 400 feet wide and 30 feet deep.
River and Harbor Act 30 August 1935	Provided for present project depth of 35 feet and channel 600-800 feet wide.
Section 202 of the Water Resources Development Act of 1986	Authorized deepening the Kill Van Kull to 45 feet MLW from deep water in the upper New York Bay to its junction with the Newark Bay Channels and the Arthur Kill Channel. (Also authorized deepening the Newark Bay Main and Pierhead Channels to 45 feet.)

TABLE 2 Prior Pertinent Authorizations New York and New Jersey Harbor	
Approving Legislation or Authority for Project Construction	**Remarks**
Kill Van Kull and Arthur Kill to Gulfport Reach (con't)	
Section 301(a)(12) of the Water Resources Development Act of 1996	Re-authorized the 45-foot project in the Kill Van Kull and Newark Bay at a higher cost in accordance with Section 902 cap procedures.
Section 202(b) of the Water Resources Development Act of 1986, subject to a Secretary of the Army Report	Authorized deepening the 35-foot Arthur Kill Channel to 41-foot MLW from its confluence with the Kill Van Kull and Newark Bay Channels in the vicinity of Shooter's Island westward to Howland Hook Marine Terminal in Staten Island. The legislation also authorizes a 40-foot deep channel to extend south to the Gulfport Reach.
Section 301b of the Water Resources Development Act of 1996	Authorized a further deepening of the Arthur Kill to Gulfport not to exceed 45-foot MLW.
Water Resources Development Act of 1999	Re-authorized deepening of the Arthur Kill to Howland Hook to 41 ft MLW and 40 MLW to Gulfport in accordance with the 23 July 1999 report.
Newark Bay	
River and Harbor Act 13 June 1902	Provided for a 12-foot deep channel, 200 feet wide on the main axis of Newark Bay.
River and Harbor Act 2 March 1907	Provided for a 20-foot deep channel, 300 feet wide on the main axis of Newark Bay.
River and Harbor Act 24 November 1915	Recommended 400-foot wide channels 20 feet deep in Newark Bay main channels and extending to Port Newark pierhead lines.
River and Harbor Act 22 September 1922	Authorized 30-foot channel in Newark Bay and 30-foot channel in Hackensack River below Central R.R. of NJ Bridge.
Rivers and Harbor Act 2 March 1945	Authorized a 35-foot, 400-foot wide project in the main channel of Newark Bay and the branch channel and inshore channel at Port Newark, along with removal of a portion of rock area at Bergen Point.

TABLE 2 Prior Pertinent Authorizations New York and New Jersey Harbor	
Approving Legislation or Authority for Project Construction	**Remarks**
Newark Bay (con't)	
River and Harbor Act 23 October 1962	The Act modified the existing Federal project for Newark Bay, Hackensack and Passaic Rivers. The Chief of Engineers in a report to the Secretary of the Army, dated 29 November 1963, concurred with the views of the Board of Engineers for Rivers and Harbors and recommended modification of the existing project for Federal maintenance after non-Federal construction to a depth of 35 feet of: Port Elizabeth Branch Channel, 500 to 950 feet wide and 3,500 feet long from the junction with the existing 400-foot channel in Newark Bay to Port Elizabeth Inshore Channel; Port Elizabeth South Branch Channel to the Port Elizabeth East and South Channels, minimum width of 550 ft and 1,250 ft long from the junction with the 400-ft channel in Newark Bay to Port Elizabeth; Port Elizabeth Inshore Channel to Port Elizabeth and Port Newark, 500 ft wide and 5,250 ft long; Port Newark East Channel connecting Port Elizabeth and Port Newark Branch Channels, 200 ft wide and 4,150 ft long; Port Elizabeth East Channel 200 ft wide and 3,750 ft long; Port Elizabeth So Channel, 200 ft wide and 3,100 ft long; subject to certain conditions of cooperation.
River and Harbor Act 7 November 1966	Authorized: a. Widening 35-foot main channel from Port Newark Branch Channel South, from 550 and 400 feet to 700 feet. b. Provision of maneuvering area south of the Central Railroad of NJ Bridge with a width of 300 feet and an effective length of 2,200 feet, of which the southern half would be 38 feet deep at MLW and the northern half 35 feet deep at MLW. c. Provision of maneuvering area north of the Central Railroad of NJ Bridge with a width of 300 feet, an effective length of 2,200 feet and a depth of 35 feet at MLW. d. Widening of the entrance into Port Elizabeth Branch Channel to 1,050 feet with additional removal of 250 feet of the north corner. Also, widening of the entrance into Port Newark Branch Channel to 800 feet. e. Deepening 32 foot main channel, north of Port Newark Branch Channel to the junction of Hackensack and Passaic Rivers, to 35 feet at mean low water and widening from 400 feet to 500 feet. f. Provision of turning basin 35 feet deep at MLW, 1,300 feet long and 900 feet wide at junction of Hackensack and Passaic Rivers.
Chief of Engineers on 2 June 1972 under discretionary authority contained in H.D. 494, 89th Cong., 2nd Session	Authorized modification for widening and deepening of private construction plans for service channel and turning areas adjacent to Port Elizabeth which base plans had been authorized for Federal maintenance after private construction.
Section 202a of the Water Resources Development Act of 1986	Authorized deepening the 35-foot deep Newark Bay Main, Port Newark, Port Elizabeth, Port Newark Pierhead, and South Elizabeth Channels, all to 45 feet MLW. A turning basin off the Elizabeth Pierhead Channel was also approved. Removal of debris of the Central Railroad Bridge to 1,000 feet was also authorized. (Also authorized deepening the Kill Van Kull feeder Channel to 45 feet.)

TABLE 2 Prior Pertinent Authorizations New York and New Jersey Harbor	
Approving Legislation or Authority for Project Construction	**Remarks**
Newark Bay (con't)	
Section 301(a)(12) of the Water Resources Development Act of 1996	Re-authorized the 45-foot Kill Van Kull and Newark Bay Channels project at a higher cost in accordance with Section 902 cap procedures.
Anchorage Areas	
River and Harbor Act 30August 1935	Authorized dredging the southern end of Red Hook Flats to 40 feet and the remaining area south of the fairway to 30 feet. Also authorized dredging Liberty Island Anchorage and New Jersey Pierhead Channel to 20 feet deep, the latter being generally 500 feet wide.
River and Harbor Act 27 October 1965	Authorized deepening Red Hook Flats (Anchorage 21) to 45 feet deep in the southern area, 40 feet deep in the middle section, and 35 feet deep in the northern section. Also authorized deepening Gravesend Bay to 47 feet deep.
Chief of Engineers Discretionary authority Contained in S.D. 17	Authorized expanding Red Hook Anchorage 200 yards to the west by shifting the Anchorage Channel 200 yards to the west.
Brooklyn Channel	
River and Harbor Act 3 March 1899	Authorized a channel 40 feet deep and 1,200 feet wide in the Bay Ridge and Red Hook Channels, NY.
River and Harbor Act 2 March 1907	Authorized dredging Bay Ridge and Red Hook Channels to first 35 feet, then to 40 feet.
River and Harbor Act 3 July 1930	Authorized widening Bay Ridge Channel, up to 1,780 feet.
Port Jersey Channel	
Water Resource Development Act 17 October 1986	Authorized deepening the existing 35 ft MLW channel to a depth of 45 feet and a width of 450 feet, subject to a favorable report of the Chief of Engineers. The Chief of Engineers draft report recommended a channel 41 feet deep.
Water Resource Development Act of 1999	Re-authorized deepening the existing 35 ft MLW channel to a depth of 41 feet in accordance with the Chief of Engineers report.
Claremont Terminal	
Water Resource Development Act 17 October 1986	Authorized deepening the existing 27-foot natural channel at a depth of 42 feet and a width of 300 feet, subject to a favorable report of the Chief of Engineers. The Chief of Engineers report recommended a channel 34 ft deep and 1,250 ft wide.

17. The three Federal studies described below are particularly germane to this study.

New York Anchorages Study

18. A previous study, the New York Anchorages Study, authorized by a resolution of the Senate Committee on Environment and Public Works adopted December 5, 1980, was

funded by Congress to investigate the feasibility of providing a deep water anchorage area in the Upper and Lower Harbor. A favorable reconnaissance report was completed under that authority in January 1994, finding that deepening of the anchorages warranted further study. Accordingly, further study of the anchorages was included in the overall scope of this effort as well as an independent study under its own authority. Under this study, the anchorages are considered as part of an overall navigation system. Under the independent authority, they will be examined as an independent solution.

Study of the Arthur Kill South of the Gulfport Reach

19. This section of the Arthur Kill was not originally in this study. Upon initiation of this study, local interests expressed an interest in extending the study area south of the Gulfport Reach. However, it was determined that expansion of this study could delay its completion. As a result, it was deemed that a separate study was warranted. A resolution authorizing a study of further deepening of the Arthur Kill south of the Gulfport Reach (sometimes referred to as, "the Arthur Kill Extension") was passed by the House of Representatives Committee on Transportation and Infrastructure on 6 May 1998. The study was included in the FY99 budget and examined the potential for deepening the Arthur Kill from Morses Creek (just south of the Gulfport Reach) to Perth Amboy, New Jersey. A reconnaissance level report determined that further Federal interest was not warranted. The results of this study have been documented in an internal Corps of Engineers report, which is under coordination.

Dredged Material Management Plan (DMMP) for the Port of NY and NJ

20. The DMMP for New York and New Jersey was initiated pursuant to Corps of Engineers policy as contained in Engineering Circular (EC) 1165-2-200, which requires each District to prepare a long-term plan (not less than 20 years) for maintaining Federal navigation channels. The study emphasizes the dual imperative of economically dredging the naturally shallow Port, and implementing environmentally suitable and cost-effective alternatives to the historic practice of ocean placement of dredged material at the Historic Area Remediation Site (HARS). The DMMP and its draft EIS public review has been completed and are being revised accordingly. It serves as the vehicle for identifying placement options for this navigation study. Accordingly, this study does not contain dredge material studies of its own, other than geotechnical characterization of the material to be dredged.

21. The following three non-Federal studies described below are also germane to this study.

Port Authority of New York and New Jersey: Port Strategic Investment Options Analysis

22. The PANYNJ conducted a study to identify the range of investments needed to maintain or upgrade Port facilities to service the needs of maritime commerce through 2040. The study notes that there are fundamental changes occurring in both the shipping industry and the world economy that could provide significant opportunities for the Port. Trade forecasts indicate that the Port's cargo volumes should grow 3 to 5% per year, which would at least double current volumes by 2015. The Port's existing marine facilities and related transportation infrastructure need to be enhanced to handle these new cargo volumes. The Port Strategic Investment Options Analysis provides the analytical framework for making decisions on which port development opportunities provide the greatest return to the region.

23. The PANYNJ's analysis will address marine terminal development activities, and land-side access issues, including rail and highway capacity. Public access to the waterfront will be an important consideration in design alternatives.

Strategic Plan for the Redevelopment of the Port of New York

24. The New York City Economic Development Corporation (NYCEDC) is currently in the process of developing strategies for improving and developing port facilities at three locations: Red Hook, Sunset Park (South Brooklyn Marine Terminal) in Brooklyn, and Howland Hook on Staten Island. The purpose of the study is to outline a series of targeted investments to develop marine cargo terminals, public access to the waterfront, improved highway and rail access, improved navigation channels, and environmental mitigation over the period from 1999-2020. Each site is being conceptualized as a "stand-alone" development with no dependence on development or improvements at the other sites.

Cross Harbor Freight Movement Major Investment Study (MIS)

25. The NYCEDC and the Federal Highway Administration are funding this MIS. The MIS is based on positive recommendations of a 1997 Intermodal Goods Movement Study, which was co-sponsored by NYCEDC and NYC Department of City Planning. The MIS is aimed at determining effective cross harbor freight movement alternatives, (*e.g.*, cross harbor rail tunnel and/or increased cross harbor barge service) with regard to engineering, environmental, economic and financial factors. The final product will be the recommendation of a preferred alternative(s) for implementation. The study is scheduled for completion in April 2000.

Format of the Report

26. The Main Report of this Feasibility Report is accompanied by the Final Environmental Impact Statement (FEIS) and Appendix A, Pertinent Correspondence and Public Involvement, which documents the coordination effort with the non-Federal partners, and citizens' and business groups in the area, and the general public. Technical appendices as listed at the end of this section provide the basis for the results presented in the Main Report.

27. The main sections of this report detail the development and analysis of the recommended plan, as well as the steps required for project implementation. The first three sections are the Existing Condition, which presents the current physical, environmental, and social conditions, followed by the expected Without-Project Condition, and the Problem Identification, Needs, and Opportunities section (a brief summary of the problem, Harbor needs, and planning opportunities). The planning process is then described in the Plan Formulation section. This section first identifies the general policies, guidelines, and regulations that are common to the assessment of any plan. The section then presents a concise statement of Planning Objectives and Constraints, followed by the Plan Formulation Rationale.

28. After establishing the planning framework, the document describes the sequential analyses undertaken to identify alternatives and to ensure that the selected plan is acceptable to all of the study participants in the Screening of Study Alternatives section. Preliminary plans are identified in the section on Screening of Preliminary Plans and the analyses used to eliminate unfeasible plans are described in the Evaluation of Alternatives section. This section details the project designs as well as estimates of alternative costs and benefits. The selected plan is identified in the National Economic Development (NED) Plan section of the document entitled "The NED Plan".

29. A brief synopsis of the project's impact on the natural and cultural environment is presented in the section titled Environmental Analysis of the NED Plan. This section also identifies the mitigation requirements and significant areas of concern. An economic summary of the selected plan is presented in the Economic Analysis of the NED Plan section. The Recommended Plan section discusses details of the project, including recommendations, as well as project costs and benefits. The Coordination and Public Involvement section reviews public coordination activities. The document then explains the remaining steps for Project Implementation, including the cost apportionment for the Pre-construction Engineering and Design and Construction phases, and the sequence of construction. Following the Conclusion is the FEIS and Appendix A, which documents the views of the interested parties.

30. The Feasibility Report summarizes many detailed technical investigations. Technical appendices were prepared to describe the detailed technical studies conducted and were used for quality control and quality assurance. The following appendices are available at the office of the District Engineer:

Appendix B: (Not Used)

Appendix C: Plan Formulation

Appendix D: Economics

Appendix E: Channel Design

Appendix F: Geotechnical

Appendix G: Structural

Appendix H: Costs

Appendix I: Real Estate

31. In an effort to maintain the continuity of the report, technical figures such as plans, photos, and design details are included after the Feasibility Report text where practical.

(THIS PAGE INTENTIONALLY LEFT BLANK)

EXISTING CONDITION

General

32. The Harbor's waterways are intensively used navigation channels. The Corps presently maintains about 240 miles of navigation channels in the Harbor and additional channels are maintained by the PANYNJ, the City of New York, the State of New Jersey, and various commercial interests. Figure 2 provides an overview of the Harbor and identifies the various pathways and terminals under consideration.

Current Cargo Capacity

33. The capacity of any given terminal to handle containers is the product of its land area and its theoretical productivity rate. Given conditions in this part of the country with respect to labor relations, the price and availability of land, and other less prominent factors, the theoretical productivity rate in the Port's terminals is estimated by the non-Federal partners to be about 1,500 lifts per acre per year. Table 3 shows the actual throughput and estimated capacity of the Port's current container terminals. Currently, the Port averages about 1,000 lifts per acre per year. Measured productivity is below theoretical productivity because at current levels of container traffic, fewer than 1,500 containers per acre per year are presented for lifting.

TABLE 3
Current Container Terminal Capacity

Terminal Name	Terminal size (acres)	1997 Measured Throughput (TEUs*/year) (Current Demand) (1,000's)	Actual Lifts per Acre	Estimated Capacity @1500 Lifts per Acre (TEU/acre/year) (1,000's)
Port Newark/Elizabeth	950	1900	1176	2423
Howland Hook	147	180	720	375
Port Jersey Peninsula	100	175	1029	255
South Brooklyn	0	0	0	0
Red Hook	79	80	596	201
TOTAL	1276	2335	(Avg) 1049	3254

*TEU: twenty-foot equivalent unit. Ratio of TEUs to lifts is approximately 1.7 to 1.

Port Operations

34. The vessel operations of the Port are outlined below. The descriptions are limited to container and liquid bulk vessels and terminals. Ship and terminal operations for barges, automobile carriers, and break-bulk vessels are not discussed because these vessels are

not currently depth-constrained and their fleet mix is not expected to change significantly because of channel improvements.

Container Operations in the Port

Light Loading and Routing

35. Many containerships arrive and depart the Port with less than full loads (light loaded). In general, this is undesirable from the carriers' point of view because average unit costs are increased if a ship is light loaded. There are three principal explanations for this light loading. First, some containerships have design drafts that exceed channel depths in the Port. In order to operate within the controlling channel depths of the Port, these containerships must discharge some of their cargo at a previous port-of-call. Second, containerships that call on the Port usually carry cargo bound for multiple ports and offload some of their cargo at other deepwater ports before reaching the Port. Third, considerations of service quality require that sailing schedules be strictly kept, regardless of the load accumulated on the ship.

Tidal Advantage

36. Tidal advantage involves using the additional bottom clearance provided by high tides to transit from sea to berth (and vice versa). The pilot's ability to exploit high tides is facilitated in the Port by a Physical Oceanographic Real Tide System (PORTS) that allows the operators of vessels moving through the Port to know the precise tidal conditions at key locations in the Harbor. However, tidal advantage is rarely used by containership operators because carriers consider tidal delays (missed tidal advantage transits – also referred to as "institutional delays") as undesirable costs, so they tend not to rely on using tidal advantage. Instead the largest vessels currently using the Harbor arrive with drafts less than their design drafts due to light loading or prior port calls.

Impacts of Vessel Size

37. Containerships of all sizes currently use the Port, including the world's largest container vessels. Depending on how they are loaded, the largest container vessels approach or exceed the limits of existing navigation conditions and practices at the Port. Air draft is also a concern on the Kill Van Kull due to the 151-ft vertical clearance at the Bayonne Bridge, but it is not yet a limiting factor.

Vessel Alliances and Deregulation

38. International container shipping is in a state of constant change due to the increasing significance of vessel alliances, the increasing presence of post-Panamax vessels (vessels which exceed the dimensions of the locks in the Panama Canal), and recently enacted deregulation. In vessel alliances, carriers pool equipment, coordinate sailing schedules, place cargo on each other's ships, and share space at their terminals. From the carriers'

perspective, alliances are attractive arrangements that provide greater opportunity for vessels to carry fuller loads, as well as the means to offer clients improved scheduling and routing. The operational changes that result from improved cooperation among carriers promote the development of larger, more fully-laden containerships and the adoption of a "hub-port" system.

Petroleum Operations in the Port

39. The world liquid bulk fleet is composed of a variety of tanker sizes. The largest tankers are used to transport crude oil on transoceanic voyages (e.g., crude oil imports from the North Sea, the Middle East, etc.). In general, many crude oil carriers have design drafts in excess of controlling depths in U.S. ports. Consequently, lightering is a common practice in many U.S. ports. To take advantage of economies of scale, the tankers arrive fully-loaded. Then some of their load is discharged (*i.e.*, lightered) onto liquid bulk barges to reduce their drafts and allow them to enter the port.

Transportation Costs

40. Transportation costs or shipping costs are calculated using two primary inputs: vessel operating costs and the number of hours in-port and at-sea, in accordance with the Corps' Institute for Water Resources (IWR) Report 91-R-13, *National Economic Development (NED) Procedures Manual – Deep Draft Navigation.* As vessels get larger and deeper, they typically carry more cargo. While the total cost of operating a larger vessel is greater than that of a smaller vessel, the cost per-unit transported (*i.e.*, average cost) is typically smaller due to the increased number of units carried.

41. Total fixed costs are the same for vessels in-port or at-sea. Total annual fixed costs consist of annual operating costs and replacement cost amortized using a capital recovery factor (CRF). Fixed annual operating costs include:

- Wages and benefits,
- Subsistence,
- Stores and supplies,
- Maintenance and repair,
- Insurance,
- Administration.

Terminal Descriptions

Port Newark/Elizabeth

Site Description

42. The Port Newark/Elizabeth site is located on the west side of Newark Bay, just east of Newark International Airport (Figure 2). The general layout of the facilities can be seen in Figure 3, and an aerial photograph of the port facilities is presented in Figure 4. The area is defined by Newark Bay to the east, the Allied Signal property and North Avenue to the south, the New Jersey Turnpike and Newark International Airport to the west and the New Jersey Turnpike extension and bridge to the north.

43. **Buildings, Berths, and Facility Layout**. The site is currently utilized for container operations as well as bulk, break-bulk and roll-on/roll-off (RoRo) cargo. There are over 30 container cranes servicing more than 17,000 linear feet (LF) of wharf and 950 acres of dedicated container terminal area. Container activity on the portion of Port Newark south of the Port Newark channel is primarily confined to the Universal/Maersk terminal at the terminus of the Elizabeth Channel. The portion of Port Newark north of the Port Newark Channel is primarily used for vehicle operations, storage and processing. Activity on the Elizabeth peninsula is principally dedicated to container operations through SeaLand and Maher terminals, although there is some RoRo activity.

44. **Current Throughput**. The marine terminal complex currently handles the majority of containers within the Port. Specifically, approximately 1.9 million TEUs per year are handled at Port Newark/Elizabeth. As a comparison, about 0.4 million TEUs per year are handled in all of the Port's other container facilities combined: Red Hook, Howland Hook, and Global Marine Terminal (on the Port Jersey peninsula).

Land-Side Access and Existing Infrastructure

45. **Highways**. Land-side access to this site is provided by the New Jersey Turnpike and Routes 1 & 9 from the north and south and I-78 and US 22 from the west. The local streets that link these highways to the Port Newark/Elizabeth Marine Terminal are Port Street and Doremus Avenue from the north and North Avenue from the south.

46. **Rail**. A Conrail Shared Asset rail line runs parallel to the NJ Turnpike and serves the Expressrail and Portside facilities. There are many sidings throughout the port at warehouses and transit sheds. The Expressrail lead track crosses Corbin Street at grade and causes considerable disruption to vehicular traffic throughout the port. This crossing is being replaced by a grade separation on McLester Street. Norfolk Southern and CSX Transportation (CSXT) have joint access via Conrail Shared Asset to the Port.

Water-Side Access and Navigation Channels

47. Access to Port Newark/Elizabeth from the Anchorage Channel is provided by the Kill Van Kull to Newark Bay. The Kill Van Kull is presently maintained at its authorized width, ranging from 500 feet to 1000 feet, and at a depth of 40-ft MLW. The other existing navigation channels serving Port Newark/Elizabeth have water depths of 40 ft MLW. Construction has begun to deepen the Kill Van Kull and Newark Bay to 45 ft MLW.

Howland Hook

Site Description

48. The Howland Hook site is located on the west side of the borough of Staten Island, just north of the Goethals Bridge. The general location of the Howland Hook Marine Terminal is shown in Figure 2. Layout of the existing facilities is shown in Figure 5, and an aerial photograph is presented in Figure 6. The site is currently the location of one of the two active container terminal operations in New York City (the other is Red Hook). It is located southwest of Shooters Island, with the existing berths adjacent to Arthur Kill. The area is bounded by the Arthur Kill to the west, Richmond Terrace to the north, the Proctor & Gamble facility to the east and railroad tracks and a rail bridge to the south. A portion of the land between Richmond Terrace and south of Shooters Island Reach is characterized as tidal wetlands.

49. The area was originally developed by a private enterprise, was purchased by the City of New York in the early 1980's, and was subsequently leased to the PANYNJ. The terminal was to become home to United States Lines, but that firm was the subject of bankruptcy proceedings that resulted in its liquidation. With the demise of United States Lines, the terminal was vacant for several years, but a new tenant is in place and the facility is currently an operating marine terminal. The terminal, although near residential property, is relatively isolated.

50. **Buildings, Berths, and Facility Layout**. The site is used for container operations. There are seven container cranes servicing 2500 LF of wharf on a 147-acre terminal. The site was recently upgraded to include a refrigerated warehouse facility. Other features of the terminal include a 200,000 square foot (SF) container freight station (CFS), maintenance and repair facilities, and an administrative office structure.

51. **Current Throughput**. The Howland Hook Marine Terminal handled 180,000 TEUs in 1997.

Land-Side Access and Existing Infrastructure

52. **Highways**. Local land-side access is provided by exits from both eastbound and westbound lanes of I-278, the Staten Island Expressway. Access to State Route 440, the West Shore Expressway, which provides access to New Jersey via the Outerbridge Crossing, is also nearby. The local streets that link this highway to the marine terminal include Gulf Avenue, Forest Avenue, Goethals Road North, and Western Avenue.

53. **Rail**. Main line (on dock) rail access will soon be provided through reactivation of the Staten Island Railroad (SIRR) route via a rail bridge just south of the site.

Water-Side Access and Navigation Channel

54. Access to the Howland Hook Marine Terminal from the Anchorage Channel is gained via the Kill Van Kull and Arthur Kill. Existing navigation channels in the vicinity of Howland Hook have low water depths averaging about 38 ft MLW. Two thousand linear feet of the wharf have been dredged to 42 ft MLW, while the remaining 500 LF is at 37 ft MLW due to high rock elevations in the area. As previously stated, the Kill Van Kull is currently maintained at 40 ft MLW. The Arthur Kill is presently maintained at 35 ft MLW, varying in width from 600 feet to 800 feet. Construction has begun to deepen the Kill Van Kull to 45 ft MLW. Section 338 of the Water Resources Development Act of 1999 authorizes construction of the Arthur Kill to Howland Hook at depth of 40 ft to 41 ft MLW, substantially in accordance with the report of the Corps of Engineers dated July 23, 1999.

Port Jersey/Military Ocean Terminal at Bayonne

Site Description

55. The Bayonne area features three adjacent peninsulas of land extending into Upper New York Bay (see Figure 2). As shown in Figure 7, the three peninsular parcels of land are the "Greenville Yards," the Northeast Auto Terminal (NEAT)/Global Marine Terminal area (Port Jersey peninsula), and the Military Ocean Terminal at Bayonne (MOTBY). An aerial photo of the area is presented as Figure 8. In order to avoid confusion, the NEAT/Global peninsula will be called the Port Jersey Peninsula for the remainder of this report. Both the Port Jersey Peninsula and MOTBY are rectangular-shaped peninsulas which parallel one another and are separated by the Port Jersey Channel. The Port Jersey Channel provides access to marine facilities located on the south side of the Port Jersey Peninsula and the north side of MOTBY. The 180-acre Port Jersey Peninsula is currently occupied by the Northeast Auto Terminal (NEAT) and the Global Marine Container Terminal. The 435-acre MOTBY site is scheduled to come

under the control of the City of Bayonne as a result of the Military Base Realignment and Closure Program and is being considered for a variety of uses.

56. **Buildings, Berths, and Facility Layout**. The total area available for development is about 180 acres. NEAT currently occupies about 80 acres of the Port Jersey Peninsula. It consists of two berths, several administrative and operational buildings, and a large parking area for autos. The Global Marine Terminal occupies approximately 100 acres and is comprised of two berths, and several administrative and operational buildings. The Port Jersey Channel, which serves both the Port Jersey Peninsula and MOTBY, presently has a depth of about 35-ft MLW. Along the northern side of the channel, a 200-foot wide cut to 38 ft MLW is maintained to the western edge of the Global Marine Terminal.

57. MOTBY served as the Department of Defense's primary materiel handling port in the northeast for many years. The terminal includes 10 berths and an U.S. Coast Guard Facility, which is located along the existing turning basin at the western end of the Port Jersey Channel. MOTBY is comprised of a relatively large number of buildings, a rail yard and a graving drydock at the eastern end of the peninsula. A large percentage of the MOTBY peninsula is suitable for container terminal development, pending structural rehabilitation of the wharves.

58. **Current Throughput**. The Global Marine Terminal handled 175,000 TEUs in 1997.

Land-Side Access and Existing Infrastructure

59. **Highways**. The Port Jersey and MOTBY sites are located near Route 169. This multi-lane, limited access highway connects with Exit 14A of the New Jersey Turnpike to the north and the Bayonne Bridge to the south. A signalized intersection provides access to and from MOTBY. Access to the NJ Turnpike is advantageous to truck traffic, however, alternative local routes to the cities of Newark, Elizabeth, and New York City exist.

60. **Rail**. Primary rail service to Port Jersey/MOTBY is provided by a Conrail Shared Asset, serving both Norfolk Southern and CSXT. Port Jersey and the commercial/warehouse area adjacent to it are served by the Port Jersey Railroad, a short haul rail system.

Water-Side Access and Navigation Channels

61. Navigational access to the site is provided by the Port Jersey Channel, which has a depth of 35 ft MLW, a width of 600 feet, and extends from the relatively deep waters of Upper New York Bay to the Port Jersey Basin through relatively shallow areas (*i.e.*, the

Jersey Flats on the north and Robin's Reef on the south). A 200-foot wide portion of the channel is maintained at 38 ft MLW alongside Global to service the terminal. Some vessels use the 1200-foot diameter turning basin at the terminus of the Port Jersey Channel to turn around.

South Brooklyn

Site Description

62. The South Brooklyn site is located on the eastern shore of the Upper Bay, in the Sunset Park section of Brooklyn. The area is comprised primarily of commercial and light industrial developments and is bounded by First Avenue on the east, and by 29th and 65th streets to the north and south, respectively. The existing marine terminal is shown in Figure 10.

63. Figure 2 illustrates the site's proximity to the Upper Bay. The South Brooklyn site has traditionally been used for marine terminal operations and has existing rail access facilities, including the Bay Ridge Branch of the Long Island Rail Road and float bridge at 65th Street. Ground transportation infrastructure needs for the area are currently being addressed as part of the NYCEDC's Cross Harbor Freight Movement Major Investment Study (MIS).

64. **Buildings, Berths, and Facility Layout**. A portion of the site is presently occupied by the former Brooklyn Army Terminal and a portion of the Bush Terminal complex, as shown in Figure 9. The waterfront itself is composed of numerous finger piers, which are in generally poor condition. Several of these piers and adjacent warehouses have collapsed and if nothing is done to rehabilitate the remaining structures, a similar fate awaits them. Some of those determined to be in poor condition have been identified for removal as part of Brooklyn Reach 2B of the New York Harbor Collection and Removal of Drift Project.

65. The northern end of the proposed site was the location of the now-defunct South Brooklyn Marine Terminal. Container cranes have been removed from that site and the yard area is currently being utilized for automobile storage. Additional maritime activity in the area includes an ongoing break-bulk operation at Berths 1 through 5 at the south end of the site.

66. One of the piers west of this complex has been reconstructed and is now being utilized as a parking lot for a passenger ferry service to Manhattan. The area suitable for Port development extends from 29th Street to 65th Street. From 29th Street to 39th Street, the area extends from 2nd avenue to the pierhead line. From 39th Street to 65th Street, the area extends from 1st Avenue to the pierhead line.

67. **Current Throughput**. Containers are not currently handled at this facility.

Land-Side Access and Existing Infrastructure

68. **Highways**. The project study site consists of a relatively long, narrow strip of land bounded on the east by 1st and 2nd Avenues (see above) and the Upper Bay on the west. Access to the site is unusually difficult due to the high degree of road traffic congestion usually experienced in this vicinity.

69. The area is adjacent to the Gowanus Expressway, which leads to I-278 and the Verrazano-Narrows Bridge.

70. Although shipping companies and terminal operators traditionally were content to "truck" containerized cargo to and from dedicated intermodal terminals, recent efforts to improve rail service and reduce costs have led to a demand for on or near dock rail facilities. Nonetheless, it is likely that 70-80% of marine cargo will still be handled by trucks in the future. Such a likelihood poses constraints for container facilities in Brooklyn, where truck access is limited by available highway capacity.

71. Local land-side access is provided with exits at 39th Street from both directions of the Gowanus Expressway. Leaving the terminal, however, requires extensive travel along local streets before it is possible to access the Gowanus Expressway. In this area, the Gowanus Expressway is elevated and Third Avenue is located below it. The local streets which link this highway to the South Brooklyn Marine Terminal include Second and Third Avenues from the north and south, and 39th Street from the east. The NYCEDC is currently working with the New York State Department of Transportation (NYSDOT) to develop additional improvements to the 39th Street and 65th Street interchanges and is studying additional modifications to the Gowanus Expressway which may improve truck access.

72. **Rail**. The New York Cross Harbor Railroad (NYCHRR) provides the primary rail service to the waterfront area and interchanges with the New York and Atlantic Railroad at the 65th Street yard. There is no convenient connection to the main east-west interstate lines and westbound containers have to travel north to Albany before they can connect with rail services to the west. There is, however, an active float bridge at 51st Street serviced by the NYCHRR that is utilized to transport rail cars westward.

73. As previously stated, the NYCEDC is currently studying alternative cross-harbor freight options, including a cross-harbor rail tunnel, or expanded barge service, to serve the city's commercial enterprises. The NYCEDC is constructing two new float bridges at the 65th Street rail yard. Upon completion, the float bridges will provide upgraded rail

service between Greenville, New Jersey and the Brooklyn waterfront. Limited road access means that some form of enhanced cross-harbor service is vital to the operational feasibility of a major container terminal in Brooklyn.

Water-Side Access and Navigation Channels

74. Access to the South Brooklyn study area from the Anchorage Channel is provided by the Bay Ridge Channel and, further north, the Gowanus Bay Channel. The Bay Ridge Channel is maintained at its authorized dimensions of 40 ft MLW, with widths from 1,200 feet to 1,750 feet. The Bay Ridge Flats, a shallow area with water depths ranging from 10 ft MLW to 30 ft MLW, lie to the northwest of the Bay Ridge Channel, while the existing pierhead line defines the channel to the southeast.

Red Hook

Site Description

75. The Red Hook site is located in Red Hook, Brooklyn on the Buttermilk Channel in the Upper Harbor directly across from Governors Island, as shown in Figure 2. As previously stated, Red Hook and Howland Hook are the two active container terminals in New York City. The Red Hook area was originally developed for break-bulk operations and was modified to accommodate containers during the late 1970's and early 1980's. The non-Federal partners have indicated their intentions to convert this container operation to general cargo and consolidate break-bulk and neo-bulk functions there following rehabilitation of the South Brooklyn Marine Terminal. Existing conditions at Red Hook Container Terminal are presented in Figure 11. The area is bisected by the right of way for the Brooklyn Battery Tunnel. An aerial photograph of the site is presented in Figure 12.

76. The Red Hook site is proximate to the relatively deep waters of the Upper Bay. Channels leading to the facilities from the Anchorage Channel are relatively short, compared with other terminal areas in the Port.

77. **Buildings, Berths, and Facility Layout**. There are currently five container cranes serving the 79-acre Red Hook site. Figure 11 shows the main container berth area with three cranes. The remaining cranes are located on Pier 9A. There are four cargo sheds in the area, several of which are still being utilized for cargo operations.

78. **Current Throughput**. The Red Hook Container Terminal handled 80,000 TEUs in 1997.

Land-Side Access and Existing Infrastructure

79. **Highways**. The Brooklyn-Queens Expressway provides the major land-side access to the site from the north and the Gowanus Expressway provides access from the south. Local streets such as Columbia Street (from north), Van Brunt Street (from south) and Hamilton Avenue (from east) link these highways to Red Hook Container Terminal.

80. **Rail**. There is no direct rail access to the site. Cross-harbor movement of containers from the container terminal are handled through a barge service to the PANYNJ's marine terminals at Port Elizabeth that is partially subsidized through the Federal Congestion Management/Air Quality (CMAQ) program.

Water-Side Access and Navigation Channels

81. Access to Red Hook from the Anchorage Channel is provided by the Buttermilk Channel. Maintained at its authorized width of 1,000 feet, it is 35 ft deep MLW in the western half of the channel and 40 ft MLW in the eastern (Brooklyn) half. The Buttermilk Channel is bounded on the west by Governors Island.

Stapleton

Site Description

82. The Stapleton site is located on the eastern shore of Staten Island in the Upper Harbor, adjacent to Stapleton Anchorage, as shown in Figure 2. It is very close to the Staten Island Ferry Terminal in St. George. The area includes the former U.S. Naval Homeport that was vacated as a result of the Military Base Realignment and Closure Program.

83. The area is now vacant. The site lies just north of Fort Wadsworth and the Verrazano-Narrows Bridge, as shown in Figure 13. Channels leading to the site would be relatively short, relatively easy to construct and relatively easy to maintain vis-à-vis other areas of New York Harbor.

84. **Buildings, Berths, and Facility Layout**. There are several warehouse, maintenance and administrative office structures on the site today as well as a 1,400-foot finger pier. None of these structures are compatible with or suitable for a modern container terminal application.

85. **Current Throughput**. Stapleton does not currently handle cargo. Container terminal development at this site would require land creation around the existing Navy pier. A very thick layer of soft clay would have to be stabilized prior to any construction.

Land creation would require installing an enclosure structure for placement of fill. This is likely to be an extremely expensive alternative.

Land-Side Access and Existing Infrastructure

86. **Highways**. The site is located east of Bay Street between Hannah Street and Edgewater Street in the Stapleton section of Staten Island. Land-side access is provided via the School Road exit off the I-278 Staten Island Expressway. The local streets which link this highway to the proposed marine terminal site include Bay Street and School Road from the south.

87. **Rail**. There is no freight rail access to the site. The electrified lines of the Staten Island Rapid Transit System are adjacent to the site, but accommodate passenger service only along the south shore of Staten Island to the ferry terminal in St. George.

Water-Side Access and Navigation Channels

88. The study area is adjacent to the Anchorage Channel. The existing low water depths in the area range from 35 to 55 ft MLW.

TOSCO

89. The Tosco Refining Company is located along the west coast of the Arthur Kill in Linden, New Jersey, as shown in Figure 2. The facility receives over 20 petroleum and petrochemical shipments per month. It also functions as a storage and distribution center.

GATX

90. The GATX Oil Depot is a major facility located along the east coast of the Arthur Kill in Staten Island, New York, as shown in Figure 2. Though the facility is presently closed, the terminal has historically received petroleum and petrochemical shipments.

Anchorages

91. The Harbor anchorages at Stapleton, Gravesend Bay and Red Hook Flats are integral to the waterborne commerce network. The anchorages are used to wait for berthing availability or favorable tides, and for lightering. Table 4 shows the types and typical numbers of vessels utilizing the anchorages.

TABLE 4 NY&NJ Harbor Anchorage Use (August 1998 – July 1999)	
Vessel Type	**Number of Vessels**
Tanker - Oil/Gas	286
Tanker – Chemical	19
Container Vessel	45
Bulk Carrier	66
Auto Carrier	5
Barge	724
Source: U.S. Coast Guard, Vessel Traffic Service New York	

Terminal Summary

92. Table 5 provides a summary of the terminals and locations described above.

TABLE 5 Terminal Descriptions – Existing Condition		
Terminal	**Description**	**Figures**
Port Newark/Elizabeth	950-acre container terminal, including all facilities	3, 4
Howland Hook	147-acre container terminal, no current rail access	5, 6
Port Jersey/MOTBY	100-acre container terminal (Global Marine) adjacent to NEAT	7, 8
South Brooklyn	No existing container terminal	9, 10
Red Hook	79-acre container terminal, no current rail access	11, 12
Stapleton	No existing container terminal	13
TOSCO/GATX	Oil facilities	None
Anchorages	Stapleton, Gravesend Bay, Red Hook Flats	None

Regional Transportation

Commercial Trucking

93. Commercial trucking remains the dominant means of transportation in the region. This is facilitated by the Port's proximity to the major I-95 corridor. While I-95 is the dominant "spine" of the North-South corridor, the majority of the commercial truck transportation travels on the other highways crisscrossing the region, which are all linked directly or indirectly to the Port through I-95. This system of highways provides ready access to the region's hinterlands (described in the Socio-Economic Profile section).

Rail

94. The major rail lines in the region provide access to Port Newark/Elizabeth and the Port Jersey Peninsula. These lines connect to major east-west rail lines and provide the bulk of rail transportation to and from the region. Likewise, the Staten Island Railroad will provide similar service to Howland Hook Marine Terminal when it reopens in the future. Rail carriers provide service to Brooklyn and other East of the Hudson destinations via a crossing at Selkirk, NY and the rail line that runs down the east shore of the Hudson River. The New York Cross Harbor Railroad (NYCHRR) provides another crossing opportunity through the use of floating bridges between Brooklyn and Greenville, but service is limited. The New York City Economic Development Corporation (NYCEDC) is studying cross-harbor freight alternatives, which include expansion of float bridge service in the Port and/or construction of a cross-harbor freight tunnel. Figure 14 shows the current locations of the major railroads in the region.

95. The region's major rail system has undergone a significant change as the assets of the former regional freight carrier (Conrail) have been divided between CSX Transportation and Norfolk Southern. However, as part of the purchase of Conrail, a regional line called Conrail Shared Asset (owned jointly by Norfolk Southern and CSX) will serve all terminals in the Northern New Jersey Areas. The division of Conrail and the use of a neutral regional line are expected to result in a higher degree of competition and increased options for shippers. However, regional transportation organizations remain focused on rail line capacity as both freight and passenger carriers continue to grow and compete for limited rail lines.

Growth and Development

96. Regional agencies, including the North Jersey Transportation Planning Authority (NJTPA) and the New York Metropolitan Transportation Council (NYMTC), have played a significant role in the continued development of the landside infrastructure in the Port. These organizations have identified freight-and-port-beneficial funding in their current Transportation Improvement Programs (TIP's) totaling over $1 billion. The planned improvements will enable carriers to meet the future transportation needs of regional shippers.

Environmental Setting

General

97. The Harbor is naturally shallow, averaging a depth of approximately 19 ft MLW, with complex geography, hydrodynamics, and ecology. It is comprised of four large embayments: Upper New York Bay, Lower New York Bay, Newark Bay, and Raritan Bay. Upper New York Bay and Lower New York Bay are separated by a constriction - the Verrazano Narrows. Newark Bay, the smallest of the four, is linked to the other embayments by narrow, natural waterways. Newark Bay is connected to Upper New York Bay by the Kill Van Kull and to Raritan Bay by the Arthur Kill. The Harbor also consists of a network of public and private channels and berths, including those constructed and maintained by the agencies of the Federal, state, and local governments as well as by private companies.

98. The Harbor is an estuary. Thus, it is strongly affected by tidal action, and within it sea water is mixed with stormwater runoff. The core area of the Harbor estuary is the Hudson-Raritan estuary, which extends from the Piermont Marsh in New York State to the Sandy Hook-Rockaway Point Transect. Habitat types that are found in the Harbor include: tidal rivers, salt and freshwater tidal marshes, woodlands, shallow bays, barrier beaches, and sand dunes.

99. Several wildlife species are found in the Harbor, many of which rely on estuarine habitats for nesting, foraging, reproduction and early development, and survival. The Arthur Kill and Kill Van Kull support populations of nesting shore birds on Federal or state-protected islands which, combined, comprise the Harbor Herons Complex.

Climate

100. The area has a predominantly continental climate with maritime influence. This results in frequent short-term meteorological changes. Southerly winds, often in the form of local sea breezes, have a moderating effect on the temperature, particularly during the spring and summer months.

101. Two types of storms are of primary significance in the region: (1) tropical storms, which typically affect the study area from July to October, and (2) extratropical storms, which are primarily winter storms. Extratropical storms ("Nor'easters") are usually less intense than hurricanes, but tend to be of longer duration. These storms often cause high water levels and intense wave conditions and are responsible for significant wave and flooding damage.

Hydraulics

102. Waves in the Harbor are limited due to the protection afforded by the adjacent land masses. Currents generally range from 0.6 to 2 feet per second (fps) throughout the Harbor. Tides throughout the Harbor are semi-diurnal, with a mean tide range of approximately 5.0 feet. As a result of the hydraulic condition, sedimentation rates in the region vary widely depending on location: around the Elizabeth peninsula it ranges from 1.5 inches per year (in/yr) to 5 in/yr around the Newark peninsula, from 5 in/yr at the inshore end of Newark Channel to 18.8 in/yr at the Pierhead Channel. In the vicinity of Shooters Island it is approximately 11.7 in/yr and in the vicinity of Port Jersey it is approximately 2.7 in/yr.

Geology

103. New York Harbor consists of numerous bays, rivers, and channels of complex shape that are connected to the Hudson River, the main element of the harbor complex. The area is underlain by both bedrock and unconsolidated materials. Coastal Plain deposits form a seaward-thickening wedge of poorly consolidated sediments, which dip gently to the east and unconformably overlie older rock units. Surficial deposits in the project area are either glacial or postglacial, being deposited either before or after the close of the most recent glaciation period. No economically significant mineral deposits are mapped in the study area, however, commercial sand mining periodically occurs in the Ambrose Channel (Lower Bay) and other locations in the Harbor.

Land Use

104. The existing land use surrounding the Port supports the industrial, transportation and waterborne commercial nature of the area. Land use adjacent to the Harbor ranges from tidal wetlands to heavy urban development. Inland, the land uses are devoted more to residential, commercial and industrial purposes. The study area is in the northeast's north-south transportation corridor and is crisscrossed by major interstate highways.

105. Generally, in all Harbor areas, as a result of long-established urbanization, the area's natural environment has been affected. Recreational opportunities are limited. Fish and wildlife resources use the area year round. With the exception of the wetlands and marshes along the Arthur Kill, limited natural shoreline habitat remains in the project area.

Upland Habitat

106. In general, upland habitat in the study area has undergone substantial alteration as a result of dredging, filling, shoreline development, commercial and industrial activities,

and runoff and discharge of pollutants. Due to extensive shoreline development and industrialization, upland habitat in the study area is generally limited to parks and the upland portions of area wetlands and marshes. Limited upland vegetation is present on the islands comprising the Harbors Heron Complex (Shooters Island and Pralls Island).

Marine Biota

107. Over the years, the biotic communities within the project area have adapted to the existing environmental conditions. Species, which were able to tolerate or adapt to those conditions, take advantage of the available habitats. Because the Harbor estuarine system provides a physical passageway from the Atlantic Ocean to Newark Bay and the Passaic and Hackensack rivers, Raritan Bay and the Raritan River, Hudson River, and East River to Long Island Sound, many species utilize its waters during seasonal migrations, or only during a particular stage in their life history. The seasonal presence of species permits optimal use of the ecosystem and usually results in the avoidance of less favorable conditions for organism growth and development.

Avian Fauna

108. A wide variety of waterfowl, wading birds, and shorebirds use the waters and wetlands of the Port wherever shallow water, mudflats, or wetlands exist, primarily in Raritan Bay, the Arthur Kill, Kill Van Kull, Newark Bay, and the Constable Hook Area. These areas provide resting and feeding areas, as well as habitat for wintering waterfowl.

109. The Harbor Herons Complex is located within the project area. This complex includes some colonial wading bird rookeries located on Prall's Island, the Isle of Meadows, and the associated foraging and resting habitat found along the Kill Van Kull and the Arthur Kill. Shooters Island, located at the juncture of the Kill Van Kull and Arthur Kill, is the oldest of the rookeries, however, it has not been used as such for the past two nesting seasons.

Wetlands

110. Several large wetland areas exist along the shore of the Arthur Kill, with two located within the study area; one east of Howland Hook at Port Ivory and one on the shoreline under, and adjacent to, the Goethals Bridge. Some wetland fringes are also located at Shooters Island and an area of shallow mudflats that exists in the southwest corner of Newark Bay, bordering the Arthur Kill along the U.S. Dike. Large wetlands areas are located north of Constable Hook, in the vicinity of Caven Point, along the eastern shore of Staten Island, along the New Jersey shoreline of Raritan Bay, and around Coney Island. Throughout the area, there are numerous small marsh areas scattered amid shipwrecks and abandoned docks.

111. In southwestern Newark Bay lies a rectangular shaped area generally known as the "mudflats." In addition, the Jersey Flats are located off the MOTBY and Port Jersey Peninsulas, and the Bay Ridge Flats are bordered by the Bay Ridge and Red Hook channels. These shallow areas are utilized by a number of fish and wildlife species. Greater benthic activity and higher dissolved oxygen levels provide important habitat for fish species, as well as feeding and resting areas for waterfowl and shorebirds.

Water Quality

112. The Harbor is a dynamic estuarine system. The water quality parameters and the residence time of the particulate constituents reflect the quality of tributary (primarily freshwater) flow and the exchange with ocean waters, and the lateral, longitudinal and vertical circulation patterns. The Hudson River is the primary tributary to the Harbor, with secondary flows from the Raritan, Hackensack, and Passaic Rivers. In addition, the tidal East River exchanges water between the Harbor and Long Island Sound. Pollutant sources to the Harbor include municipal and industrial discharges, runoff (stormwater and combined sewer overflows), tributaries, landfill leachate, atmospheric deposition, accidental spills, and tidal waters.

Air Quality

113. Six priority pollutants have been identified by the EPA as being of concern in the study area: carbon monoxide, nitrogen oxides, ozone, particulates, sulfur oxides, and lead. Specific pollutants in the study area are summarized as follows:

- Carbon monoxide levels have declined in recent years;
- Sulfur dioxide and sulfate levels have continued to decline;
- Area nitrogen dioxide concentrations continue to remain below the level of the air quality standard;
- 1996 particulate concentrations were the 2nd lowest recorded since particulate sampling commenced in 1986;
- Area lead concentrations have remained unchanged or have declined and have remained in compliance with air quality standards.
- Ozone levels have improved over time, however, New York City is listed as a"high-severe" ozone non-attainment area.

Archeological, Historical and Cultural Resources

114. Archaeological resources within the study area are likely to be limited to prehistoric remains as the area has historically been inundated. Prehistoric resources may be present as much of the Harbor area was dry land at the end of the last ice age and now-

inundated areas may have been inhabited by Native American populations. Due to the submerged nature of the project area it is unlikely that traditional archaeological sites will be found, however, the paleoenvironment can be reconstructed through an analysis of soil borings. The results of recent analyses have allowed archaeologists to identify locations within the study area that were sensitive locations on the former landscape. Prehistoric archaeological sites on present-day dry land are generally located near certain key physiographic resources such as fresh water and ecologically rich habitats. The same, it is believed, holds true for sites now submerged. The preservation of continental shelf sites was affected by many factors associated with a rising sea level but it appears that a number of locations may have survived this inundation.

115. The Port area has been subject to numerous cultural resources surveys that have been directed at particular project locations within the Harbor. Many of these previous studies were conducted for the District as part of the Collection and Removal of Drift Program, individual channel navigation projects, beach erosion control projects and the Dredged Material Management Plan (DMMP). Due to significant project area overlap between this study and other projects these previous surveys have been used for cultural resources identification and impact assessment as well as Section 106 coordination with the New York and New Jersey State Historic Preservation Offices (SHPO's) and the New York City Landmarks Preservation Commission.

116. Areas considered to possess moderate sensitivity will be subject to additional studies in the form of remote sensing surveys and additional borings. These areas include, but are not limited to, the Jersey Flats adjacent to the Port Jersey Channel, the shallows in Newark Bay, the area northeast of Shooters Island in the Arthur Kill, and several areas in the Arthur Kill and Kill Van Kull where channel widening may impact derelict vessels deemed to be of historical significance.

Socio-Economic Profile

General

117. The geographic scope of the socio-economic profile extends beyond the New York – New Jersey metropolitan area to include the domestic economic hinterlands of the Port, which reach into the continent's interior. The socio-economic conditions in the Port's hinterlands are relevant to this study because the intensity, character, and location of their economic activity will directly affect future commodity movements through the Port.

Domestic Economic Hinterland

118. For this study, four different definitions of the Port's economic hinterland were used, as shown in Figure 15. The four hinterland definitions focus on container

movements through the Port (petroleum products entering the Port are largely for local consumption or transshipment by barge to nearby states, and bulk commerce makes up a very small portion of commodity traffic through the port).

31-County Metropolitan Area

119. The core of the Port's hinterlands is the New York and New Jersey metropolitan area. Approximately 70% of containerized cargo moving through the Port is destined for or originates in the metropolitan area. This area consists of 31 counties, including 14 counties in southern New York State (five in New York City, two in Long Island, and seven in the Mid-Hudson region); 14 counties in northern New Jersey; and three counties in southwestern Connecticut.

260-Mile Radius

120. Another delineation consists of a 260-mile radius from the Harbor. This radius, which includes the 31-county metropolitan area, is used by the New York Shipping Association to collect fees from carriers assessed on behalf of the International Longshoremen's Association. The 260-mile radius encompasses all or part of 13 states, including: New York, New Jersey, Massachusetts, Rhode Island, New Hampshire, Vermont, Connecticut, Maine, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, and Washington D.C. Approximately 82% of the containerized cargo that moves through the Port is destined for or originates within 260-miles of the Port.

17-State Region

121. A third hinterland definition provides another description of the Port's primary hinterland, in this case a 17-state region that extends from New York to Missouri and from Maryland to Maine. This description of the hinterland was used to analyze costs associated with the transportation of cargo from Southeast Asia to New York for comparison with cargo destined for Los Angeles and Long Beach. The analysis compared the potential costs and delivery times to all states in the continental U.S. for vessels originating in Hong Kong. These 17-states met the criteria of being serviced through the Port at a lower cost and within a reasonably small time disadvantage, when compared to service through Los Angeles or through Long Beach. The resulting 17-state region encompasses New York, New Jersey, Massachusetts, Rhode Island, New Hampshire, Vermont, Connecticut, Maine, Pennsylvania, Delaware, Maryland, Ohio, Michigan, Indiana, Illinois, Iowa, Missouri, and Washington D.C.

31-State Secondary Hinterland

122. The Port's secondary hinterland is defined as the remaining 31 states within the continental United States. In this 31-state region, the Port has a relatively small share of international trade. However, the Port actively competes in the secondary hinterland with other ports (especially west coast ports) to capture a greater market share of this trade.

Figure 16 shows the general distribution of import and export movement through the Port and the hinterland.

Population

123. The Port's primary hinterlands, including the 17-state region and the 260-mile radius, contain approximately 40 percent of the population of the entire continental United States. The populations in the Port's metro area and primary hinterlands (17 states and 260-mile radius) are expected to grow much more slowly than the national average due to the rapid population increases anticipated for the western states, as represented by the 31-state secondary hinterland.

Income

124. Income levels in the Port's hinterland suggest their potential to generate imports for the Port because they imply consumer spending power and serve as broad measures of economic activity. Per capita incomes in the metro area, the 260-mile radius, and the 17-state region exceed the national average by 32, 15, and 8 percent, respectively. Estimates of 1998 total personal income show that approximately 25 percent of the nation's total personal income is generated within the 260-mile radius, and the 17-state region accounts for approximately 42 percent of the nation's total personal income.

Employment

125. For the 1998-2045 period, all-industry employment growth rates in the 31-county metropolitan area, in the 260-mile radius, and in the 17-state region are expected to be slower than projected national growth rates. This is consistent with the expected slower growth in total population for these regions relative to the nation. In contrast, projected employment growth for the 31-state secondary hinterland is expected to exceed national levels. The 1998-2045 sectoral employment forecasts suggest that the Port hinterlands – and the nation as a whole – will continue their current transitions from manufacturing to service economies. For the 31-county metropolitan area, the 260-mile radius, and the 17-state region, manufacturing employment is expected to decline, while employment in the construction and services sectors is expected to grow significantly. In contrast, manufacturing employment in the 31-state secondary hinterland is expected to experience modest gains over the 1998-2045 period.

(THIS PAGE INTENTIONALLY LEFT BLANK)

WITHOUT-PROJECT CONDITION

General

126. The Without-Project Condition is defined by the Corps' Engineering Regulation (ER) 1105-2-100, *Policy and Planning Guidance for Conducting Civil Works Planning Studies (Planning Guidance Notebook)* to be the future condition expected to occur within the study area in the absence of project implementation. It is the baseline condition upon which the physical and beneficial impacts of proposed plan alternatives are measured. The vast majority of goods entering the Port are destined for the Port's primary hinterland, which encompasses a 260-mile radius around the Harbor. Forecasts indicate that as a result of population growth, development of worldwide markets, and shifts in the world trading routes that the quantity of goods passing through the Harbor can be expected to increase from 2.4 million TEUs today to over 19.1 million TEUs by the year 2060. Accordingly, the Without-Project Condition will likely include some Harbor improvements aimed at capturing a portion of the forecasted trade that otherwise could not be handled based on projected throughput capacity of the Port's container terminals. The nature and extend of the Without-Project improvements will depend on the investments deemed economically viable to the non-Federal partners. An assessment of future Without-Project Conditions is described in the following paragraphs.

Non-Federal Partners' Comprehensive Port Improvement Plan

127. The non-Federal partners' developed a Comprehensive Port Improvement Plan (CPIP) which reflects their proposed terminal improvements. The plan is predicated on the assumption that they will desire to increase throughput capacity in order to handle a higher volume of trade. They have demonstrated some commitment to increasing capacity by devoting resources to detailed planning for their development. However, this plan is only reflective of the non-Federal partners' level of commitment without any Federal improvement. No inference of endorsement or other expression of approval of these plans on the part of New York District or any of the appropriate permitting agencies, including New York District Operations Division, is intended or should be drawn. In general, those plans put forward by the non-Federal partners to increase capacity via expansion of container terminals through the use of fills, have not been included in the Without-Project Condition.

Shortage of Throughput Capacity

128. Unconstrained projections of the volume of commerce passing through the Port over the planning period (2010-2060) exceed the Port's projected theoretical throughput capacity. At the present theoretical productivity of 1,500 lifts per acre per year, the Port's terminals taken together are capable of handling 3.25 million TEUs (1.9 million

containers, given the current mix of container sizes) annually. Assuming that by 2040 theoretical productivity rises to 3,500 lifts per acre per year, as discussed in the following sections, the Port would then be capable of handling 7.1 million TEUs (4.2 million containers) annually. However, commerce volume is projected to grow to 19.1 million TEUs (11.2 million containers) annually by 2060 (even if the channels are not improved), leaving an annual throughput shortfall of 11.5 million TEUs (6.7 million containers). If this excess quantity of container cargo handling services demanded is to be fully or partly accommodated, throughput capacity must be increased further. This might be accomplished in any of several ways or a combination of them: productivity can be further increased, non-water dependent facilities can be relocated upland to provide additional container yard space, the terminals can be expanded or new facilities developed. On the assumption that they will find it to be in their interest to increase capacity sufficiently to provide all of the quantity of container cargo handling services demanded implied by their economic forecast, the non-Federal partners have proposed expansion of terminal land area as the means of accommodating some portion of the future commodities seeking to pass through the Port. As there is a lack of available waterfront land, the expansion and development of new facilities would require new waterfront fills. The non-Federal partners have indicated in this vision of the future they anticipate about 600 acres of new land for container terminals would be desired and that it will come mostly from new waterfront fills. It is important to note that none of this contemplated increase in capacity, however it is to be accomplished, is necessary to justify improving any of the Port's channels and were not deemed to be part of the Without-Project Condition.

Productivity Increases

129. The land-side productivity of marine terminals located in the Harbor (i.e., potential throughput per terminal acre) is anticipated to increase significantly due to advances in technology and changes in operating procedures. Theoretical land-side productivity is currently affected by the following equipment and operational factors:

- Number of berths at the terminal;
- Number and speed of cranes;
- Stevedoring productivity rate;
- Terminal yard area and storage technology;
- Utilization of terminal area;
- Container dwell time;
- Gates.

130. As stated above, the Port's theoretical productivity per acre is expected to increase with a concomitant increase in throughput capacity. As evidenced by the recent purchase of 4 new cranes for the Global Marine Terminal, it is anticipated that the

terminals will be investing in upgraded equipment over the planning horizon. Moreover, pressure to increase throughput through existing terminals to meet the rising quantity demanded will result in enhanced operating procedures. Enhancements may result in reduced dwell-time, more efficient use of yard space, and implementation of modern intermodal transportation facilities. The non-Federal partners have predicted that theoretical productivity of land will increase at an average annual rate of about 2% per year. This will cause theoretical productivity to rise from 1,500 container lifts per acre now to about 3,500 container lifts per acre in 2040, the endpoint of their analysis. Because the period of analysis for the present study extends beyond 2040 to 2060, it was assumed for planning purposes that the theoretical productivity of land would level off at that point and remain essentially constant through the year 2060. At approximately 1.7 TEUs per container lift this means the throughput capacity will increase from about 2550 TEUs/acre/yr to about 5950 TEUs/acre/yr over the next forty years.

131. Estimates of future South Brooklyn Marine Terminal productivity (*i.e.*, container lifts/acre/year) were adjusted to reflect uncertainties regarding the specifics of the cross-harbor improvements presently under study by the NYCEDC. Discussions with those involved in the study indicate that the cross-harbor improvement may consist of a rail tunnel and/or barge system. Productivity of the South Brooklyn container terminal will be closely tied to the type of cross-harbor improvement constructed and may be less than, or exceed, the other terminals in the Port. Moreover, there may be additional costs associated with moving containers through the terminal (*e.g.*, it may be necessary to place a container on a truck after it has been moved through a rail tunnel from the South Brooklyn terminal.). Inasmuch as the plans for the cross-harbor improvement have not yet been completed, future productivity rates have been reduced to 75% of the productivity estimated for the other terminals in the Port. This reduction was made on the basis of professional judgement in order to facilitate a prudent assessment of the feasibility of the South Brooklyn terminal.

Proposed New and Expanded Terminal Development in the CPIP

South Brooklyn

132. The New York City Economic Development Corporation (NYCEDC) is planning the development of a 315-acre container terminal in South Brooklyn. The terminal will include the rehabilitation of the currently deteriorated waterfront area and the placement of 145 acres of waterfront fill. Execution of this plan relies on enhanced cross-harbor movement of goods from Brooklyn to New Jersey. The NYCEDC is exploring alternatives for this cross-harbor movement, including a rail tunnel and an enhanced barge operation. However, the results of their ongoing study of cross-harbor alternatives will not be available until after the present Feasibility Report is completed. Therefore, development of South Brooklyn hinges on several critical environmental and

infrastructure-related issues that remain unresolved at the present time. In this regard, the viability and certainty of construction of this option are in question.

Military Ocean Terminal at Bayonne (MOTBY)

133. At the present time, negotiations for purchase or lease of MOTBY or a portion thereof are continuing. Uncertainty surrounds both the development of the peninsula as a container terminal and the anticipated size of the developed terminal. The non-Federal partners currently envision a 130-acre container terminal to occupy a portion of the 435 usable acres. However, terminal development is contingent upon the transfer of land from the US Government to the City of Bayonne followed by the purchase or lease of the peninsula space by an interested developer.

Port Newark/Elizabeth Marine Terminals

134. The PANYNJ expects to expand the existing terminals as follows:

- Reconfigure the existing container terminals;
- Expand terminals through the demolition of warehouses for an additional 100 acres of terminal space;
- Construct an intermodal terminal at Port Newark;
- Convert a 387-acre confined placement area (fill) to new terminal(s).

Howland Hook Marine Terminal

135. Capitalizing on the re-activation of the Staten Island Railroad, the PANYNJ and the City of New York plan to expand operations at the Howland Hook Marine Terminal by acquiring the adjacent Proctor & Gamble site and expanding the facility north of Richmond Terrace via a land connection. The new terminal acreage will be used as an intermodal yard with floating bridge access and a 40-acre warehousing/distribution center.

136. The existing berths at Howland Hook will be strengthened to provide stability for channel depths of up to 50 ft MLW.

Terminals Scheduled for Closure or Other Uses in the CPIP

Red Hook Container Terminal

137. The non-Federal partners have indicated that container-handling operations at Red Hook Container Terminal will be phased out by approximately 2010. Moreover, no productivity increases are expected between 2000 and 2010.

Claremont Terminal

138. The non-Federal partners have also indicated that there is no interest in developing the Claremont Terminal, currently a scrap metal import and export facility located at the head of the Claremont Channel, as a container terminal, either at its present size or through proposed expansions.

Oil Terminals

139. The non-Federal partners have indicated that there will be no increase in the number of or spatial requirements for petrochemical facilities due to environmental and practical constraints. Navigation improvements are required only to increase the efficiency of deliveries to existing facilities and to reduce the exposure to risk of environmental damage stemming from lightering operations.

Summary of the Non-Federal Partners' CPIP

140. Table 6 provides a summary of the non-Federal partners' Comprehensive Port Improvement Plan.

TABLE 6
Summary of Non-Federal Partners' Comprehensive Port Improvement Plan

Terminal	Planned Terminal Acreage and Fill (Year 2060)	Description of Major Terminal Modifications
Port Newark/Elizabeth	1437 / 387	100-acre reconfiguration 387-acre terminal creation on 387 acres of fill (Port Elizabeth)
Port Jersey/MOTBY	310 / 0	80-acre reconfiguration (NEAT) 130-acre terminal (MOTBY)
Howland Hook	147 / 0	Additional acreage may be provided by Proctor &Gamble site acquisition
South Brooklyn	315 / 145	315-acre terminal creation on 145 acres of fill
Red Hook	0 / 0	Phased out by 2010
Total	2209/ 532	

Without-Project Condition

141. The non-Federal partners' Comprehensive Port Improvement Plan (CPIP) for the Port's terminals is predicated on maximizing market share by creating sufficient capacity to provide all of the quantity of container cargo handling services demanded predicted in their economic analysis. However, the plan calls for development and expansion through land reclamation that is uncertain at this time. The Port Newark/Elizabeth expansion will impact the Newark Bay mudflats and the South Brooklyn development will impact fish habitat in the vicinity of the former Bush Terminal. As discussed previously, these plans

have a strong level of commitment from the non-Federal partners, but the regulatory agencies responsible for permitting these developments have indicated that alternatives to fills must be evaluated. A separate environmental analysis of the non-Federal partners' actions must be completed prior to construction. Based on coordination between the Environmental Protection Agency, the New York District, and the non-Federal partners, it was determined that a Comprehensive Port Improvement Plan EIS (CPIP-EIS) would be required to determine how to prioritize and screen potential terminal expansions put forth in the non-Federal partners' CPIP. Recent reclamation projects have been permitted in the ports of Long Beach and Los Angeles. Accordingly, it might reasonably be expected that a permit could eventually be granted for some or all of the proposed fills, however, the District is not considering any regulatory decisions at this time.

142. The project was formulated on the basis of a Without-Project Condition that does not include fills as the most likely future condition. The terminal reconfiguration at Port Newark that consists of demolishing existing warehouses (Figure 17) to provide 100 acres of additional productive container terminal yard area is included in the Without-Project Condition. Similarly, as shown in Figure 18, the rehabilitated 100-acre terminal at the South Brooklyn Marine Terminal was included in the formulation process as part of the Without-Project Condition. The configuration of the proposed terminal does not require or include any waterfront fills. The Without-Project Condition for Port Jersey Channel is shown in Figure 19 and consists of the existing 100-acre Global Marine Terminal, a 130-acre portion of the former MOTBY property, and the reconfiguration of the 80 acres that currently comprise the Northeast Auto Terminal (NEAT). Combined, these anticipated Without-Project actions result in an additional 410 acres of terminal area. This will result in an increase in Port terminal capacity from 7.1 million TEUs to 9.6 million TEUs at the predicted theoretical productivity of 3,500 lifts per acre per year. Table 7 summarizes the Without-Project Condition for the terminals as used in the plan formulation, none of which require the placement of fill for land reclamation.

TABLE 7
Terminal Descriptions – Without-Project Condition

Terminal	Description
Port Newark/Elizabeth	1050-acre container terminal, including all facilities (950 acres + 100 acres reconfiguration) – no fill
Howland Hook	147-acre container terminal – no fill
Port Jersey/MOTBY	310-acre container terminal, incl. MOTBY (100 acres + 80 acres NEAT + 130 MOTBY acres) – no fill
South Brooklyn	100-acre container terminal – no fill
Red Hook	No container terminal (converted to general cargo by 2010)
TOSCO/GATX	Oil facilities

Channel /Anchorage Maintained Depths

143. Table 8 presents the authorized dimensions of the navigation channels and anchorages in the Harbor along with their presently maintained depths. As indicated in Table 8, it is anticipated that the Without-Project Condition depths will coincide with the authorized depths except for the Arthur Kill where reauthorization of an interim depth is pending, and the Ambrose and Anchorage Channels in which authorization was subject to a favorable report by the Chief of Engineers which was not pursued.

TABLE 8
Navigation Channels and Anchorages in New York & New Jersey Harbor
(Federally Authorized & Maintained)

Waterway	Authorized Depth	Without-Project	Authorized Width	Presently Maintained Dimensions
Ambrose Channel	55 ft MLW, subj to a favorable rpt by the Ch.of Eng.	45 ft MLW	2000 ft	Authorized width is maintained. Depths are greater than the constructed 45 feet MLW in many areas due to commercial sand mining.
Anchorage Channel	55 ft MLW, subj to a favorable rpt by the Ch.of Eng.	45 ft MLW	2000 ft	Same as presently constructed and maintained. Little maintenance is required.
Kill Van Kull and Newark Bay	45 ft MLW	45 ft MLW	500-1000 ft	Authorized width maintained. Interim depth of 40 ft MLW is maintained pending construction of the 45 ft MLW depth.
Arthur Kill to Gulfport	45 ft MLW, subj to a favorable rpt by the Ch.of Eng.	41 ft MLW to Howland Hook, 40 ft to Gulfport	600-800 ft	Authorized widths maintained. The previously authorized depth of 35 ft MLW is currently maintained, pending reauthorization of a 40 ft MLW interim depth. A GRR is underway for the 45 ft MLW channel.
Port Jersey Channel	41 ft MLW	41 ft MLW	370-600 ft	Authorized width maintained. A 35ft/38ft MLW depth is maintained. Construction of a deeper Federal channel will federalize maintenance requirements.
Bay Ridge- Red Hook Channels	40 ft MLW	40 ft MLW	1200-1750 ft	Same as authorized.
Buttermilk Channel	35 ft MLW west half, 40 ft MLW east half	35 ft MLW / 40 ft MLW	1000 ft	Same as authorized.
Claremont Channel	42 ft MLW, subj to a favorable rpt by the Ch.of Eng.	15-30 ft MLW	300 ft, subj to a favorable rpt of Ch.of Eng	A natural channel, 27 ft deep MLW, roughly at the authorized width, exists and is utilized, pending construction of the authorized channel.
Stapleton	None, naturally 45 to 75 ft deep	Same		None
Gravesend Bay	47 ft MLW	Same		Same as authorized.
Red Hook Flats	45, 40 and 35 ft MLW south to north in fed. maintained portions; 10 to 20 ft MLW in the NE, unmaintained barge anchor.	Same		Same as authorized.

PROBLEM IDENTIFICATION, NEEDS, AND OPPORTUNITIES

Problem Identification

General

144. In terms of cargo volume, the Port is the largest container port on the East Coast of North America and the third largest container port in the U.S. (after the Ports of Los Angeles and Long Beach). According to American Association of Port Authorities (AAPA) figures, container traffic through the Port in 1997 totaled 12.6 million metric tons of cargo in 1.3 million containers, equaling 2.4 million twenty-foot equivalent units (TEUs). The Port provides more than 166,000 jobs and $20 billion in economic activity, while serving more than 17 million consumers in the States of New York and New Jersey, in addition to a larger 31-state hinterland. Additionally, the 30 billion gallons of petroleum and petroleum products delivered to or originating from the Port each year make it also the largest petroleum port in the country.

145. The Port handles this large volume of commerce in spite of the fact that it lacks sufficient depth to serve fully loaded ships of the latest designs. In general, channel depths range from 35 ft MLW in the Arthur Kill to 45 ft MLW in the Ambrose and Anchorage Channels, with no more than 40 ft MLW presently to any of the major container terminals.

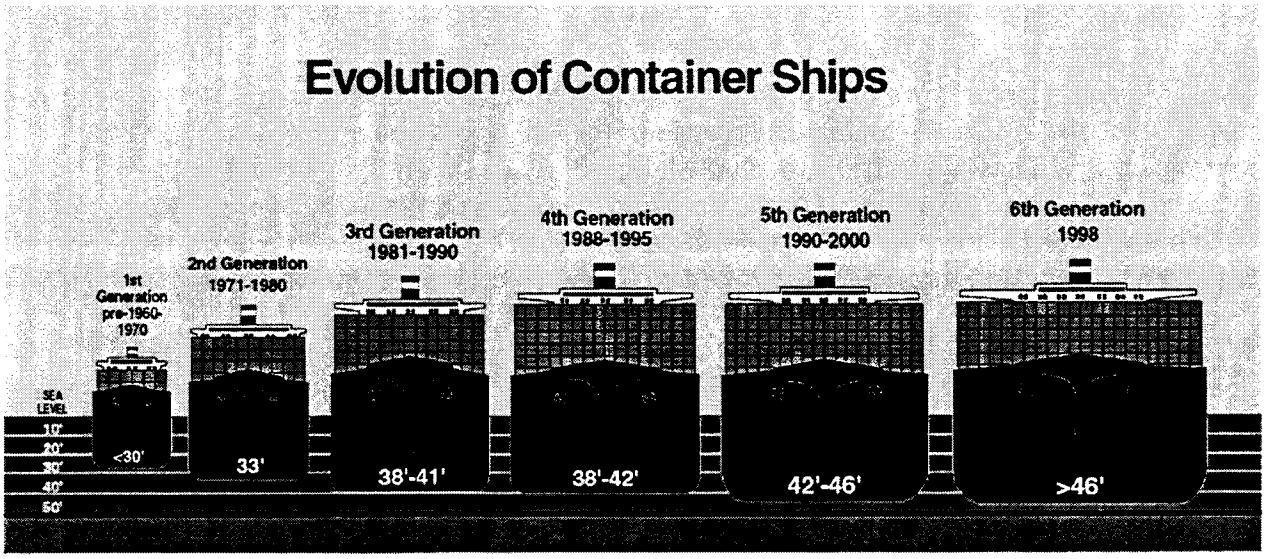
146. Assuming that the volume of cargo grows at an average annual rate of 3% (this rate matches the average annual rate of growth of the U.S. gross domestic product (GNP) in this century), container traffic through the Port will reach 11.2 million containers (over 19 million TEU) by 2060. Since the end of World War II, the dollar volume of world trade has grown at a little over twice the daily rate of U.S. GNP growth. Therefore, the 3% annual growth assumption for the volume of commerce is probably conservative.

147. By 2060, the number of vessel passages required to transport cargo through the Port would be six times the number required in 1996 if channels were not deepened and there was no concomitant change in the vessel fleet. Some of the containerships that currently utilize the Port Jersey Channel, the Kill Van Kull and the Arthur Kill can do so now only under favorable tide conditions. To increase the number of vessel passages during the period of favorable tide by a factor of six or more may not be physically possible and certainly would pose a grave increase in the probability of accidents.

148. As the volume of water-borne commerce has grown, however, it has become possible for shipping lines to realize the economies of scale offered by ships with larger

carrying capacity. Since the introduction of containerized cargo in the 1950s, six generations of container ships have evolved. Periodic channel deepening projects have been initiated in order to keep the Port accessible to the newest, most cost-efficient vessels. The fourth generation of container ships with drafts of up to 42 feet, necessitated the most recent improvements of the Kill Van Kull and Newark Bay, which will include deepening those channels to 45 ft MLW. The rapid production of larger, fifth and sixth generation vessels has generated the need for even deeper channels. The evolution of container ships is illustrated in Figure 20. By the end of 1999, the largest vessels will account for 34% of the world fleet's containership capacity, but only 18% of the hulls. Therefore, the world's containership fleet is moving to a new composition with a high proportion of larger vessels. At their design drafts, these ships cannot reach the majority of the container handling facilities in the Port. To reach the facilities, these ships must be light loaded, anchor in deeper water awaiting favorable tide conditions, call on a deeper port and transship some of their cargo on smaller ships of shallower draft or by road or rail, or use some combination of these techniques. All of these approaches require the operator to surrender potential transportation cost savings stemming from the economies of scale associated with the larger ships. These same considerations apply to tankers and bulk carriers. Therefore, ships using the Port in the near future must either be of a relatively economically inefficient design or be economically efficient design but operated in an economically inefficient manner.

Figure 20
Evolution of Container Ships



Source: Final EIS/Environmental Impact Report and Final Feasibility Study (FEIS/R/FS) - Port of Oakland and the USACE, 1998

Channels Leading to Existing Container Terminals

149. Citing existing and future generations of container vessels which are unable to fully load, Port interests have expressed a desire for improved channels of 50 ft MLW, or greater, to container terminals at Newark Bay, Port Jersey, Howland Hook, and at a future improved terminals in South Brooklyn. Previously authorized studies showed that the Claremont Channel optimized at 38 ft MLW. Until such time that other plans have been advanced for the area in the vicinity of Claremont Channel, there is no need for further deepening of this channel.

Channels Leading to Oil Terminals on the Arthur Kill

150. Similarly, local interests and petroleum terminals along the Arthur Kill have requested deepening the existing 35 ft MLW channels so as to reduce the need for lightering and in-harbor transfer systems. At the time this study was initiated, local interest in deepening the Arthur Kill south of the Gulfport Reach had not yet been determined.. It was only after the study was initiated that local interests made their desires to deepen the Arthur Kill to Perth Amboy known. As a result, a separate study was authorized to specifically investigate this area and funds were allocated in the FY 99 budget to do so. An internal reconnaissance level report, completed in the later part of fiscal year 1999, concluded that a favorable cost-to-benefit ratio could not be attained. The report is now under coordination.

Anchorages

151. In the event that this study recommends deepening the common Ambrose and Anchorage Channels, operators of oil facilities throughout the Harbor desire improvements of the harbor anchorages to facilitate safer in-harbor lightering.

152. No other area of the harbor has been identified as being in need of further improvement.

Needs

153. The Port needs a long-term solution that will reduce unit transportation costs by providing an environmentally acceptable means to accommodate the growing fleet of larger merchant ships. The specific needs are as follows:

Navigation Needs

- Need for a channel or channels of sufficient depth and width, and with proper alignment to allow safe access to Port container terminal(s) by the newest class of deep draft container vessels;

- Need for deeper anchorages to minimize or help ensure safer lightering and in-harbor transfer operations for petroleum tankers.

Environmental Needs

- Need to ensure minimal impacts to environmental resources;

- Need to reduce the potential for environmental damage resulting from petroleum product spills occurring during in-harbor transfer operations.

Regional Needs

- Need to protect jobs and insure revenue generation by limiting the motive (*i.e.*, shallow port) for carriers to move to alternative ports or to otherwise reduce the levels of maritime cargo passing through the Port's marine terminals.

Opportunities

154. Planning opportunities that have been identified include:

- The opportunity to bring the forecast volume of goods into the Harbor on fewer ships;

- The opportunity to eliminate or reduce navigational restrictions and inefficiencies (*i.e.*, channel depth limitations) to enable maritime carriers to realize the transportation economies of scale without adversely impacting their shipping operations;

- The opportunity to reduce the risk of adverse environmental impacts due to oil spills occurring during lightering and in-harbor transfer operations.

- The opportunity to ensure efficient use of the Port's marine cargo terminals.

PLAN FORMULATION

Federal Planning Requirements

Principles and Guidelines

155. The formulation process used in this study is consistent with the national objectives as stated in the *Planning Guidance Notebook.* In accordance with the *Planning Guidance Notebook*, plans must contribute to the National Economic Development (NED) consistent with protecting the nation's environment. Plans to address the needs in the study area must be formulated to maximize NED benefits while providing a complete, effective, efficient, and acceptable plan of protection. These objectives impose general planning constraints within any study area.

- Completeness is defined in ER 1105-2-100 as,

  "the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to realization of the contributions to the objective."

- Effectiveness is defined as,

  "the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities."

- Efficiency is defined as,

  "the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment."

- Acceptability is defined as,

  "the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies."

National Economic Development (NED) Plan

156. The NED plan is the alternative that reasonably maximizes net excess benefits and is the baseline against which other alternatives are compared. Normally, the Federal share of the NED plan is the limit of federal expenditures on any more costly plan.

Locally Preferred Plan

157. Although the NED plan must normally be recommended, the planning process recognizes that the non-Federal partners may have additional desires for channel development or navigation improvement beyond that provided by the NED plan. A locally preferred plan may be recommended provided the non-Federal partner agrees to pay the difference in cost.

Planning Objectives and Constraints

Study Objectives

158. The fundamental study objective is to develop an optimal plan that can accommodate existing and future vessel traffic. The optimal plan must also be acceptable from the NED perspective, as directed by the *Planning Guidance Notebook*, as well as from Environmental Quality (EQ) and Regional Economic Development (RED) perspectives, and to account for Other Social Effects (OSE). Plans were formulated to be complete, effective, efficient and acceptable, and to reasonably maximize net benefits. In summary, these objectives are:

- To produce a comprehensive harbor water-side improvement plan to address the projected challenges, needs, and opportunities for safe and economically efficient navigation and cargo movement through the Port, which includes:
  - To increase the value of the nation's output of goods and services and increase national economic efficiency (*i.e.*, NED);
  - To reduce the forecasted diseconomies of shipping in the study area attributable to current and future channel/shipping configurations;
- To preserve and maintain existing environmental resources;
- To provide a plan which is compatible with future, regional economic development opportunities.

Constraints

159. Channel improvement alternatives that satisfy area needs and objectives are partially limited by current channel alignments and depths, existing terminal infrastructure, and environmental and structural constraints. The list of constraints is as follows:

Economic Constraints

- Plans must be justifiable, that is, plan benefits must exceed plan costs (there must be net excess benefits);

- Plans must be efficient. They must represent near optimal use of resources in an overall sense. Accomplishment of one economic purpose cannot unreasonably impact another economic system.

Environmental Constraints

- Plans cannot unreasonably impact environmental resources;

- Where a substantial impact is established, plans must consider mitigation or replacement and should adopt such measures, if justified.

Regional and Social Constraints

- The needs of the region must be considered and one area cannot be favored to the unacceptable detriment of another;

- No favoritism can be shown; all reasonable opportunities for development within the study scope must be weighed, one against the other.

Technical Constraints

- The encroachment on public and private lands by expansion of the channel side slopes should be avoided where possible;

- Plans must be technically achievable and cannot contain obstructions which obviate accomplishment of the desired output;

- Plans must be realistic and utilize existing technologies;

- Plans must represent sound, safe, acceptable engineering solutions;

- Design of channel depths with the use of high tide is unsafe;

- The channel widths at bridge crossings cannot be expanded if widening could impact the structural integrity of bridge support.

Institutional Constraints

- Plans must be consistent with existing Federal, state, and local laws;

- Plans must be locally supported to the extent that local interests must guarantee local pier, berths, and other works necessary to realize benefits since the Federal government is constrained from construction of these works;

- Works cannot be adopted which would benefit a single user to an unreasonable degree;

- The plan must be fair and find overall support in the region.

Plan Formulation Rationale

General

160. The Port contains a variety of channels, anchorages, and berths, which support commercial navigation. In general, the deep draft channels and anchorages have been constructed and are maintained as part of Federal navigation projects and berthing areas are maintained by non-Federal institutions or organizations (public and private). The existing Federal channels have been authorized by Congress and constructed over the Port's long history as a variety of separate projects.

161. The purpose of this investigation is to consider the Harbor in its entirety and to comprehensively evaluate plans to improve navigation in the Harbor. The formulation process is conducted consistent with Federal statutes and Corps' policy. Specifically, the principal focus of this investigation is the anticipated effects of alternative plans on the National Economic Development (NED) account. Although the Port is an important contributor to the New York and New Jersey regional economy, Federal decision making regarding infrastructure improvements are primarily based on anticipated effects on the national economy. In navigation studies, the costs of navigation improvements are compared to national benefits expected to result from reduced transportation costs. For the purpose of this investigation, reduced transportation costs were computed using commodity projections based on macroeconomics dictated by growth in world population and income. These projections are independent of channel improvements and no attempt was made to capture induced trade. Procedures for estimating NED effects are specified

in the *Economic and Environmental Principles and Guidelines for Water Related Land Resources Implementation Studies* (U.S. Water Resources Council, 10 May 83), Corps' ER 1105-2-100, and other Corps Guidance, such as the *National Economic Development Procedures Manual: Deep Draft Navigation* (November 1991).

162. Therefore, the preliminary assessment of plans was measured in terms of contributions to the primary objective in water resources project planning, namely, National Economic Development. The assessment's result is the identification of plan(s) which best serve the objectives. The study considered three categories of alternative plans:

- A No-Action Plan;
- Non-structural plans which would provide for the more efficient use of the existing waterways and shipping facilities;
- Structural plans involving new channels, interim terminal facilities, deepening and widening existing channels in the study area, and/or terminal expansions.

Economic Principles

163. The assessment of the alternative plans was carried out using several economic and environmental principles:

164. Projected Commerce Levels. Projected commerce levels were derived from worldwide macroeconomic trends. They were compared to the Without-Project Condition terminals' and channels' capacities to determine whether terminal or channel throughput capacity is expected to constrain the volume of commerce anticipated to enter the Harbor.

165. Costs. Costs that were considered in the analysis include dredging costs; operating costs; mitigation costs; project-dependent terminal expansion costs.

166. Benefits. The primary benefit to offset the construction costs associated with deepening the navigation channels is the transportation cost savings associated with the operation of deeper draft vessels. The analysis compares marginal (incremental) benefits to marginal costs on a channel by channel and foot by foot basis. Capacity at any given terminal is constrained by land area, berths, cargo handling equipment (including cranes), and carrier practices with respect to leases, alliances, and exclusive use of particular terminals.

167. Benefit Optimization. The combination of pathways and channel depths that maximizes the net excess benefits was identified. For each pathway evaluated, the total difference in transportation costs under With- and Without-Project Conditions for various channel depths was compared to the annualized investment cost for its respective pathway and channel depth. For each pathway and channel depth combination that results in net excess benefits, the pathway and channel depth that maximizes the net excess benefits was identified. This pathway and channel depth then became the "first-added" increment of the project. In the next iteration, the incremental costs of all of the remaining pathway/channel depth combinations were compared to any remaining benefits that were not realized by the "first-added" increment. The pathway/channel depth combination that provided the greatest positive net benefits was then identified and became the "second-added" increment of the project. In order to identify the NED plan, this process was continued until none of the remaining pathway/channel depth combinations have positive net benefits.

SCREENING OF STUDY ALTERNATIVES

Screening of Preliminary Plans

No Action Plan

168. In the event that no proposed alternative meets the Federal criteria of having a benefit-cost ratio (BCR) greater than 1.0 (*i.e.*, positive net excess benefits), the No Action Plan would become the study's recommended plan. Future conditions under such a plan are detailed in the "Without-Project Condition" section of this document.

Non-Structural Plans

169. Non-structural measures were examined as a means of achieving the planning objectives or portions thereof. Non-structural measures generally do not improve the available depth or width of navigation channels, but rather fall into two other effect categories:

- **Measures that allow for greater unit vessel loading economies with no deepening of navigation channels.** Several measures that allow for greater vessel loading economies are currently in use in the Port and are discussed in the "Port Operations" section. These measures include: light-loaded vessels, high tide transits (tidal advantage), and lightering. The largest vessels currently in the fleet have maximum navigational drafts in excess of Harbor channel depths, therefore, non-structural port operation measures will not allow carriers to realize transportation cost savings and will only exacerbate problems facing carriers as they attempt to reduce transportation costs;

- **Alternate sites for, or means of, commerce delivery.** This non-structural measure generally refers to an alternative site either within or outside the port. Existing sites within the port are usually being used for other types of cargo transportation (*e.g.*, bulk cargo). Sites outside the port would require transportation back to the region by other means. The scope of this study considers all container terminal sites in the Port, including existing, expanded, and planned terminals. Moreover, the non-Federal partners have not identified any other alternative terminal sites. Therefore, no additional Port terminal sites have been identified or proposed for cargo routing or handling. The delivery of goods to an alternative site outside the Port (*i.e.*, another East Coast port) with cargo transported back to the region via road or rail is inherently more costly to the carrier. Accordingly, this alternative has not been included as a likely alternative in the present report.

Structural Plans

170. Structural plans consist of deepening and widening the Port's navigation channels to permit the flow of goods on the larger, more cost effective ships. To facilitate the screening process for structural plans, the Harbor was divided into "pathways" (*i.e.*, a series of existing channels or channel segments) leading to the existing and proposed Port facilities. Alternatives considered involved each of the pathways at various depths and in various combinations with one another. In addition, as described below a new channel across the Bayonne Peninsula and an off-shore island were evaluated. The designated pathways, all of which having Ambrose Channel and sections of the Anchorage Channel as common elements, are:

- Pathway 1 Kill Van Kull to Newark Bay to Elizabeth and South Elizabeth Channels;
- Pathway 2 Kill Van Kull to the Arthur Kill to Howland Hook;
- Pathway 3 Kill Van Kull to the Arthur Kill to Gulfport (at tanker design depth);
- Pathway 4 Port Jersey Channel to Port Jersey and MOTBY;
- Pathway 5 Bay Ridge Channel to South Brooklyn;
- Pathway 5A Bay Ridge, Red Hook, Buttermilk Channels to Red Hook Marine Terminal;
- Pathway 6 Stapleton, Gravesend Bay, and Red Hook Flats anchorages, for container vessels;
- Pathway 7 Stapleton, Gravesend Bay, and Red Hook Flats anchorages, for tankers;
- Pathway 8 Claremont Channel to Claremont Terminal.

Design Criteria

General

171. Structural plans for providing access to the Port's container terminals were developed on the basis of the 46-ft static draft Maersk K Class container vessel as the design vessel. Although, newer and larger container vessels are currently being deployed, this is occurring more rapidly than ship modeling studies and fleet forecasts can be prepared, rendering these studies as "point in time" forecasts. Therefore, in order to compute project benefits, it was necessary to establish a fleet forecast based upon the best information available at the time, recognizing that even larger vessels might be introduced before the study could be completed. Accordingly, the District has incorporated vessels with sailing drafts up to 48 ft in our fleet forecast. The forecast was "capped" at 48 ft for several reasons. First, discussions with shipping lines have indicated that 48 ft is approaching the maximum practical draft of container vessels

without employing a twin screw design (which would result in a significant cost per TEU increase). Instead, the experts consulted during the study expect that, for the foreseeable future, additional TEU capacity will be obtained by increases in length and beam, not draft.

172. Second, container vessel sailing drafts are a function of a variety of factors, only one of which is design draft. These other factors (including fleet deployment, loading patterns, ship schedules, and prior port-next port considerations) would all have to align perfectly to assume that vessels would arrive in the Port in excess of 48 ft at any time in the foreseeable future. Finally, while vessels even larger than the *Regina (or Sovereign) Maersk* are expected to enter the world fleet in the future, the District does not believe there is sufficient data available to incorporate a specific number of these vessels (including required drafts, TEU capacity, and operating costs) into the study's fleet distribution at specific dates, on specific routes. Therefore, the District has chosen to use a maximum static draft of 46 ft, recognizing that this may be a conservative estimate.

173. It is emphasized that the Maersk vessels are simply examples of the largest container vessels. Similar sized vessels owned by other shipping lines would also use any structural plans that are developed in connection with this present study. The 55-ft draft Suezmax oil tanker was the design vessel for channels providing access to the Port's petrochemical facilities along the Arthur Kill.

Design Vessel Parameters

174. **Factors Increasing Design Vessel Draft.** Factors increasing the static vessel draft, including squat, trim, and salinity, were included in the channel design as listed below (see Figure 21). A complete discussion of the development of the design vessel parameters is included in the Channel Design Appendix.

DESIGN PARAMETERS FOR CONTAINER VESSELS

Static Draft = Maersk "K Class" or equivalent	= 46 ft
Squat + Trim + Salinity	+ 2 ft
Sailing Draft	= 48 ft

DESIGN PARAMETERS FOR TANK VESSELS

Static Draft = Suezmax tanker	= 55 ft
Squat + Trim + Salinity	+ 3 ft
Sailing Draft	= 58 ft

175. **Design Vessel Underkeel Clearance.** Underkeel clearance or "safety clearance" for the design vessels is different for "soft" and "hard" (*e.g.*, rock) channel bottoms as previously described and listed below (see Figure 21):

DESIGN PARAMETERS FOR CONTAINER VESSELS

Design Vessel = Maersk "K Class" or equivalent	
Sailing Draft	= 48 ft
Safety (soft bottom)	+ 2 ft
Safety (hard bottom)	+ 4 ft
Safety (soft bottom + waves) [Ambrose]	+ 5 ft
Channel Depth(1) [soft]	= 50 ft
Channel Depth(2) [hard]	= 52 ft
Channel Depth(1)(2) [Ambrose]	= 53 ft

DESIGN PARAMETERS FOR TANK VESSELS

Design Vessel = Suezmax tanker	
Sailing Draft	= 58 ft
Safety (soft bottom)	+ 2 ft
Safety (hard bottom)	+ 4 ft
Safety (soft bottom + waves) [Ambrose]	+ 3 ft
Channel Depth(1) [soft]	= 60 ft
Channel Depth(2) [hard]	= 62 ft
Channel Depth(1)(2) [Ambrose]	= 61 ft

(1) Maintained depth.
(2) Excavated depth.

Channel Design

176. The channel section designs were developed with 3H:1V side slopes in non-rock material and 1H:1V in areas of rock. Channel widths and alignments were developed to provide for safe navigation of all vessels.

177. There are four bridges spanning the channels under consideration: the Verrazano Narrows Bridge, the Bayonne Bridge, the Goethals Bridge, and the Arthur Kill Lift Bridge. The Verrazano-Narrows Bridge spans a naturally deep channel (the Anchorage Channel - approximately 90 ft deep under the bridge), therefore, channel excavation beneath it would not be required. No widening of the Kill Van Kull is expected beneath the Bayonne Bridge. Horizontal channel clearance under the Goethals Bridge and Arthur Kill Lift Bridge, located south of the Howland Hook Marine terminal in the Arthur Kill, is limited by the position of the bridge piers and the fender and dolphin protective structures. If channel improvements are proposed to this section of the Arthur Kill, expansion of the channel widths at these bridge crossings may be limited as the structural stability of these structures must not be threatened.

178. The channels listed below were considered to have a "hard" bottom (*i.e.*, rock or glacial till) and require a 4-ft underkeel safety clearance.

- Kill Van Kull,
- Newark Bay,
- Arthur Kill,
- Port Jersey.

179. The initial dredging will include the 4-foot safety clearance, which corresponds to a deepening 2 feet below the maintained depth. This additional 2 feet of safety clearance will then be permitted to silt in over time effectively creating a "soft" bottom, which only requires a safety clearance of 2 feet.

180. Environmental conditions (*e.g.*, waves, currents, salinity) are different for each channel in the Harbor, as shown in the previous "Design Vessel Parameters" section. In order to provide a consistent level of service along a pathway from sea to berth, it may be necessary to construct and/or maintain the various channels along that pathway at different depths in order to account for the environmental variations. For example, consider Pathway 1 (which goes from sea to Port Newark/Elizabeth). The 46-ft Maersk K Class design vessel requires a channel depth of 53 ft MLW in Ambrose Channel but only a 50 ft MLW depth in the Anchorage Channel. Likewise, this vessel requires a 52 ft MLW channel depth in the Kill Van Kull and Newark Bay due to the "hard" bottom, but the channel will be maintained at 50 ft MLW, essentially allowing a "soft" bottom of sediment to deposit in the lower 2 ft of the channel. For convenience, "maintained depth" refers to the limiting or controlling depth along a path. It should be noted that quantities and costs developed for maintained depths are based on the parameters described above (*i.e.*, that is, estimated quantities for "hard" bottom channels include the additional 2 ft of depth beyond maintained depth). Due to imprecision in dredging technology and to ensure that they perform their contract obligation fully, contractors will dredge beyond the required depth. Historically, by permit, this "overdredge" has been allowed to be up to an additional two feet.

Bayonne-Newark Bay Canal

181. A plan to construct a canal across Bayonne, New Jersey was considered. The Bayonne-Newark Bay (BNB) Canal was to extend the Port Jersey Channel to Newark Bay across the Bayonne Peninsula near the Bayonne-Jersey City limits, as shown in Figure 22. This plan allows for the deepening of the Port Jersey Channel as well as Newark Bay (northern portion), including the Elizabeth and South Elizabeth channels. In this way, there would be access via 50 ft deep MLW channels to terminals representing

80% of the existing container handling capacity in the Port without having to deepen the Kill Van Kull.

182. This plan reduced the distance to be dredged to reach Port Newark/Elizabeth from over 8 miles via the Kill Van Kull to approximately 5.3 miles and provided deepwater access to the terminals along the existing Port Jersey Channel. In addition, a significant portion of this route would have crossed what is now dry land and could be excavated using conventional land-based equipment. The canal alignment would require relocating several major roadways and rail lines that were expected to add significantly to the project cost. The following are the most significant advantages and disadvantages of this plan.

Advantages:

- Eliminate the need to dredge (*i.e.*, excavate underwater) 8+ miles of the Kill Van Kull (rock);
- Provide access to Newark Bay without significant turns (*e.g.*, Bergen Point);
- Eliminate the potential air draft problem posed by the Bayonne Bridge.

Disadvantages:

- Significant real estate costs would be associated with buying-out or relocating approximately 300 structures in the channel footprint, as well as the additional structures in the road or rail tunnel footprints;
- Significant costs associated with the placement and/or remediation of hazardous, toxic, and radioactive waste (HTRW) sites within the proposed channel and tunnel footprints;
- Large amounts of rock excavation would be required with associated blasting impacts on adjacent structures;
- Relocation of rail lines and roadways and the construction of several road or rail tunnels under the canal;
- A high rate of sedimentation would be expected in the canal, necessitating frequent maintenance dredging;
- Increased sedimentation rates, due to changed hydraulics, could result in significantly increased O&M dredging quantities throughout the Harbor.

183. In addition to the listed disadvantages, garnering public support, which would be critical to constructing this plan, would be difficult and unlikely due to the significant quality of life changes resulting from construction, including the displacement of residents and the increased traffic congestion due to limited channel crossings. In addition, cursory estimates showed construction costs to be very high. Based on these factors, the non-Federal partners requested that the plan be eliminated from further consideration.

Off-Shore Island Port

184. The construction of an off-shore island port or terminal was evaluated. This terminal was conceived as an interim solution to addressing the Port's depth constraints. It was identified as an interim solution because the proposed island terminal would not be large enough to handle the deep draft container volume forecasted for the Port.

185. The terminal would be located on top of a portion of an offshore confined placement facility (*i.e.*, an "island" of dredged material) as shown in Figure 23, with pier-side depths in excess of 60 ft MLW, thus providing access for the largest container vessels. The terminal would be used to offload a portion of a large container vessel's cargo such that the vessel's draft would be reduced to a level where the vessel could then safely transit to a container terminal at existing channel depths. However, the following advantages did not outweigh the significant disadvantages of this plan.

Advantages:

- Little or no construction dredging of the Harbor would be required;
- The terminal would provide unrestricted access of vessels with sailing drafts of 60 feet or more to the Port, depending on final siting;
- The terminal could potentially reduce the depth requirements of the Harbor as a whole.

Disadvantages:

- The location of the island terminal/port will be relatively unprotected, as conceived, hampering vessel dockings/sailings and barge operations during inclement weather conditions;

- Carriers would have to incur the additional expense to transship cargo from the island port to in-Harbor terminals as well as require two vessel stops in one port;

- It would be a short-term solution only – the island port would not have enough capacity for all deep draft vessel cargo;

- Upon implementation of a permanent solution, post-operational use/benefits of the island port (*e.g.*, as an island habitat) may not offset environmental impacts associated with construction.

186. Envisaged, the Off-Shore Island Port was not intended to fully meet the planning objectives but rather to serve as an interim solution by providing a terminal for the deepest draft vessels while other channel improvement plans were developed or implemented. This study has identified channel improvements that can meet the planning objectives in a reasonable timeframe and, therefore, the non-Federal partners requested that the plan be eliminated from further consideration.

Channel Deepening Plans

187. Channel deepening plans were the final structural plans considered. The alternatives focused on deepening the channels or channel segments so as to provide access for fully-loaded deep draft vessels to the Port's container and petrochemical terminals. Additionally, channel widening and/or realigning, and turning basin construction were considered to improve large vessel traffic flow and reduce the potential for maritime accidents. The study evaluated deepening all or some of the designated channels/pathways, at various navigational depths, in order to develop a plan that would realize the maximum net benefits.

Evaluation of Channel Deepening Alternatives

Tanker Channel Deepening Alternative

188. Interviews with oil company personnel indicate that tanker operations in the Port would change significantly if harbor depth were increased under the With-Project Condition. First, vessels with fully loaded drafts of 42-45 ft, which currently arrive light-loaded at oil terminal facilities in the study area, would be able to arrive fully loaded. Second, the volume of individual deliveries would increase. The Port would no longer need to be scheduled as the last leg of a multi-port delivery, which would allow the oil terminal to utilize land-side storage capabilities more fully. Third, as channel depths increase, the volume of liquid cargo transferred during lightering operations and the

frequency of lightering operations would decrease. At channel depths approaching 55 ft, the 150,000 Dead Weight Tons tankers that currently lighter offshore would be able to transit the Port at or near capacity, thereby eliminating the need for offshore lightering operations.

189. The fourth change in tanker operations would be that larger vessels would make direct calls on Port oil terminals. Currently, oil companies charter vessels best suited to local conditions (*i.e.*, requisite draft) to make regularly scheduled calls on the Port. With increased channel depths, oil companies could charter larger vessels to take advantage of new local conditions.

190. Pathway 3, the channel deepening alternative providing unconstrained access to the two petrochemical facilities identified in the study, was evaluated. This alternative included deepening Ambrose Channel, the Anchorage Channel, the Kill Van Kull, and the Arthur Kill to Gulfport (Pathway 3) to depths sufficient for safe passage of the Suezmax design vessel (*i.e.*, a 60 ft MLW maintained depth). As stated in the study scope, no additional petrochemical facilities that would require access by the tanker design vessels are anticipated. Benefits derived from channel deepening would be transportation cost savings associated with the elimination of the need for lightering in order to safely transit to berth. The economic analysis estimated $1 million in benefits could be realized by this alternative. These benefits will support less than $15 million in construction costs given the current federal discount rate. The estimated construction cost for a 60 ft MLW channel depth to Gulfport as a last-added increment to a 50 ft MLW depth container vessel alternative through the Kill Van Kull is approximately $1.3 billion. Accordingly, it was concluded that the tanker deepening alternative is not economically viable even as a last-added feature to a plan based on container vessels and Pathway 3 was dropped from further consideration.

Anchorage Deepening Alternative

191. Pathways 6 and 7 considered deepening alternatives for the Harbor's major anchorages. Due to the ongoing New York Anchorages Study (discussed in the "Previous and Ongoing Studies" section), which is entering the Feasibility Study Phase, further evaluation of anchorage deepening alternatives will be deferred until completion of that Feasibility Study.

Container Vessel Channel Deepening Alternatives

192. The remainder of the structural alternatives focused on access to the Port's container terminals by the Maersk K Class or equivalent design vessel. The non-Federal partners indicated that container terminal operations will be terminated at Red Hook Container Terminal by the year 2010. As a result, the Red Hook and Buttermilk

Channels, which provide access to the terminal from the Bay Ridge Channel, were removed from further consideration for deepening, hence, Pathway 5A was eliminated as a viable pathway in the economic analysis. The non-Federal partners also indicated that there is no interest in developing the Claremont Terminal as a container terminal, either at its present size or through proposed expansions. The terminal located at the head of the Claremont Channel is currently a scrap metal import and export facility serviced by shallow draft barges and bulk vessels with insufficient trade volume to support a Federal interest in further deepening the channel. Therefore, Pathway 8 was eliminated from consideration for channel deepening. The following describes the analysis used to screen the remaining pathways; 1, 2, 4, and 5.

Preliminary Quantities and Costs

General

193. Project costs are borne by the Federal Government and the non-Federal partners in accordance with Federal Cost Sharing guidelines as stated in the Water Resources Development Acts (WRDA's) of 1986 and 1996, ER 1165-2-131 (*Local Cooperative Agreements for New Start Construction Projects*), and Project Guidance Letter (PGL) #62, dated 29 July 1999. Alternative plan costs include the following:

- Channel dredging costs,
- Construction costs (*i.e.*, bulkheads, wharves, dredged material placement areas, etc.),
- Aids to navigation relocation,
- Utility relocation,
- Operation and Maintenance (O&M) costs,
- Land-side terminal expansions/improvements undertaken only because a deeper channel is made available,
- Environmental mitigation costs,
- Pre-construction Engineering and Design (PED) costs,
- Construction Supervision, Inspection and Administration (SI&A) costs,
- Contingency costs.

Estimated Dredged Material Quantities

194. The estimated dredged material quantities are based upon the draft of the design vessel plus the total underkeel clearance required for the channel bottom type. Quantity estimates were based on the results of a comprehensive boring plan conducted throughout the Harbor and assumed that the channels were maintained at their authorized depths as listed in Table 1. Quantities were calculated for a maintained depth of 50 ft MLW. Estimated quantities were then calculated for two other depths at 2-foot intervals.

Quantities for additional depths were interpolated from the calculated depths using regression equations and curve fitting techniques.

195. For all Federally-maintained channels it is assumed that all O&M material will be removed independently of and prior to project construction. No O&M material quantities, with the exception of additional, incremental O&M material quantities which result from channel sedimentation rate changes, are included in the estimated quantities. For channels without rock, the total quantity of material was calculated by generating a 3-dimensional surface profile from the channel surveys. Rock quantities, however, were developed using material contours generated from the boring analyses. As no chemical or biological testing was performed, the thickness of the material layer unsuitable for placement at the HARS was estimated from the presence of hydrocarbons, moisture content, and color of the borings. Table 9 provides a summary of the estimated dredged material quantities for deepening the Harbor channels based on geological (*in situ*) conditions, exclusive of the Arthur Kill beyond Howland Hook and the Red Hook and Buttermilk Channels.

196. Due to imprecision in dredging technology and to ensure that they perform their contract obligation fully, contractors will dredge beyond the required depth. Historically, by permit, this "overdredge" has been allowed to be up to an additional two feet. This additional quantity is not included in following table.

TABLE 9
Estimated Geologic Dredged Material Quantities – NY&NJ Harbor

Maintained Channel Depth	Dredged Material Category (millions of cu. yds.)			Total
	Rock	Non-Rock	Unsuitable for HARS	
48 ft	2.52	16.66	8.17	27.35
50 ft	4.21	25.92	8.17	38.30
52 ft	5.81	36.51	8.17	50.49

Unit Costs

197. Table 10 summarizes the unit costs used in the analysis. The unit costs reflect current cost levels being utilized by the Corps for the costing of navigation improvement projects in the Port of New York and New Jersey as of October 1999. The range of unit costs for dredging is due to differences in material types, dredge productivity, dredge type, and placement costs.

TABLE 10 Channel Deepening Alternatives – Unit Costs			
Category		**Unit**	**Unit Cost**
Dredged Material	Rock	CY	$13 to $18
	Non-Rock	CY	$7 to $33
	Unsuitable for HARS	CY	$5 to $8 dredging plus $29 (tipping fee)
	Blasting/Drilling	CY	$57 to $81
Bulkheads		LF	$1,000 to $2,000
Wave Screen and Pier (Elizabeth Marina)		Ea	$2,300,000
Berthing		Ea	$1,500,000 to $14,600,000
New Aids to Navigation (Bay Ridge)		Ea	$3,100 to $15,500
Utility Relocation		LF	Anchorage 36" Water - $1,700 42" Water - $2,300 Newark Bay 12" Gas - $1,200
Mitigation		Acre	$250,000
Mobilization		Ea	$3,000,000
Preliminary Engineering & Design (PED)		%	5
Supervision & Administration (S&A)		%	5
Contingency		%	15 to 20

Utility Relocations

198. Channel depth alternatives for the Harbor include the relocation of the following utilities. Due to their shallow depth and the risk of damage during initial construction and future maintenance dredging, these utilities must be relocated. The relocation of all utilities as a result of project implementation is cost-shared between the non-Federal partners and the utility owners in accordance with the Water Resources Development Act of 1986.

- **Upper Bay**. Two water mains (36-inch and 42-inch) currently located at depths (minimum) of 53 ft and 53.7 ft MLW, respectively, in the Anchorage Channel. These water mains cross Upper New York Bay between Brooklyn and Staten Island: one crosses the Bay Ridge Channel, the southern portion of Red Hook Flats Anchorage and Anchorage Channel, and the other crosses the Anchorage Channel and Bay Ridge Channel. These relocations are a primary project cost affecting all pathways. The current cost estimate (first cost) for relocation of these lines is approximately $37 million.



- **Newark Bay**. A 12-inch natural gas pipeline currently located at depth (minimum) of 36 ft MLW crosses Newark Bay south of the entrance to the South Elizabeth Channel. This pipeline is at a depth of 36 ft MLW on the westernmost side of the bay and at a depth of 127 ft MLW on the easternmost side of the bay. This relocation cost is reflected in the Pathway 1 first costs. The current cost estimate for relocation of the pipeline is approximately $3.24 million.

199. Three additional pipelines exist beneath channels considered for improvements: a Coastal/IMTT oil pipeline (12-inch) and two TOSCO refinery oil pipelines (8-inch and 12-inch) cross lower Newark Bay and the upper reaches of the Arthur Kill. These pipelines are scheduled for relocation as part of the Kill Van Kull/Newark Bay 45 ft Deepening Project. At their new depths, they will not be impacted by channel deepening considered in plan formulation.

Mitigation Costs

200. Mitigation costs were developed by identifying the direct environmental impacts of channel deepening, estimating costs for additional archeological investigations and mitigation, and estimating costs associated with beneficial use of dredged material. Specifically, environmentally sensitive areas that would be impacted by dredging were identified and the costs of mitigating these areas developed as part of an overall Mitigation Plan. Where possible, preliminary channel designs were modified to avoid or minimize dredging impacts on environmentally sensitive areas. Sites of potential archeological significance were also identified as part of the cultural resources investigations and were prioritized for additional investigations. Costs associated with beneficial use of dredged material were also estimated based on proposed beneficial uses in the DMMP. Discussions regarding the significance of the environmental impact and cultural resources impacts are contained in the FEIS and are summarized in the section titled "Environmental Impacts of the NED Plan". Table 11 lists the sizes of environmentally sensitive areas impacted by the channel deepening alternatives. The first cost of mitigating unavoidable environmental impacts was estimated to be $13,000,000. The cost of the Mitigation Plan does not vary significantly with the different channel improvement depths.

TABLE 11 Preliminary Area of Environmental Impact				
Channel	Environmental Areas Affected (acres)			
	Wetlands	Inter-tidal (MHW to MLW)	Littoral (MLW to -6ft)	Sub-littoral (-6ft to -15ft)
Ambrose	0	0	0	0
Anchorage	0	0	0	0
Kill Van Kull	0	0	0.06	1.41
Newark Bay	0	0	2.72	7.79
Elizabeth	0	0	0.25	1.42
South Elizabeth	0	0	0	15.84
Arthur Kill	0	0	3.23	3.22
Port Jersey	0	0	0	12.35
Bay Ridge	0	0	0	0
TOTAL	0	0	6.26	42.03

Land-side Infrastructure Costs

201. Land-side infrastructure costs were developed by the non-Federal partners and reviewed and confirmed by the study team. These include project-related costs for terminal improvements and modifications necessary to handle, process, and store containers carried on the fleet of larger ships that would be expected following channel improvement project implementation. Costs of scheduled equipment or facility improvements, upgrades, and replacements that would have occurred at the terminals regardless of channel deepening are not related to project implementation and are not included in project costs.

NED Investment Costs

202. In addition to the first cost of construction, NED Investment Costs include Interest During Construction (IDC). IDC represents the opportunity cost of capital incurred during the construction period. The investment cost of a project, which is the sum of construction and other initial costs plus IDC is the cost incurred from the start of construction to the project base year (2010). Costs incurred during the construction period are increased by adding compound interest at the 6-7/8% discount rate from the date the expenditures are incurred to the base year. For plan formulation, the IDC was calculated considering costs and construction duration for all pathways included in the alternative being considered. The total NED Investment Costs were calculated using the compound interest for the series of payments over the anticipated construction duration on a pathway-by-pathway basis with consideration of channel elements already constructed. The IDC was calculated on the basis of total alternative costs, including Pre-construction Engineering and Design (PED), Supervision and Administration (S&A), and mitigation.

Annual Costs

203. The annual costs comprise the interest and amortization of the Investment Costs over the life of the project plus the project-related increase in annual Operation and Maintenance (O&M) costs. Investment Costs are annualized from the project base year of 2010 using the Capital Recovery Factor over a 50-year project life at the current Federal Discount Rate of 6-7/8%. The O&M costs are associated with the dredging required to maintain the channel at the desired depth. The majority of the channels are already maintained at an authorized depth under the Without-Project Condition. Accordingly, the O&M costs associated with this project are only the incremental costs necessary to maintain the deeper channel.

204. The O&M costs reflect the sedimentation rates in each channel. Sedimentation rates depend on a number of factors, including current velocity, direction of flow, and depth of the channel, and differ from channel to channel. The various sedimentation rates found throughout the Harbor are discussed in detail in the Channel Design Appendix. In summary, sedimentation rates in Newark Bay and the Port Jersey Channel are higher than the Upper New York Bay and the Kill Van Kull. These different sedimentation rates are reflected in the different O&M costs.

Costs by Pathway

205. For each of the remaining potentially viable pathways, costs were developed for providing access from the open ocean to each pathway-served terminal. Each pathway was considered as a stand-alone-path, thus each included elements common to other pathways such as Ambrose and Anchorage channels which are common to all pathways. The Construction Cost, Investment Cost, and Annual Cost for each pathway are shown in Table 12 for various depths. Construction Costs include PED Costs and S&A Costs.

Benefits Model

206. The primary objective of the Benefits Model is to integrate the fleet forecasts, associated transportation cost savings, and channel and terminal capacity constraints to identify the benefits attributable to each pathway/alternative over a series of depths in order to identify the NED plan. As part of this analysis, which is fully described in the Economics Appendix, the model is structured to look at the various pathways as first- and last-added elements in order to develop the overall plan that provides the greatest net excess benefits. Benefits are distributed to a particular pathway on the basis of terminal and channel capacity in relation to forecast quantity of container cargo handling services demanded. Under the Without-Project Condition, the deepest available pathway into the Harbor is anticipated to be a maintained channel depth of 45 ft MLW leading to Port

Newark/Elizabeth. The vast majority of transportation cost savings and thus benefits associated with this study are attributable to vessels requiring a maintained channel depth in excess of 45 ft MLW. The volume of commodities projected to be carried on this class of vessel is the focus of the analysis. In other words, allowing for 2 feet of underkeel clearance, vessels with sailing drafts in excess of 43 feet provide the majority of the benefits. Benefits to vessels with sailing drafts between 39 and 43 feet were also evaluated for those pathways in which the without-project condition depths were less than 45 ft MLW.

TABLE 12
Construction Costs, Investment Costs, and Annual Costs by Pathway*

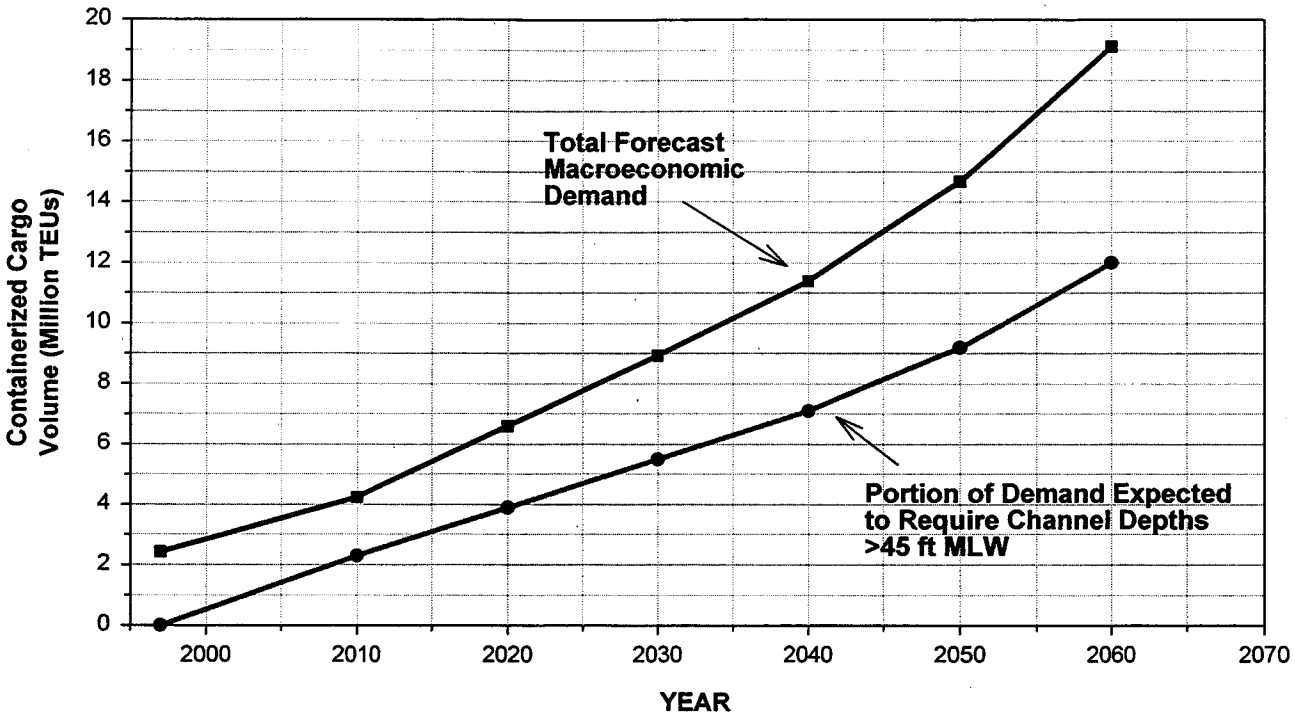
Pathway	Costs (million $)	Maintained Channel Depth				
		45 ft	46 ft	48 ft	50 ft	52 ft
1 Port Newark/ Elizabeth	Construction Costs	N/A	618.9	1017.9	1195.1	1422.1
	Investment Costs	N/A	791.9	1306.3	1532.6	1825.0
	Annual Costs	N/A	55.4	93.5	111.0	133.2
2 Howland Hook	Construction Costs	281.6	716.9	1029.1	1174.3	1345.8
	Investment Costs	347.0	897.1	1296.6	1478.4	1695.3
	Annual Costs	25.8	65.2	94.3	107.8	123.9
4 Port Jersey/ MOTBY	Construction Costs	N/A	234.1	345.4	408.3	472.1
	Investment Costs	N/A	264.5	389.2	460.2	532.1
	Annual Costs	N/A	18.4	27.6	33.0	38.4
5 South Brooklyn	Construction Costs	N/A	242.5	310.2	354.0	401.4
	Investment Costs	N/A	268.7	343.9	392.6	445.1
	Annual Costs	N/A	14.8	21.3	25.8	30.7

*Pathways are from sea (Ambrose) to the major terminal served by the pathway.

Port Outlook

207. During the 2010-2060 period, the growth rates of containerized imports and exports for primary bulk commodities passing through the Port are expected to be relatively low. In contrast, the growth rates for containerized manufactured goods are anticipated to be significant. Overall, containerized imports and exports through the Port are expected to increase significantly during the period of analysis, from approximately 2.4 million TEUs in 1999 to over 19 million TEUs in 2060, as shown in Figure 24

Figure 24
Forecast Container Terminal Demand



Expected Fleet Distribution

208. The containership fleet projected to call at the Port was estimated by applying a gradual shift in fleet capacity to larger vessels based on the actual 1998 port fleet composition. The Maersk K Class design vessel has the maximum projected vessel sailing draft for this estimate. Three projected fleet sailing draft distributions are used to account for the different mix of vessels on major (long haul – high volume), minor (short haul – low volume), and northern European routes. The three fleet sailing draft distributions are based on the current (1998) dead weight tonnage distributions for containerships calling at the Port.

209. The growth rate implied by the gradual shift in fleet capacity is less than the historic growth rate in fleet capacity at New York Harbor and is assumed to be zero after the midpoint in the study period (2010 through 2060). The projected number of large containerships required to maintain weekly service to the Harbor on the Major and northern European routes is fewer than the number of large containership vessels that will be added to the fleet calling at the Harbor between the years 2000 and 2010. The allocation of commodity share for each vessel size on the three routes is based on the assumption that vessels are sailing with an efficient load (although only a portion of the

load is bound for or originates out of New York Harbor). Under this assumption, the resulting transportation costs are the minimum transportation costs required to move the cargo. Table 13 presents the expected distribution of vessels, by sailing draft (*i.e.*, static draft plus 2 ft due to squat/trim/etc.), expected to call on the Port over the planning horizon.

TABLE 13
Expected Fleet Distribution (Calling on the Harbor)

Sailing Draft	Year			
	2010	2020	2030	2040*
<31	3.91%	3.10%	2.34%	1.95%
31	1.30%	1.03%	0.78%	0.65%
32	1.30%	1.03%	0.78%	0.65%
33	1.30%	1.03%	0.78%	0.65%
34	2.19%	1.73%	1.29%	1.07%
35	2.69%	2.12%	1.59%	1.32%
36	2.67%	2.11%	1.58%	1.31%
37	4.68%	4.97%	5.33%	5.50%
38	3.35%	3.65%	4.00%	4.18%
39	2.73%	3.04%	3.39%	3.56%
40	5.77%	6.05%	6.41%	6.59%
41	2.55%	2.85%	3.20%	3.37%
42	5.64%	5.04%	4.50%	4.23%
43	4.84%	3.80%	2.81%	2.30%
44	4.84%	3.80%	2.81%	2.30%
45	10.42%	11.05%	11.56%	12.15%
46	15.86%	17.06%	18.19%	18.41%
47	15.86%	17.06%	18.19%	18.41%
48	8.09%	9.47%	10.50%	11.39%
Total	100.00%	100.00%	100.00%	100.00%

*Fleet distribution beyond 2040 is expected to remain the same.

210. The benefit analysis does not assume a perfect match between carrying capacity and projected traffic. Instead, it was assumed that the loading pattern is determined by controlling depth and market forces, including considerations of service quality and ship routing. The method was as follows:

- Determine the current loading pattern (both inbound and outbound) for vessels of each design draft calling the Port.

- Impose the observed loading pattern for the deepest design draft vessels calling the Port currently onto the deepest design draft vessels that could call

on the Port in the with-project condition.

- Impose the observed loading pattern for the second deepest design draft vessels calling the Port currently onto the second deepest design draft vessels that could call on the Port in the with-project condition.

- Repeat this process until each design draft classification has been assigned a market determined loading pattern that is related to the controlling depth of the channel in the with-project condition

Ship Transportation Cost Savings

211. The trend in the containership industry is to maximize the economies of scale that occur with the largest vessels. Current industry efforts towards exploiting economies of scale can be seen in the consolidation of container transport by vessel alliances and increased containership size and drafts. Carriers constrained by the controlling depths described in the Port's Without-Project Condition will not be able to take advantage of the economies of scale of the most efficient vessels. Adequate depths to allow safe passage by post-Panamax vessels are necessary for the largest and most efficient vessels operating in vessel alliances that frequent the Port. The potential transportation cost savings which will likely result from increased competition among alliances and the deployment of post-Panamax vessels are reduced if vessels are regularly light loaded, as they must be in order to currently transit the Port.

212. Numerous sources of transportation cost savings have been identified through analyses of vessel operations, port and terminal operations, and vessel deployments. The sources of transportation cost savings can be categorized as:

- Vessel efficiencies. In the category of transportation cost savings resulting from vessel efficiencies, sources of benefits have been identified based on the shift to larger vessels on specific trading routes. Vessel efficiencies have been identified for containerships servicing the following routes:

  - Major routes: Far East, South East Asia, and the Middle East (including the Indian sub-continent);
  - Minor routes: west coast of South America, east coast of South America, Central America, Caribbean, West Africa, East and South Africa, Australia and New Zealand, Eastern Europe, and Mediterranean;
  - Hybrid route: Northern Europe.

- Some ports on these routes having channels depths ≥ 50 ft MLW:
  - Hong Kong — Kobe
  - Singapore — Pusan
  - Halifax — Norfolk
  - Kaoshiung — Baltimore
  - Colombo — Rotterdam
  - Tacoma — Seattle
  - Los Angeles — Long Beach

- Operational efficiencies. Benefits resulting from operational efficiencies have been identified for:

  - Reduced tide delays,
  - Reduced queuing delays,
  - Reduced liquid bulk lightering,

- Improved safety. Identified benefits resulting from improved safety in the Harbor include:

  - Reduced natural resource injury: Deeper channels would reduce the overall number of vessel calls, reduce congestion, and lightering operations in the harbor, thereby reducing the expected value of natural resource damages;
  - Reduced disruptions of services: As described above, deeper channels would reduce the probability of oil spills or other contaminant spills in the harbor. Reducing the probability of such incidents in the harbor would also reduce the probability of waterway closures and service disruptions that result from related clean-up, salvage, and restoration activities. The reduction in incident probability would reduce the expected value of damages related to disruptions of waterway services.

213. Although each of the benefit types identified above is reasonable and anticipated, few can be quantified to a reasonable level of certainty. Therefore, only a small sub-set of benefit types has been quantified in the Benefits Model.

214. Economic benefit calculations include only the transportation cost savings associated with vessel efficiencies for containerships on the Hybrid and Major routes. Benefits related to operational efficiencies are not quantified because the multitude of operational options available in the Harbor pose a high level of uncertainty for future alternative scenarios. Benefits related to improved safety are not quantified due to the high level of uncertainty related to projecting spill magnitudes and frequency. Benefits accruing from vessel efficiencies for containerships on the 9 Minor routes are also not

quantified because of the uncertainty associated with projected fleet distributions for these routes. Since the projected Minor route fleet would not be constrained under with out project conditions there is a high level of uncertainty associated with predicting the way that vessels on the Minor routes would be replaced by larger vessels displaced from the Major and Hybrid routes. Given this level of uncertainty, the projected fleet for the Minor routes portrays the same characteristics as the existing fleet.

Benefits by Pathway

215. The transportation cost savings were determined using the Benefit Model and ranked for the four pathways. In order to assign benefits to individual pathways, the current and anticipated port operating procedures at terminals were assessed to determine their capacity to handle vessels with sailing drafts deeper than 43 ft. Only these vessels are capable of generating transportation cost savings for the channels that are to be 45 ft deep MLW under without-project conditions, therefore, determining "greater than 43 ft capacity" effectively allocates a majority project benefits. For those channels that have without-project condition depths less than 45 ft MLW benefits can also be realized by deepening the channels to 45 ft MLW. These channels are the Arthur Kill to Howland Hook, Port Jersey Channel, and Bay Ridge Channel to South Brooklyn. The benefits were calculated by allowing the fleet distribution to those segments to increase by one-foot increments until their distributions matched the port-wide distribution at 45 ft MLW. In this way, each segment with a channel depth of 45 ft MLW then faced the same forecasted fleet distribution. Benefits generated by deepening these segments beyond 45 ft MLW accrue only to vessels requiring more than 45 ft MLW as previously discussed.

216. The operational criteria used to allocate "greater than 43 ft capacity" include the formation of carrier alliances, the share of New York Harbor containerized cargo handled by the alliances, and the carriers' preferences for dedicated berths and terminals. Six carrier alliances and two large independent carriers accounted for 87% of the loaded TEUs handled in the harbor in 1998. Each of these alliances and large independents has the ability to direct greater than 43 ft sailing draft vessels to the Harbor. Two alliances currently use, and others are negotiating for, dedicated terminals and berths in the Harbor. Some terminal operators have long-term leases with the PANYNJ. Additionally, more than 35 carriers currently use common (multi-carrier) terminals. Therefore, only a portion of the berths at any of the Harbor's largest facilities (Port Elizabeth, Port Newark, and Port Jersey/Global) can be dedicated to an alliance or large independent carrier. At Port Newark/Elizabeth, 11 out of 18 berths are currently dedicated to single users and the remaining 7 berths are operated as common facilities. At Port Jersey/Global Marine Terminal, it is assumed that the low acreage to berth ratio (52 acres per berth), configuration, and productivity constraints restrict the allocation of dedicated berths to one major alliance or large independent carrier using 3 of the 6 berths. The remaining 3 berths at Port Jersey/Global are allocated to common usage. Berths at South Brooklyn



and Howland Hook are assumed to be available for dedicated use by smaller alliances or independents. Overall, 20 of 26 berths (77%) are assumed to be available for dedicated use.

217. Utilizing the foot by foot distribution of benefits procedure, benefits were computed for each pathway at various depths. Table 14 displays the benefits by pathway.

TABLE 14
Pathway Annual Benefits

Pathway	Maintained Channel Depth	Annual Benefits (Million $)
1 Port Newark/ Elizabeth	46 ft	22.2
	48 ft	60.6
	50 ft	99.0
	52 ft	99.0
2 Howland Hook	46 ft	30.3
	48 ft	35.9
	50 ft	41.6
	52 ft	41.6
4 Port Jersey/ MOTBY	46 ft	60.0
	48 ft	71.4
	50 ft	82.6
	52 ft	82.6
5 South Brooklyn	46 ft	15.9
	48 ft	21.0
	50 ft	26.1
	52 ft	26.1

Channel Deepening Economics

218. In order to identify the first element of construction the annualized benefits and costs were compared for each pathway and the pathway with the greatest net excess benefits was identified. Table 15 presents the investment costs, annual costs, benefits, and net excess benefits for each pathway over a range of depths.

TABLE 15 Economic Summary by Pathway						
Pathway	Maintained Channel Depth	Invest. Costs	Annual Costs	Annual Benefits	Net Excess Benefits	BCR
		(Million $)				
1 Port Newark/ Elizabeth	46 ft	791.9	55.4	22.2	(33.4)	0.40
	48 ft	1306.3	93.5	60.6	(32.9)	0.65
	50 ft	1532.6	111.0	99.0	(12.0)	0.89
	52 ft	1825.0	133.2	99.0	(34.2)	0.74
2 Howland Hook	45 ft	347.0	25.8	27.1	1.3	1.05
	46 ft	897.1	65.2	30.3	(34.9)	0.46
	48 ft	1296.6	94.3	35.9	(58.4)	0.38
	50 ft	1478.4	107.8	41.6	(66.2)	0.39
	52 ft	1695.3	123.9	41.6	(82.3)	0.34
4 Port Jersey/ MOTBY	46 ft	264.5	18.4	60.0	41.6	3.26
	48 ft	389.2	27.6	71.4	43.8	2.59
	50 ft	460.2	33.0	82.6	49.6	2.50
	52 ft	532.1	38.4	82.6	44.2	2.15
5 South Brooklyn	46 ft	268.7	14.8	16.0	1.2	1.08
	48 ft	343.9	21.3	21.0	(0.3)	0.99
	50 ft	392.6	25.8	26.1	0.3	1.01
	52 ft	445.1	30.7	26.1	(4.6)	0.85

219. Pathway 4 to Port Jersey/MOTBY, Pathway 5 to South Brooklyn, and Pathway 2 at 45 ft MLW only to Howland Hook are the only pathways as "stand-alone" pathways to provide positive net excess benefits. Pathway 4 to Port Jersey/MOTBY at a 50 ft MLW provides the greatest net excess benefits and is clearly the "first added" element; Pathway 5 to South Brooklyn at 50 ft MLW provides the next greatest amount of net excess benefits. Pathway 2 to Howland Hook at 45 ft MLW provides positive net excess benefits because at that depth only the Arthur Kill requires further deepening for the pathway to realize the projected benefits.

220. Pathway 1 to Port Newark/Elizabeth as a "stand-alone" pathway results in a BCR of less than unity. Therefore, it would not appear, at first glance, to warrant further consideration as a viable alternative. However, a portion of Pathway 1 is common to Pathway 4 to Port Jersey (Ambrose Channel and portion of Anchorage Channel) which has shown to yield positive net excess benefits at a maintained depth of 50 ft. MLW. Therefore, Pathway 1 to Port Newark/Elizabeth was re-evaluated as a last-added increment to Pathway 4; only the incremental costs of dredging the Kill Van Kull and Newark Bay Channels were included in the Pathway cost. The results of considering Pathway 1 as a last-added increment to Pathway 4 are shown in Table 16.

TABLE 16 Economic Summary of Pathway 1 as Last-Added Element to Pathway 4						
Pathway	Maintained Channel Depth	Incremental		Annual Benefits	Net Excess Benefits	BCR
		Invest. Costs	Annual Costs			
		(Million $)				
1	46 ft	634.1	44.2	21.2	(23.0)	0.48
	48 ft	1,061.7	75.8	57.9	(17.9)	0.76
	50 ft	1,243.0	89.9	94.6	4.7	1.05

221. As indicated in Table 16, Pathway 1 as a last-added element to Pathway 4, yields net excess benefits above unity for a maintained channel depth of 50 ft MLW. The incremental investment cost for the 50 ft MLW channel is estimated to be $1,243 million with a an annual cost of $89.9 million. When compared to the annual benefits of $94.6 million associated with extending the channel through the Kill Van Kull and Newark Bay Channels to Port Newark/Elizabeth, Pathway 1 yields $4.7 million in net excess benefits and a Benefit to Cost Ratio (BCR) of 1.05. Therefore, Pathway 1 to Port Newark/Elizabeth at a maintained depth of 50 ft MLW was considered viable as a last-added element to Pathway 4.

222. Pathway 2 to Howland Hook was only justified at 45 ft MLW because at that depth only the Arthur Kill had to be dredged to complete the pathway. As a last-added element to Pathway 1, additional depths up to 50 ft MLW could be considered on a similar basis. Therefore, Pathway 2 to Howland Hook was re-evaluated as a last-added element to Pathway 1 with only the cost to dredge the Arthur Kill in the evaluation. Table 17 presents the results of that analysis.

TABLE 17 Economic Summary of Pathway 2 As Last-Added Element to Pathway 1						
Pathway	Maintained Channel Depth	Invest. Costs	Annual Costs	Annual Benefits	Net Excess Benefits	BCR
		(Million $)				
2	45 ft	347.0	25.8	27.1	1.3	1.05
	46 ft	362.4	27.0	29.7	2.7	1.10
	48 ft	382.4	28.8	34.2	5.4	1.19
	50 ft	431.7	32.6	38.7	6.1	1.19

223. As indicated in Table 17, when considered in conjunction with Pathway 1, Pathway 2 at a maintained depth of 50 ft MLW provides the most net excess benefits and is the optional plan for that Pathway.

Summary of Preliminary Plans Screening

224. The screening of study alternatives showed that the structural plans involving deepening Pathways 4 and 5, and Pathways 1 and 2 as a last-added element to Pathway 4 all meet the planning objectives and support a Federal Interest. None of the aforementioned four pathways appear to involve insurmountable environmental issues. Pathway 3, the Tanker Channel Deepening Alternative to TOSCO and GATX and Pathway 8 to the Claremont Terminal do not support a Federal Interest. Pathway 5A is not viable due to the planned termination of the Red Hook Container Terminal as a container facility. Evaluation of the anchorages, Pathways 6 and 7, has been deferred to a separate study authority. The Bayonne-Newark Bay Canal was determined to be costly and institutionally unacceptable and the Off-shore Island Port did not to meet the long-term planning objectives. Thus, neither plan was supported by the non-Federal partners. The Non-Structural Plan and No Action Plan do not meet the planning objectives of meeting the needs of the changing world fleet. Thus, only the structural plans using Pathways 1, 2, 4 and 5 need to be considered further in the formulation process.

(THIS PAGE INTENTIONALLY LEFT BLANK)

IDENTIFICATION OF THE NED PLAN

225. For each pathway not previously eliminated in the screening process, alternatives consisting of pathway combinations were evaluated using an Equimarginal Analysis as required by the *Planning Guidance Notebook* to identify the NED Plan. As shown in Table 15, Pathway 4 to Port Jersey provides the greatest net excess benefits and is therefore considered the "first-added" element. The incremental costs for each of the other remaining pathways was compared to the remaining benefits not realized by the "first-added" increment. The next pathway that provided the greatest net excess benefits was then identified and became the "second-added" increment of the alternative. This process continued until none of the remaining pathways resulted in a positive change in net excess benefits.

Alternatives Analysis

226. To identify the NED Plan individual pathways were combined to form Plan Alternatives. Taking Pathway 4 at a maintained depth of 50 ft MLW as the "first-added" element, the "next-added" analysis builds on Pathway 4 plus the non-common segments leading to other terminals. Table 18 provides a summary of the costs and benefits for each alternative considered as a "second-added" element.

TABLE 18
Economic Summary by Alternative for Second-Added Feature

Alternative	Pathway	Additional Channel Segments	Invest. Costs	Annual Costs	Annual Benefits	Net Excess Benefits	BCR
			(Million $)				
A	4_{50}	Port Newark/Elizabeth$_{52}$	1997.9	145.2	177.3	32.0	1.22
A1	4_{50}	Port Newark/Elizabeth$_{50}$	1703.2	122.8	177.3	54.4	1.44
A2	4_{50}	Port Newark/Elizabeth$_{48}$	1521.8	108.8	143.2	34.4	1.32
A3	4_{50}	Port Newark/Elizabeth$_{46}$	1094.3	77.1	104.8	27.7	1.36
B	4_{50}	South Brooklyn$_{52}$	651.8	45.1	108.8	63.7	2.41
B1	4_{50}	South Brooklyn$_{50}$	594.6	40.0	108.8	68.8	2.72
B2	4_{50}	South Brooklyn$_{48}$	586.7	38.5	103.7	65.2	2.69
B3	4_{50}	South Brooklyn$_{46}$	582.3	37.3	98.6	61.3	2.64

227. Based on the results displayed in Table 18, Pathway 4 to Port Jersey/MOTBY at 50 ft MLW combined independently with South Brooklyn at 50 ft MLW provides more net excess benefits than the pathway to Port Jersey alone. In addition, the 50 ft MLW depth at South Brooklyn is shown to be the optimum depth. To further develop the NED Plan, the pathway combination from Table 18 that provides the greatest net excess benefits was then regrouped into additional alternatives to identify the plan providing the most net excess benefits. Since the South Brooklyn Pathway in combination with the

Port Jersey Pathway (Alternative B1) provides the greatest net excess benefits for a dual-pathway plan, this combination is common to subsequent alternatives. Table 19 summarizes the alternatives evaluated.

TABLE 19
Economic Summary by Alternative for Comprehensive Plan Alternatives

Alternative	Additional Channel Segments	Invest. Costs	Annual Costs	Annual Benefits	Net Excess Benefits	BCR
		(Million $)				
C	PJ_{50}+ SB_{50}+PNE_{50}	1837.6	129.8	203.8	73.9	1.57
D	PJ_{50}+ SB_{50}+HH_{45}	941.6	65.7	135.0	69.3	2.05
E	PJ_{50}+ SB_{50} +HH_{50}	1783.4	126.7	149.5	22.8	1.18
F	PJ_{50}+ SB_{50}+PNE_{50}+HH_{45}	2184.6	155.6	230.9	75.3	1.45
G	PJ_{50}+ SB_{50}+PNE_{50}+HH_{50}	2269.2	162.4	238.5	76.1	1.47

PJ_{50} = Port Jersey$_{50}$; PNE_{50} = Port Newark/Elizabeth$_{50}$; SB_{50} = South Brooklyn$_{50}$; HH_{50} = Howland Hook$_{50}$; HH_{45} = Howland Hook$_{45}$

The NED Plan

228. The incremental plan that provides the greatest amount of net excess benefits is a harbor-wide channel improvement plan with maintained 50 ft deep MLW channels to the existing or proposed terminals at Port Jersey, South Brooklyn, Port Newark/Elizabeth, and Howland Hook. This plan is the NED Plan. It is institutionally acceptable because it provides deep water access to both sides of the Harbor. It meets NED criteria in that it maximizes net excess benefits and does not result in insurmountable environmental impacts.

RECOMMENDED PLAN

Overview

229. The Recommended Plan is the NED Plan. It provides for navigation improvements to the nine major channels in the Harbor that provide access to the five main existing or proposed container terminals (Port Newark/Elizabeth Marine Terminal, Howland Hook Marine Terminal, Global Marine Terminal on the Port Jersey Peninsula, the former MOTBY, and South Brooklyn Marine Terminal).

Description of the Recommended Plan

230. The Recommended Plan requires deepening the nine major navigation channels serving the Harbor. The following describes the recommended action, as summarized in Table 20 and shown in Figures 25 through 33.

Ambrose Channel

231. The plan requires deepening the entire 10.6 nautical miles of the Ambrose Channel extending from deep water in the Atlantic Ocean to the Narrows. The channel will be excavated (i.e., deepened) and maintained at a depth of 53 ft MLW. The existing channel will be extended along its present bearing an additional 2,400 ft toward the Atlantic Ocean in order to provide the desired depth. The trapezoidal channel will be 2,000 ft wide at its base with three horizontal to one vertical (3H:1V) side slopes excavated primarily in sand. The Ambrose Light Tower will not be impacted by the project. As part of the project cost, a large mound immediately northwest of the former site of the Ambrose Light Tower will be excavated to the proposed channel depth of 53 ft MLW. The proposed channel alignment is shown in Figure 27.

Anchorage Channel

232. The Anchorage Channel will be dredged for 19,000 feet from the Narrows to the point 1,000 feet north of the junction with the Port Jersey Channel. The recommended channel will remain at its present width of 2,000 ft. The channel will be deepened and maintained at a depth of 50 ft MLW. The trapezoidal channel will be cut through soft material comprised of silt and clay in the southern portion of this channel and sand in the northern portion. The channel will be constructed with 3H:1V side slopes. Two water mains will be relocated below the proposed channel as part of this segment of the project. The relocations consist of 8,500 LF and 7,200 LF of 36-inch and 42-inch diameter water mains, respectively. The proposed channel alignment is shown in Figure 28.

TABLE 20
Recommended Plan – Pertinent Features

Channel Name:	Ambrose	Anchorage	Port Jersey	Kill Van Kull	Newark Bay	Elizabeth	South Elizabeth	Arthur Kill	Bay Ridge
Improvement Features									
Length of Improvement	63,600 ft	19,000 ft	10,000 ft	31,800 ft	14,000 ft	8,800 ft	2,700 ft	14,400 ft	18,000 ft
Maintained Depth (ft MLW)	53	50	50	50	50	50	50	50	50
Initial Depth Excavated (ft MLW)	53	50	52	52	52	52	52	52	50
Channel Bottom Width	2000 ft	2000 ft	500 ft	800 ft	800-2200ft	500-800 ft	500 ft	800 ft	600 ft
Predominant Side Slope:	3:1	3:1	3:1	Varies between 1:1 & 3:1	3:1 western side; 1:1 eastern side	3:1; 1:1 on western end.	Varies between 1:1 & 3:1	3:1 & 1:1 compound	3:1
Predominant Channel Bottom Material Type:	Sand-Classified as Soft	South: silt and clay, north: sand	Sand, Pleistocene sand, clay	Rock, glacial till, sand and silt	Silty sand, silt and clay, rock	Silt and clay, rock	Sand, silt and clay	Rock, silt and clay, silty sand and gravel	Blk silt & clay, silty sand
Special Design Features	Extend channel 2,400 ft along bearing to sea, Remove debris hump from old Ambrose Tower	Deepening 1,000 ft beyond Port Jersey Channel junction	Tapered channel width: 1,500 ft at Anch Chl junction to 500 ft at NJ Pierhead Chl; Berth deepening (3 berths X 1,200 ft X 150 ft)	Shore line stabil. – NYC Parks near Richmond Terrace S.I.-1450 LF; Shore line stabil. – Atlantic Salt Co. Property, S.I.-1050 LF.	Channel deepening 1,500 ft north of Elizabeth Chl Berth deepening PANYNJ Marine Terminal (2 berths X 1,200 ft X 150 ft)	Berth deepening (3 berths X 1,200 ft X 150 ft)	Berth deepening (1 berth X 1,200 ft X 150 ft)	Berth deepening (1 berth X 1,200 ft X 150 ft)	Eastern 600ft of chl deepened, 1600ft turning basin; berth deep/strength (2 berths X 1,200 ft X 150 ft)
Lands Easements & Rights-of-Way									
Permanent Easement:	None	None	None	None	None	None	None	None	None
Temporary Easement:	None	None	None	1.43A: Richmond Terr-.83A, Atlantic Salt -.6A)	None	None	None	None	None
Utility Relocations									
Type:	None	Water	None	None	None	None	Gas	None	(see Anch)
Diameter:	None	36" / 42"	None	None	None	None	12"	None	None
Length:	None	8,500 LF / 7,200 LF	None	None	None	None	2,700 LF	None	None
Env. Disturbances									
Littoral Zone (MLW to –6 ft. MLW)	None	None	None	0.06 A	2.72 A	0.25 A	None	3.23 A	None
Sub-Littoral Zone (-6 to –15 ft. MLW)	None	None	12.35 A	1.41 A	7.79 A	1.42 A	15.84 A	3.22 A	None

Port Jersey Channel

233. The Port Jersey Channel is to be deepened to 52 ft MLW and maintained at a depth of 50 ft MLW allowing 2 ft of the naturally-hard bottom to fill with soft sediments. The channel will be deepened for a distance of 10,000 ft from its juncture with the Anchorage Channel through the berthing areas at the Global Marine Terminal and MOTBY Peninsula. The berths at each of the two facilities will be deepened. The existing 1,200 ft turning basin at the head of the Port Jersey Channel will not be deepened. The turning basin is inadequate for the K-class containership, which has an overall length of 1,044 ft. Without a turning basin, vessels will be required to either back into or out of Port Jersey. In order to facilitate the backing maneuvers, the northern channel limit will be straightened, removing a narrow portion of the New Jersey Flats. Deepening the Anchorage Channel 1,000 ft to the north of the channel junction will permit inbound vessels to bring the bow past Port Jersey Channel, swing the stern around, and then back into berth.

234. The channel will be improved to a width of 500 ft between the Global Marine Terminal and MOTBY Peninsula. To facilitate turning into the channel on a flood tide, the entrance to the Port Jersey channel will flare out. The flare will be 1,500 ft at the junction with the Anchorage Channel and taper to 500 ft at the intersection with the New Jersey Pierhead Channel. The channel will be trapezoidal in shape with generally 3H:1V side slopes except in areas of where the side slopes will transition to 1H:1V. Construction of the proposed channels will remove a narrow portion of the New Jersey Flats impacting 12.35 acres of sub-littoral zone (-6 to -15 ft MLW) habitat. The proposed channel alignment is shown in Figure 29.

Kill Van Kull

235. The Kill Van Kull is to be deepened to a depth of 52 ft MLW and maintained at a depth of 50 ft MLW allowing the bottom 2 ft of the channel to fill with soft sediment over time. Extending from its juncture with the Anchorage Channel to its juncture with the Newark Bay Channel near Bergen Pont, 5.3 nautical miles of channel will be cut through a variety of geologic conditions including rock, glacial till, sand, and silt. Side slopes of the 800 ft wide trapezoidal channel will vary from 3H:1V to 1H:1V as the channel passes from soft deposits to rock with many of the sections being a compound of both. The alignment of the proposed channel will require two sections of 1,450 LF and 1,050 LF of Staten Island shoreline to be stabilized with rip rap along NYC Parks property north of Richmond Terrace and Atlantic Salt Co. property, respectively. As described in the Real Estate Appendix, construction activities associated with the bulkhead and shoreline stabilization will require a temporary easement of 1.43 acres; 0.83 acres near to NYC Parks property north of Richmond Terrace and 0.6 acres near property owned by the Atlantic Salt Co. on Staten Island, NY. As proposed, the channel will

impact 0.06 acres of littoral zone (MLW to -6 ft. MLW) and 1.41 acres of sub-littoral zone (-6 to -15 ft. MLW) habitat. Mitigation is provided for the littoral zone impact. The proposed channel alignment is shown in Figure 30.

Newark Bay Channels

236. The Newark Bay Channels are comprised of the Main Channel (South, Middle and North Reaches) plus numerous access channels (South Elizabeth Channel, Elizabeth Channel, Elizabeth Pierhead Channel, Port Newark Pierhead Channel and Port Newark Channel). Together, these channels service over 60 berths at the Port Newark/Elizabeth Marine Terminal on the west shore of Newark Bay. The main Newark Bay Channel will be dredged from its juncture with the Kill Van Kull near Bergen Point to a point located 1,500 ft north of the Elizabeth Channel. The channel will extend north of the Elizabeth Channel to aid vessels in turning and backing into berth. The Port Newark Pierhead Channel and Port Newark Channel are not anticipated to be deepened in connection with this investigation. The 14,000 LF of improvement proposed for the main Newark Bay Channel remains at its present width varying from 800 ft at its northern terminus to 2,200 ft near Bergen Point. The channel will follow its present alignment.

237. Similarly, the 8,800 ft long Elizabeth Channel will also remain at its present width, which varies from 500 to 800 ft, and alignment. The 2,700 ft long South Elizabeth Channel will be significantly widened from its present 290 ft to 500 ft. In addition, the berths at Port Elizabeth will be widened to 150 ft and deepened.

238. Each of the aforementioned channels will be dredged to 52 ft MLW and maintained at 50 ft MLW. The main north-south Newark Bay Channel, including the Elizabeth Pierhead Channel, will generally be constructed with a composite trapezoidal channel having side slopes of 3H:1V along its western side and as a result of rock paralleling the channel, and 1H:1V along the eastern side.

239. The South Elizabeth and Elizabeth Channels will have side slopes varying from 3H:1V to 1H:1V as the channel passes through changing strata. Construction of the South Elizabeth Channel will require relocating 2,700 LF of 12-inch diameter gas line. The line will be relocated away from the proposed channel template. The proposed channel alignments are shown in Figure 31.

240. As displayed in Table 21, the alignment of these channels will impact on a total of 2.97 acres of Littoral Zone and 25.05 acres of Sub-Littoral Zone habitat. The Littoral Zone impacts will require mitigation.

TABLE 21 Littoral Zone Impacts of Newark Bay Channels		
	Impacted Area (Acres)	
	Littoral Zone (MLW to –6 ft. MLW)	Sub-Littoral Zone Habitat (-6 ft. MLW to –15 ft. MLW)
Newark Bay Channel	2.72	7.79
South Elizabeth Channel	0	15.84
Elizabeth Channel	0.25	1.42
Total	2.97	25.05

Arthur Kill Channel

241. The Arthur Kill Channel is proposed to be deepened from its juncture with the Kill Van Kull near Bergen Point to the Howland Hook Marine Terminal. This 2.4 nautical mile segment of channel will be dredged to a depth of 52 ft MLW and maintained at 50 ft MLW. The channel will generally follow the alignment of the 41 ft MLW channel presently under final design and anticipated to be in place in the Without-Project Condition. The existing channel varies in width from 500 to 800 ft, but will be widened to 800 ft as part of the 41 ft MLW project. This width will be maintained for this project. The trapezoidal shaped improvement is generally a compound section with 3H:1V side slops in the softer upper portions of the excavation and 1H:1V in the underlying rock. The alignment of the channel will impact 3.23 acres of Littoral Zone habitat requiring mitigation and 3.21 acres of Sub-Littoral Zone habitat. The proposed channel alignment is shown in Figure 32.

Bay Ridge Channel

242. The nearly 3 nautical mile long Bay Ridge Channel is proposed to be improved and maintained to a depth of 50 ft MLW. The proposed channel will parallel the eastern side of current channel at a width of 600 ft, reduced from the current width of 1,200 to 1,750 ft. The width of the existing channel was based upon the fact that the existing finger piers required that a ship turn perpendicular to the channel before berthing. The 600 ft. one-way channel will be adequate for the two deep draft berths as anticipated in the Without-Project Condition. A proposed turning basin, with a diameter of 1,600 ft, is to be located opposite the terminal, enabling vessels to back out of or into berth. The development of this channel will require relocating two aids to navigation and the purchase of an additional eight. As a result of the channel alignment, 0.12 acres of Sub-Littoral Zone habitat will be impacted. The proposed channel alignment is shown in Figure 33.

(THIS PAGE INTENTIONALLY LEFT BLANK)

DESIGN OF THE RECOMMENDED PLAN

Overview

243. The design of the Recommended Plan required detailed engineering design, environmental studies, and real estate investigations and gross appraisals. Channel configurations were designed to avoid and minimize environmental and cultural resource impacts while still meeting navigation safety requirements. The engineering design incorporated physical modeling and a detailed analysis of the Harbor geology in order to develop precise quantity and cost estimates. This section provides a summary of the engineering analysis conducted for design development.

Description

244. Table 22 summarizes the channel improvements in the Recommended Plan, as briefly discussed above. A full description of the proposed channel improvements, including widenings, realignments, and turning basins is included in the Channel Design Appendix. Figures 25 through 33 show the channel improvements in the Recommended Plan.

TABLE 22
The Recommended Plan

Channel Name	Maintained Depth	Excavated Depth
Ambrose	53 ft	53 ft
Anchorage	50 ft	50 ft
Bay Ridge	50 ft	50 ft
Port Jersey	50 ft	52 ft
Kill Van Kull	50 ft	52 ft
Newark Bay	50 ft	52 ft
Elizabeth	50 ft	52 ft
South Elizabeth	50 ft	52 ft
Arthur Kill (to HH)	50 ft	52 ft

HH – Howland Hook

Basis of Design

General

245. The navigation channels in the Recommended Plan were designed in accordance with the guidelines and criteria contained in the following documents:

- EM 1110-2-1613 "Hydraulic Design of Deep Draft Navigation Channels", 8 April 1983, 8 January 1994 (Draft Revision);
- ER 1110-2-1404 "Hydraulic Design of Deep Draft Navigation Channels", 31 January 1996;
- PIANC PTC II-30 "Approach Channels – A Guide for Design", June 1997.

246. Coordination meetings were held with the various pilot organizations (Sandy Hook Pilots Association, New York Harbor Pilots, docking pilots, etc.), the U.S. Coast Guard, and the non-Federal partners to ensure that the proposed channel improvements provide for safe navigation of all vessels while meeting the needs of the port facilities and the maritime community.

Geotechnical Investigations

247. Geotechnical investigations of the Harbor were conducted in order to document the distribution of the soil and rock types and their properties to the degree that:

- The dredging, blasting, channel side slope, and structure stability analyses could be performed;
- Estimates of the quantity of rock and contaminated sediments could be determined.

248. Geotechnical investigations included:

- Review and Inventory of Existing Subsurface Data: Public and private sources were contacted for existing subsurface data. The computer program MICROSTATION was used to catalogue and plot all available data. Due to recent or ongoing studies and projects, significant data was already available for the Kill Van Kull, the Arthur Kill, Newark Bay, and the Port Jersey Channel;

- Implementation of a Boring Plan: An extensive boring plan was initiated consisting of over 530 boring locations throughout the Harbor. One hundred thirty vibracores were collected at deepwater locations in the Ambrose and Anchorage channels. Subsurface data acquisition and soil testing was conducted on the other 400 locations. An extensive boring log database, including boring identification, coordinates, elevation, and strata descriptions, was created and was used to aid in the geological mapping of the Harbor.

Geotechnical Analyses

249. Geotechnical analyses included:

- Dredgeability Analysis: The computer program "DREDGABL", developed by the Corps' Waterways Experiment Station (WES) to aid in determining the applicability of various dredges to remove the different soil types, was applied to evaluate each channel;

- Channel Side Slope Analysis: Slope stability analyses were performed on the Ambrose, Anchorage, Bay Ridge and Port Jersey Channels using the computer program UTEXAS 3. The side slope stability of any channel is critical for two reasons: (1) failure of the side slope of a channel will result in significant shoaling, requiring frequent maintenance dredging, and (2) structures close to the top of the slope when failure occurs may lose structural integrity and may suffer significant damage;

- Blasting Analysis: An analysis of the effects of required blasting was conducted. This analysis included identifying the location of sensitive structures and determining those that would be most effected by blasting. The means for minimizing the effects of blasting were then determined.

Surveying and Mapping

250. The boring log database was employed to construct several essential contour maps. A complete description of how the maps were constructed and the purpose of each are included in the Geotechnical Appendix. The following is a summary of the maps.

- Top of Bedrock (Structure) Map,
- Thickness (Isopach) of Contaminated Material,
- Top of Pleistocene Structure (Paleostructure) Map,
- Percent Sand Maps.

251. Preliminary soil profiles were also completed for each channel. The profiles and cross-sections illustrate the type and aerial extent (stratigraphy) of the soil and bedrock types encountered within the various channels. The profiles were used to subdivide the channels into similar reaches where the dredging conditions are relatively uniform. Uniform soil and/or rock conditions are a major factor to be considered when dredging contract limits are defined.

Structural Studies

252. The non-Federal partners identified structures potentially affected by channel deepening alternatives based on preliminary channel designs, existing subsurface data, and their own geotechnical boring data. Several structures were initially identified as

potentially impacted in the Kill Van Kull, Arthur Kill, and Newark Bay. The structures were assigned a level of predicted impact based on anticipated channel depths, geotechnical data, and channel geometry. The structures with the highest predicted impact were further evaluated to determine methods and costs of stabilization. Structure stabilization costs were estimated in the channel deepening alternatives as Non-Federal Cost Items. The conceptual modifications are included in the Structural Appendix and include shoreline stabilizations in the Kill Van Kull (Atlantic Salt Co. and NYC Parks property north of Richmond Terrace) and the Arthur Kill (Elizabethport Marina) and stabilization of the Arthur Kill Lift Bridge.

Ship Simulation Modeling

253. A vertical ship motion study was conducted at the WES Coastal & Hydraulics Laboratory to determine the total underkeel clearance required for the design vessels in Ambrose Channel. This study included wave modeling in the New York Bight and Lower Bay to determine incident wave conditions, a ship tracking study (utilizing Differential Global Position System – DGPS – receivers on board vessels inbound and outbound) to measure vertical ship motions, and a ship motion model to predict vertical ship motion of vessels under various wave conditions. The ship motion model used 1-year frequency wave conditions for the design conditions. The results of the simulation modeling determined that the container design vessel would require a total of 7 feet underkeel clearance and the tanker design vessel would require a total of 6 feet underkeel clearance in Ambrose Channel. These underkeel clearances are reflected in the previous sections describing underkeel clearances.

Dredged Material Placement

254. The implementation of the proposed project will generate dredged material that will require placement. The quantities of dredged material were computed for rock, non-rock and material unsuitable for placement at the Historic Area Remediation Site (HARS). For each category of dredged material, quantities were computed based on the geotechnical investigations described previously and in greater detail in the Geotechnical Appendix. Non-rock material unsuitable for placement at the HARS was quantified using an ISOPACH map with unsuitable areas identified based on the presence of hydrocarbons, moisture content and color. No chemical or biological testing was performed for this phase of investigation. Additional testing for the presence of contaminants will be conducted in accordance with established protocols, as described in the Project Management Plan. Initially, quantities were computed based on geologic conditions within the Harbor. However, mechanical dredges cannot completely remove the layer of non-rock from the top of rock in an economical manner. Experience has shown that approximately one foot of material will remain on top of the rock. Therefore, geologic quantities requiring placement were modified to account for this by treating the

one foot of the material that will remain on top of the rock as if it were rock. This revised set of quantities is referred to as pay quantities. The pay quantity of non-rock will be less than the geologic quantity of non-rock while the pay quantity of rock will accordingly be greater than the geologic quantity of rock. In addition, when considering dredged material placement, the permitted non-paid overdredge quantity must be included in the volume. This includes the potential of as much as an additional two feet of overdredging and is referred to as the gross quantities.

255. In addition, the recommended project entails 50 years of maintenance dredging beyond that which is required to maintain the existing channels. The total volume of dredged material generated by the Recommended Plan is shown in Table 23.

TABLE 23
Dredged Material Gross Quantities

	Non-HARS Material (cy)	HARS Material (cy)	Rock Material (cy)
Initial Construction	7,662,000	35,507,000	8,168,000
50 Years Maintenance*	145,000	1,600,000	0
Total	7,807,000	37,107,000	8,168,000

*Certain channels, due to changes in the hydraulic regime, will actually require less maintenance dredging than prior to project implementation. They have been assumed not to contribute to the maintenance volumes.

256. The District is currently in the process of finalizing the Dredged Material Management Plan (DMMP) for the Port. Corps' policy (EC-1165-2-200) requires each District to prepare a DMMP for maintaining the Federal navigation channels for at least 20 years. The plan identifies how much material will be dredged to maintain the channels and how the dredged material will be managed in an economically sound and environmentally acceptable manner. In addition to the placement needs for Federal dredged materials, the DMMP also considers private and local/state needs. In this manner, the DMMP strives to develop a regionally supported, comprehensive plan to meet all the dredged material management needs for the Port.

257. As part of the DMMP study, dredged material placement alternatives were developed to manage material generated from construction as well as O&M of the Recommended Plan.

258. The Project will not require acquisition of real property interests for placement of the dredged materials. Rock material will be placed on off-shore artificial reefs at Sandy Hook and Atlantic Beach. Materials meeting the standards for ocean placement and suitable for remediation purposes will be placed at the HARS. Required permits for these activities will be obtained during the Project's PED stage.

259. During the formulation process, the District determined that the NED option for dredged material not suitable for placement at the HARS would be in-channel placement

cells. The non-Federal partners concurred in this approach in a letter dated March 17, 1999. The material is to be placed for a tipping fee of $29/cy and deemed to be the most cost-effective solution. Since the formulation of the project, the non-Federal partners have expressed an interest in continuing to pursue the use of upland sites for such placement, and have reserved the right to substitute any sites that may later prove to be more environmentally acceptable, or cost-effective or both. In letters dated August 25, 1999 and September 17, 1999 addressed to the District and contained in the Pertinent Correspondence and Public Involvement Appendix, the non-Federal partners have indicated a number of potential sites that they will continue to explore. The placement sites identified by the non-Federal partners, shown in Table 24, would provide sufficient volume to meet the needs of the Recommended Plan. In addition, they have indicated their understanding that all costs incurred in excess of the NED unit costs as a result of the use of upland sites will be borne by the non-Federal partners.

TABLE 24
Placement Options for Project Dredged Material

Project (maintained)	Source	Material Type	Total Volume (mcy)	Placement Option	Volume (mcy)	Site Volume Remaining (mcy)	Note
Ambrose 53 ft	Construction	HARS Sandy	13.371	Hunterdon Quarry, NJ	13.371	16.629	1
	Maintenance	HARS Sandy	17.504	Hunterdon Quarry, NJ	16.629	0.000	
				HARS	0.875	38.125	2
Anchorage 50 ft	Construction	HARS Glacial	4.159	HARS	4.159	33.966	2
	Construction	Non-HARS	0.717	NJDIG Program	0.717	39.983	3
Port Jersey 50 ft	Construction	HARS Glacial	2.581	HARS	2.581	31.385	2
	Construction	Non-HARS	0.311	NJDIG Program	0.311	39.672	3
	Maintenance	Non-HARS	2.762	NJDIG Program	2.762	36.910	
Kill Van Kull 50 ft	Construction	Rock	3.211	NY/NJ Reef	3.211	N/A	4
	Construction	HARS Glacial	4.019	HARS	4.019	27.366	2
	Construction	Non-HARS	2.212	NJDIG Program	2.212	34.698	3
	Maintenance	Non-HARS	2.412	NJDIG Program	2.412	32.286	
Newark Bay 50 ft	Construction	Rock	1.250	NY/NJ Reef	1.250	N/A	4
	Construction	HARS Clay	8.596	HMDC	5.000	0.000	5
				HARS	1.596	25.770	2
	Construction	Non-HARS	2.356	NJDIG Program	2.356	29.934	3
	Maintenance	Non-HARS	14.197	NJDIG Program	14.197	15.737	
Arthur Kill 50 ft	Construction	Rock	2.695	NY/NJ Reef	3.211	N/A	4
	Construction	HARS Glacial	1.206	HARS	1.206	24.564	2
	Construction	Non-HARS	0.782	NJDIG Program	0.782	14.955	3
	Maintenance	Non-HARS	5.132	NJDIG Program	5.132	9.823	
Bay Ridge 50 ft	Construction	HARS Glacial	2.973	HARS	2.973	21.591	2
	Construction	Non-HARS	1.993	Sub-Channel Cells	1.993	7.007	6
	Maintenance	Non-HARS	4.259	Sub-Channel Cells	4.259	2.748	

Notes:

1. Hunterdon Quarry: Initial capacity 30 mcy. Cost of transport and placement of material from pierside delivery from dredger will be borne by the non-Federal partners.
2. HARS. Initial capacity 39 mcy. HARS material includes glacial till, sandy, and clay materials.
3. NJDIG Program. The program has identified upland placement sites with an initial capacity of 40.7 mcy. Additional capacity of 950,000 cy/yr has also been identified.

CTI Lehigh Anthracite	20 mcy	JCI Upcycle Decon	0.5 mcy/yr
CTI Carteret	0.8 mcy	Biogenesis Kearny Decon	0.25 mcy/yr
SK Service Koppers Coke	3.4 mcy	IGT Koppers Decon	0.1 mcy/yr
SK Service Port Reading	1.0 mcy	Westinghouse Plasma Arc Decon	0.1 mcy/yr
OENJ Bayonne	4.5 mcy	TOTAL	0.950 mcy/yr
OENJ Port Reading	3.0 mcy		
Sayreville National Lead	5.0 mcy		
Allied Signal Elizabeth	3.0 mcy		
TOTAL	40.7 mcy		

4. NY/NJ Reef. Fish reefs off NY and NJ. Effectively, there is no known limit for rock placement at these sites.
5. Hackensack Meadowland Development Corporation (HMDC). Initial capacity 5 mcy. HMDC has identified a need for clay for landfill capping material.
6. Sub-Channel Placement Cells (SPC) New York. Initial capacity 9 mcy as identified in the draft report "NY Harbor DMMP Aquatic Placement Option Report" dated Dec 18, 1998 (NYNJ Harbor Partnership).

Source: PANYNJ letter to New York District dated August 25, 1999.

Real Estate Requirements

260. The non-Federal partners are required to provide all Lands, Easements, Rights-of-way, and Relocations (LERR) that are necessary for a navigation project in the Harbor. This is in accordance with the provisions of WRDA 1986 and will be included as an obligation of the non-Federal partners in the Project Cooperation Agreement. The Recommended Plan calls for dredging to a maintained depth of 50 ft MLW. Insofar as the channels that are to be dredged as part of Recommended Plan are Federal channels, the Government will exercise its rights under the doctrine of Navigational Servitude and therefore, no real estate taking is required. The estimated total acreage associated with the LERR requirements of the Recommended Plan, as shown in Table 25, is approximately 25.03 acres consisting of approximately 23.6 acres in fee for environmental mitigation and 1.43 acres of perpetual easements for shoreline stabilization.

TABLE 25
LERR Required

Fee	Acreage Required
Mariners Harbor, NY site	4.6
South of Goethals Bridge, NJ site	3.0
Woodbridge, NJ site	16.0
Fee Total	23.6
Perpetual Easements	
Atlantic Salt Company, Staten Island, NY	0.6
NYC Parks (Richmond Terrace), Staten Island, NY	0.83
Perpetual Easement Total	1.43
Total LERR Required	25.03

261. The land (in fee) required for environmental mitigation includes three parcels of land. The first two sites consist of littoral zone habitat (0-6 ft deep MLW) adjacent to the shoreline in the Kill Van Kull and Arthur Kill, respectively. The third site is 16 privately owned acres in the Township of Woodbridge in Middlesex County, New Jersey. Access to all sites is via public roadways. The two perpetual easements, described above, consist of 25-foot wide strips along the Kill Van Kull waterfront for stream bank stabilization. The easement of the Atlantic Salt Co. is approximately 1,050 feet in length. The easement on the parcel owned by the City of New York and administered by its Department of Parks and Recreation is approximately 1,450 feet. Construction along these easements will take place from the water, therefore no additional temporary construction easements are required.

262. A standard Right-of-Entry will be required for replacement of the wave screen and pier at the municipally-owned City of Elizabeth Marina. The modification will be accomplished from the water with no land access required and O&M activities after

completion will be the responsibility of the City of Elizabeth. No LERR costs will be associated with the placement of dredged material. Rock material will be placed at the Sandy Hook and Atlantic Beach reef sites. In compliance with current Federal regulations for ocean placement, materials meeting the standard for ocean placement will be used for remediation material at the HARS. For non-rock material deemed unsuitable for placement at the HARS, the present intent is placement at in-channel cells to be located in the lower bay. The placement will be accepted for a "tipping fee" thereby eliminating the need for real estate acquisition. The local sponsors have expressed an interest in upland disposal and have indentified a number of potential sites. Their intent is to have the construction contractor place the material at the sites for a "tipping fee". There is no intent for any project participants (non Federal partners) to acquire these sites. Furthermore, as the placement of unsuitable material into the channel cells represents the NED costs, the non-federal partners have agreed to pay any additional costs associated with upland placement as a "betterment".

263. The field office for this project will be placed on approximately a 0.5 acre portion of the 32 acres of Federally-owned land situated in Jersey City, NJ at the Caven Point Marine Base. The non-Federal partners will not receive LERR credits for this land.

264. There are three "Deep Draft Utility Relocations" required for this project. Two of these three utilities (consisting of one 36-inch water line and one 42-inch water line, both owned by the City of New York) cross the Anchorage Channel between Brooklyn and Staten Island, NY. They also cross the Bay Ridge Channel and the southern portion of the Red Hook Flats Anchorage. Approximately 8,500 lineal feet of the 36-inch line and 7,200 lineal feet of the 42-inch line will be relocated at an estimated cost of $37 million.

265. The third utility to require a "Deep Draft Utility Relocation" is a 12-inch gas pipeline, owned by Public Service Electric and Gas Company of New Jersey (PSE&G). Situated south of the South Elizabeth Channel, the line crosses Newark Bay from Elizabeth, NJ to Bayonne, NJ. Approximately 2,700 lineal feet of the 12-inch diameter pipeline needs to be relocated at an estimated cost of $3.24 million.

266. In addition, several aids to navigation (floating buoys) will require relocation. The specific buoys to be relocated will be identified during the project's PED stage. At that time the New York District will notify the Coast Guard in writing of the specific requirements and request relocationof the aids upon PCA execution.

267. The Real Estate Plan for this project is included as an Appendix to this Feasibility Report.

(THIS PAGE INTENTIONALLY LEFT BLANK)

ENVIRONMENTAL ANALYSIS OF THE RECOMMENDED PLAN

Overview

268. A FEIS was prepared for this study according to NEPA requirements. The FEIS presents project alternatives; documented existing conditions; and direct, indirect, and cumulative impacts associated with implementation of the Recommended Plan. A Mitigation Plan was prepared for those impacts that are determined to be unavoidable. The FEIS for this investigation is limited to impacts directly associated with Harbor channel improvements. A Memorandum of Understanding (MOU) between the Environmental Protection Agency (EPA), the New York District Army Corps of Engineers, and the non-Federal partners establishing procedures to address the land-side impacts associated with the non-Federal partners' Comprehensive Port Improvement Plan, or CPIP. A copy of the MOU is provided in Appendix B-1.8 of the FEIS. The version provided contains the signatures of the parties as of the printing of this report. A separate EIS will be developed in connection with the CPIP.

Comprehensive Port Improvement Plan EIS (CPIP-EIS)

269. As previously discussed, the terminal expansions presented in the non-Federal partners' CPIP were not considered in the economic analysis of project alternatives. However, in order to maximize market share, the non-Federal partners through the CPIP have expressed an interest in further expansion of the Port's terminal facilities. Because the CPIP has the potential to recommend several major federal or state actions (*e.g.*, permits for fill to expand port facilities, modification/expansion of existing transportation networks, channel improvements, and habitat enhancement/restoration projects) that could have significant environmental effects, the EPA, the Corps, and the non-Federal partners have developed an MOU to clarify an agreed upon cooperative approach for achieving land-side improvement decisions among themselves and regional stakeholders. The decision making process associated with the above listed actions requires the preparation of an EIS pursuant to NEPA. In light of this, and in an effort to consolidate and effectively use limited resources, the parties to this MOU agree that the most effective approach is to prepare a comprehensive EIS on all contemplated land-side improvement activities requiring federal regulatory consideration.

270. Regardless of any agreements between the above mentioned parties, the FEIS for the Recommended Plan is limited to actions associated solely with implementation of the proposed project improvements and does not attempt to address any proposed land-side expansions or reconfigurations presented by the non-Federal partners in the CPIP nor the terminal reconfigurations presented in the Without-Project Conditions. Likewise, the

proposed CPIP-EIS will evaluate terminal improvement impacts that are exclusive of the Recommended Plan's impacts.

Physical Resources

General

271. The Harbor Estuary is a complex, dynamic system of hydraulics, salinity, sedimentation, water quality, dissolved oxygen, and other physical attributes and it is difficult to predict the environmental impacts of a construction or development project within such a complex system. For this project, a hydrodynamic model was used to evaluate impacts to certain physical and water quality parameters, including water surface elevation, salinity, water temperature, and dissolved oxygen. The model selected for this study was MIKE3, a modeling system for simulating three-dimensional, unsteady flows in rivers, estuaries, and coastal seas. Model results were evaluated at survey locations in Upper and Lower New York Bays, the Arthur Kill, the Kill Van Kull, and Newark Bay, as well as numerous locations in the Hudson and East Rivers. The impacts associated with the proposed channel improvements predicted from this model are described below.

Hydraulics

272. The bays, channels, and rivers surrounding the Harbor comprise a complicated hydrologic and hydraulic system. The Hudson River is the largest river entering the Harbor. Other major tributaries include the Passaic and Hackensack Rivers, which enter Newark Bay north of Port Newark, and the Raritan River, which enters Raritan bay and Lower New York Bay near the southern entrance of the Arthur Kill.

273. Variations in topography, freshwater input, tidal energy and meteorological forces produce regions of different hydraulic characteristics in the Harbor. The Harbor tidal cycle generally responds to the tide propagating in from the New York Bight with some amplification and small phase lags between Upper New York Bay and Newark Bay. Tidal currents in the system are also variable.

274. The MIKE3 model indicates that the proposed channel improvements will not result in measurable changes in hydraulic conditions throughout the Harbor.

Sedimentation

275. Sedimentation rates in the dredged channels are on average greater than sedimentation rates elsewhere in the Harbor. Project dredging is expected to result in an alteration of the equilibrium between sediment deposition and sediment suspension in the channels, and the resulting sedimentation rates in newly dredged channels will be greater

than in other areas of the Harbor. Nonetheless, the project is not expected to significantly impact the long-term overall sedimentation patterns in the Harbor.

Water Quality

276. A survey was conducted by the New York City Department of Environmental Protection (NYCDEP) and Battelle Ocean Sciences, in which water quality parameters were measured in the Harbor. While biochemical oxygen demand (BOD) concentrations were relatively uniform throughout the study area, nutrient concentrations in the western portions of the Harbor were typically higher than in Upper and Lower New York Bays. A similar pattern was noted for ammonia and phosphate. Nutrient concentrations in the Harbor have historically been high and are usually greater than those limiting primary productivity.

277. The NYCDEP/Battelle survey also indicated that salinity values may vary by as much as 10-15 parts per thousand (ppt) at a given location in the Harbor as freshwater flow varies throughout the year. In addition, measurements in the Upper New York Bay indicated that differences in salinity between the surface and bottom of the water column may be nearly 10 ppt during periods of high Hudson River flows. Salinity differences are on the order of 1-3 ppt during other times of the year. A similar pattern occurs in the northern reaches of Newark Bay. The results of the MIKE3 model indicate that the Passaic and Hackensack Rivers will experience an average increase in salinity of less than 0.1 ppt as a result of the project, with much smaller changes expected in other areas of the Harbor.

278. The Dissolved Oxygen (DO) results of the MIKE3 model indicate that differences in dissolved oxygen will be very small at all locations in the Harbor as a result of the project. The largest differences were predicted in the Arthur Kill, the Kill Van Kull, and Newark Bay where reductions in average DO of up to 0.03 parts per million (ppm) were projected. Changes in dissolved oxygen in other areas of the Harbor (*e.g.*, the East and Hudson Rivers) are estimated to be less than 0.01 ppm.

Air Quality

279. The impacts to air quality associated with the Recommended Plan can be segmented into two separate issues: temporary impacts associated with construction activity, and long-term impacts associated with changes in the fleet mix calling on the Harbor in the With-Project Condition. The construction activities will be carried out in phases under a number of separate construction contracts over a period of several years. Construction activities will involve the use of hydraulic and mechanical dredges, support vessels, and other items of equipment that generally operate on diesel power. Emissions from diesel engines have a potential to impact air quality. Any air quality impacts,

however, would be short-term and localized. Moreover, these localized potential impacts would occur over a relatively wide area that is characterized by coastal winds that area expected to rapidly disperse the emissions.

280. As the proposed channel improvements will not increase the amount of cargo through the Port, the long-term impacts of the Recommended Plan as compared to the Without-Project Future Condition result from a change in the fleet that would call on the Harbor due to the availability of deeper channels in the With-Project Condition. As there is little or no published data on ship emissions, fuel consumption has been used as a surrogate to imply emission impacts. Within the Port, fuel consumption is comprised of two elements: transit in and out of the Harbor, and time at the dock. For analysis purposes, a total of 4 hours of transit time was used in the Harbor: 2 hours inbound and 2 hours outbound. Dockside time was computed based on the off-loading rate of 40 TEU/hr. Fuel consumption was estimated for the ships' main engines when in transit and auxiliary engines when docked. Fuel consumption for the various vessel types was computed based on data provided in the USACE document *Economic Guidance Memorandum 99-05, Deep Draft Vessel Operating Costs* dated February 1, 1999. The fleet mix in the Without- and With-Project Future Conditions was developed as described in the Economic Appendix. Applying the fuel consumption rates to the anticipated fleet mix over the 30 year period from 2010 (project base year) to 2040 revealed that with the navigation improvements in place, there will be a reduction of approximately 665,000 metric tons (mt) of fuel burned in the Port over the 30-year period as compared to the Without-Project Condition. Approximately 415,000 mt of fuel savings are attributable to the main engines and 250,000 mt to the auxiliary engines. As the fuel consumed is only a surrogate for emissions and the exact amount of fuel consumed varies based on the tide, speed of the vessels, etc., these figures should not be taken as a quantitative assessment of emissions reduction but rather as an indication that the implementation of the navigation improvements will result in no long-term adverse impacts to air quality.

HTRW Consequences

281. Hazardous, toxic, and radioactive waste (HTRW) consequences are only applicable to land-side areas, since waste generated in aquatic areas will be tested under dredged material placement criteria. The study area is situated in a region with a long history of heavy commercial and industrial development and usage. Where construction related to channel improvements is proposed (*e.g.*, bulkhead strengthening/stabilization), it is recommended that a sampling plan be developed and site-specific investigations be performed.

Biological Resources

General

282. The Harbor is home to a diversity of biological species and habitats. Coastal wetlands in the Harbor region cover approximately 105,000 acres. These wetlands support a large diversity of aquatic birds, including many threatened or endangered species. The Arthur Kill Complex plays a significant role in the nesting and foraging of herons, egrets, and ibises. The Harbor also lies within the Atlantic Flyway, a major pathway for birds migrating between their northern breeding grounds and their southern wintering grounds. A variety of macro- and micro-invertebrates and over 100 fish species have also been identified in the Harbor. A variety of marine mammals and sea turtles, many of which are threatened or endangered, are also known or suspected to frequent the Harbor.

Aquatic Resources

283. The proposed project would disturb 6.26 acres of littoral and 42.03 acres of sublittoral habitat beyond what has been authorized for other projects. These estimates of acreage, which do not take into account potential slumping of channel slopes after dredging, are nonetheless conservative, because disturbance of this underwater acreage will not necessarily mean loss of the entire acreage as habitat. For example, while 6.26 acres of littoral habitat will be deepened, not all will be deepened to the point (i.e., below 6 ft MLW) where it is no longer littoral habitat. The same applies to sublittoral habitat: only a portion will become deeper than 15 ft below MLW. Moreover, some of the littoral habitat that will become deeper than 6 ft below MLW will by definition become sublittoral habitat. Therefore, while it is difficult to quantify how many acres of littoral and sublittoral habitat will actually be lost, the loss will certainly amount to less than the 48.29 acres to be disturbed by the project.

284. The greatest littoral zone disturbance is projected for the Arthur Kill/Howland Hook vicinity (3.23 acres), followed by the vicinity of the Newark Bay Channel (2.72 acres), the flats area on the western side of Newark Bay south of Port Elizabeth (0.25 acres), and the Kill Van Kull (0.06 acres). No disturbance of littoral zone habitat is projected for the dredging work to be conducted in the Ambrose Channel, the Anchorage Channel, the Bay Ridge and Red Hook vicinity, Port Jersey, and the South Elizabeth Channel. In addition, no disturbance to vegetated or emergent marsh (intertidal) areas is projected as a result of the project.

285. A loss of benthic habitat will also occur in the channel bottoms and side slopes where dredging takes place. In most cases, however, this impact would only be temporary since natural sedimentation would rapidly produce a benthic habitat

comparable to preexisting conditions. A permanent loss of habitat, however, could result from the removal of rock outcroppings in the Kill Van Kull, Arthur Kill, and Newark Bay. These areas would no longer be available for invertebrate species that require hard substrate.

Wildlife Resources

286. Channel improvements could cause generally localized changes in benthic, shellfish, and forage fish species distribution and wildlife utilization. Temporary losses of benthic habitat in the channel bottoms and side slopes will cause a temporary loss of benthic populations inhabiting these areas. This loss would only be temporary because, although the project involves a large area overall, construction will be implemented incrementally; therefore, the vast majority of benthic habitat in the channel bottoms and side slopes would remain undisturbed and would act as a source for recolonizing species. This, together with natural sedimentation, would result in benthic populations in the channel bottoms and side slopes that are comparable to preexisting conditions. However, as discussed previously, the removal of rock outcroppings in some areas will result in a permanent loss of benthic populations that require hard substrate in these areas.

287. Depending on the timing of dredging operations, a temporary loss of the benthic community could also result in a temporary loss of foraging opportunities for organisms that consume benthic invertebrates. Such organisms include some macroinvertebrates, fish, waterfowl, wading birds, shore birds, terrapins, and sea turtles. Since this loss will be temporary, and since these organisms are mobile and can forage in other areas in the interim, these impacts are expected to be minimal.

288. No disruptions to productive shellfish beds, which are primarily located in Lower New York Bay, are expected. In addition, dredging activities are not expected to have a direct impact on commercially or recreationally harvested shellfish.

289. Sharp pressure changes due to underwater rock blasting may result in damage to hard-bodied invertebrates and organisms with gas bladders (fish) in the immediate vicinity of the blast area. Impacts to benthic organisms are projected to be minimal at areas adjacent to the blasting area. Blasting may also displace resident fishes, although this impact is expected to be only temporary.

Threatened and Endangered Species

290. Federal and state-listed threatened and endangered species that occur in the Harbor are listed in the FEIS. Although it is likely that Peregrine falcons residing in the study area are adapted to daily levels of noise and line-of-sight visual disturbances that are much higher than that of non-urban environments, the threshold disturbance levels

that may induce nest abandonment or reproductive failure are not well-understood and may vary among individual birds. Dredging and blasting in the immediate vicinity of the bridges used for nesting will produce an increased level of disturbance during the initial deepening activity. Additionally, increased human and vessel presence in the vicinity of nesting sites increases line-of-sight visual disturbance. However, these disturbances are not expected to have an impact on nesting Peregrine falcons. No direct impacts to other threatened or endangered birds are anticipated from the project.

291. The primary, potential, indirect impact to the peregrine falcon, terns, and skimmers is the potential for exposure to contaminants as a result of dredging. Dredging may release contaminants into the water column, thereby making them more bioavailable to aquatic organisms. Contaminants could bioaccumulate in aquatic organisms and in turn biomagnify through higher trophic levels in the food chain. However, the suspension of contaminants into the water column is expected to be temporary, and the removal of contaminated sediments from the channels by dredging could potentially off-set such an effect. No other indirect impacts to threatened or endangered birds are anticipated from the project.

292. Dredging activities are not anticipated to result in any direct or indirect impacts to the northeastern beach tiger beetle or to any threatened or endangered plants in the study area since the proposed construction will not involve human or vehicular traffic at any beaches in the Harbor.

293. No direct impacts to marine mammals are expected as a result of channel deepening, since marine mammals can swim quickly to avoid the slow-moving dredge. The primary, potential, indirect impact to marine mammals from the project is the potential for exposure to contaminated food organisms as a result of dredging.

294. The disturbance of macroinvertebrate habitat in the channel bottoms and the littoral zone would indirectly impact sea turtles, since they feed on organisms such as crabs and some mollusks that inhabit these areas. The loss of channel bottom feeding areas would be temporary because natural sedimentation is expected to return these habitats to pre-dredging conditions relatively quickly. In the interim, sea turtles would probably avoid these less desirable areas. The loss of littoral zone feeding areas in the Kill Van Kull, Newark Bay, and the Arthur Kill would be permanent, although these areas are very small compared to the total feeding area remaining (channel and littoral combined). Because sea turtles are infrequent visitors to the inner Harbor, the proportion of individuals affected by this loss would most likely be small.

295. Shortnose sturgeon are not generally found in the Harbor; therefore, no direct or indirect impacts to this species from channel improvement activities are anticipated.

Essential Fish Habitat

296. Modeling of salinity, water temperature and DO under proposed project conditions indicates that long-term impacts to Essential Fish Habitat (EFH) water quality parameters are not expected. Short-term water quality impacts to EFH due to project construction would most likely be limited to changes in turbidity and suspended solids in the immediate construction areas. Some change in DO may also occur concomitant with sediment resuspension.

297. Other potential impacts to EFH due to the proposed project include changes in underlying substrate and changes in water depth. Impacts to EFH sediment type would be short-term as natural sedimentation and subsequent recolonization of benthic invertebrates is expected to occur rapidly following construction activities.

298. Changes in water depth and bathymetry would be long-term, involving the excavation of both channel and shoal habitat. Potential EFH impacts would be limited primarily to demersal (*i.e.*, bottom-oriented) species and life-stages occurring in the project area. During construction, pelagic species could experience disturbance to a small portion of EFH due to avoidance of the active project area; however, the vast majority of the project area would remain available for foraging, breeding and growth. The project area contains approximately 16,064 acres of open water habitat. The habitat breakdown is as follows: 1,196 acres of littoral zone (0-6 ft MLW); 4,516 acres of sublittoral zone (6-15 ft MLW);and 10,352 acres of pelagic habitat (>15 ft MLW). Pelagic larval and egg life stages (*i.e.*, those life stages with limited motility) would be carried through the active project area with prevailing tides and currents, resulting in only limited exposure to potential construction disturbance.

299. Impacts to fish species would be temporary due to short-term disruption of deep water bottom habitat in the channels. In addition, impacts to fish from the minimal disruption of shallow water habitat in the project area would be seasonal, limited to the duration in which the species and life stages are most common in the estuary. These impacts would be localized and confined to the immediate excavation area.

Upland Impacts

300. No Port facility modifications or infrastructure changes are directly or indirectly related to the proposed navigation channel improvements; therefore, there are no upland impacts associated with the implementation of the Recommended Plan.

Cultural Resources

Prehistoric Resources

301. The geomorphological and archaeological study conducted by Geoarchaeology Research Associates (GRA) determined that the Port Jersey and Anchorage Channels have a moderate-high potential for prehistoric resources, the channel margins of Newark Bay have a moderate potential, and insufficient data was recovered from the borings along the Ambrose Channel. Therefore, for these channels, it is recommended that additional borings be excavated and analyzed to better determine the potential for prehistoric resources.

302. The Bay Ridge Channel was assessed at a moderate-low sensitivity in the DMMP investigations, and it was recommended that additional samples be excavated and analyzed.

303. The Kill Van Kull has been dredged to bedrock thereby removing any prehistoric deposits that may have existed there. However, excavation into the sideslopes may impact sensitive areas, necessitating additional boring investigations.

304. The Arthur Kill was evaluated in connection with an on-going study to deepen the channel to 41/40 ft MLW. The area just northeast of Shooters Island was evaluated as sensitive for prehistoric deposits. Additional borings and analyses will be undertaken late in 1999 in this area.

305. South Elizabeth Channel will also require further studies in the form of borings and analyses.

Historic Resources

306. It is not anticipated that dredging any existing channels will have an effect on any National Register of Historic Places (NRHP) listed or eligible structures or districts, nor will there be any effect on National Historic Landmarks within or adjacent to the project area. Blasting, however, would require additional agency coordination, and possibly an architectural survey, to ensure that no damage occurs to significant historic structures. Channel widening associated with Harbor improvements may impact abandoned vessels that have been determined eligible for the NRHP. More detailed project plans are required to determine if there will be any impacts associated with each channel. If there are impacts related to the project, mitigation measures may be necessary if avoidance of the resources is not feasible. Shipwrecks had not been considered for this project since most work for the proposed deepening of the Harbor will occur in existing navigation channels that are subject to on-going maintenance dredging, so any historic resources would have already been significantly disturbed or destroyed by dredging activities.

Impacts Associated with Rock Blasting

307. Potential impacts associated with blasting include biological impacts, noise, thermal energy release, increased turbidity, and damage to structures. These impacts could be generated as a result of vibrations, explosion-induced surface water waves, and air overpressure.

308. Current construction techniques, including controlled blasting and seismic monitoring, are expected to limit potential impacts from blast vibrations. This was successfully demonstrated during previous construction of the Kill Van Kull deepening. Physical impacts due to blasting, such as bedrock fracturing, will not occur outside the navigation channels. Directional drilling and line drilling with controlled blasting procedures, as well as rock berms, will be used to safely excavate rock near bridge foundations. Therefore, no impacts to bridge foundations, piers, bulkheads, or marinas are expected. Blasting using patterns and explosives similar to what was used previously in the Kill Van Kull is not expected to produce surface water waves that are detrimental to shoreline structures. However, it has been recommended that wave propagation during initial blasting in the Arthur Kill be monitored. Similarly, during previous blasting in the Kill Van Kull, air pressure wave readings below the New Jersey limit of 140 dB were typically recorded at land-based seismograph stations. Since the same patterns and explosives are being proposed for this project, it is unlikely that air overpressure will have any significant adverse impacts.

Socioeconomic Resources

309. The proposed project is not expected to impact socioeconomic resources in the study area.

Secondary Impacts

Side Slope Stability

310. During the structural studies the non-Federal partners identified twenty structures which may be impacted by the extent of channel side slopes in the Kill Van Kull, Arthur Kill, and Newark Bay. The structures were assigned a level of predicted impact based on anticipated channel depths, geotechnical data, and channel geometry. The structures with the highest predicted impact were further evaluated to determine methods and costs of stabilization. Conceptual designs for stabilization of these structures have been developed and the costs included in the project costs.

Biological Exposure Potential

311. The proposed channel improvements may potentially affect the degree of exposure of biological receptors to contaminants. Dredging activities may re-suspend contaminated sediments, thereby potentially increasing the exposure of biological receptors. However, this is only expected to occur in areas of close proximity to the dredging operations and is expected to be relatively short-lived because suspended sediments are expected to settle out of the water column relatively quickly. Furthermore, it has been shown that sediment suspension from ship traffic may be significantly greater than from dredging activities. Therefore, any increase in exposure due to dredging may be minimal compared to other more frequent disturbances in the Harbor.

Noise, Odor, and Aesthetics

312. Ambient noise levels throughout the study area are similar to levels generated by industrial activities throughout the Harbor. Noise produced by dredging and disposal operations will be temporary and likely overshadowed by existing noise levels from marine terminals, airports, and nearby transportation corridors. Therefore, no direct impact due to noise is anticipated.

313. The potential exists for odor to be produced from newly dredged material because dredged materials may contain traces of organic matter, which are associated with the release of hydrogen sulfide and methane. However, scows being filled at the dredging site will typically have a thin layer of water covering the majority of the load, which will minimize odor release. Also, once a single barge is filled, the material is hauled away to the placement or transfer site, thus the odor will not persist once the material is removed from the area.

314. Dredges and scows temporarily operating at the dredging sites will be the only visible sign of the project. This equipment and other cranes and barges with similar visual characteristics operate within the Harbor on a daily basis; therefore, viewscapes will not be substantially altered by the presence of dredging equipment. No visible signs of the channel deepening will remain after the project is completed.

Recreation

315. Recreational fishermen may be impacted should fish in the vicinity of the dredging operations leave the area during dredging operations.

Cumulative Impacts

Relationships to Other Projects

316. A variety of related projects are currently ongoing or are planned for the Harbor. It is not anticipated that the proposed channel deepening project will preclude or prevent these projects from being completed. During the plan formulation, the States of New York and New Jersey, the City of New York, PANYNJ, Federal resource agencies, and other public and private groups were included in the process to provide input and to review the plan's progress. While many other projects were discussed both inside and outside of the Harbor area, none were identified that would be negatively impacted by construction of the Recommended Plan.

Habitat Disturbance

317. Fish and invertebrates have been shown to return to dredged areas in less than one year. This rapid rate of recovery is important with regard to the potential for adverse cumulative impacts related to habitat. It is likely that there will be a number of projects in the Harbor involving dredging and material placement that will take place during the construction of each phase of this project. The location and timing of these projects is uncertain, but it is reasonable to assume that they will not all occur simultaneously. Because of the rapid recovery rate, the temporary disturbance associated with each individual project are not expected to be cumulative over the construction period of the project.

Contamination

318. Since it is not possible to predict the magnitude or timing of future remedial actions or contaminant releases into the Harbor, and since synergistic and antagonistic chemical reactions are poorly understood, it is difficult to assess cumulative impacts related to contamination. Channel improvements could potentially result in alterations to the patterns of sediment deposition and the hydraulics of the Harbor. Deepened channels could provide a settling basin for sediments moving throughout the Estuary from other sources, thereby removing, at least temporarily, contaminated sediments from wider dispersal. However, this would cause only a minor redistribution of a very small quantity of contaminated sediments compared to the overall distribution of contaminated material in the Harbor.

Irreversible and Irretrievable Commitment of Resources

319. Petroleum is the primary resource that will be irreversibly and irretrievably committed for the project. Petroleum products will be utilized to power the machinery

for dredging, maintenance of the channels, the resulting ship traffic in the Harbor, and most other related activities.

Mitigation

320. Initial mitigation efforts centered upon avoidance and minimization of impacts to wildlife habitat, to the extent practicable, during preliminary design of the channel improvements. Avoidance and minimization was accomplished by focusing design efforts on realigning the channels, at the proposed plan's new depths and widths, to avoid or minimize impacting wetland or littoral zone habitats or important wildlife resources. Where avoidance and minimization measures were impracticable compensatory mitigation actions were instigated. Compensatory mitigation is simply the restoration or development of wildlife habitat to replace those wildlife values lost due to project related actions. The Mitigation Plan is summarized in the FEIS and details actions proposed to offset project impacts to environmentally sensitive areas. To determine compensatory mitigation levels, a functional analysis suitable for the impacted areas was developed because the standard Habitat Evaluation Procedures (HEP) process does not apply to open water areas. The HEP process normally assesses both habitat quality and quantity for target species selected by an evaluation team. However, since the HEP process did not apply, the functional analysis suitable for subtidal areas was conducted. The functional analysis evaluated specific littoral zone habitat variables to develop suitable, HEP-equivalent indices (numerical scores). Habitat quality was determined by field observations of specific habitat variables at the potentially impacted areas.

321. The mitigation phase of the functional analysis focused on determining the level of proposed mitigation actions required to satisfactorily mitigate the adverse project impacts. Initially, a number of mitigation sites were identified in the Harbor, using preferential lists from various local environmental agencies and groups. Proposed mitigation sites were then selected on the basis of reasonable equivalent economic value based on a reasonable replacement ratio and proximity to the disturbed areas.

322. Implementation of the Recommended Plan is expected to impact 6.26 acres of littoral zone habitat. The dominant functional value of this habitat was determined to be a feeding and congregation area for forage fish species. The proposed Mitigation Plan consists of creation and restoration of 7.6 acres of littoral zone habitat at the Mariners Harbor, New York and South of Goethals Bridge, New Jersey sites and the restoration of 11 (of 16) acres at the Woodbridge, New Jersey site. The conceptual designs and costs for these sites are contained in the Study's Mitigation Report.

(THIS PAGE INTENTIONALLY LEFT BLANK)

ECONOMIC ANALYSIS OF THE RECOMMENDED PLAN

Overview

323. Federal participation in project construction requires a demonstration of economic feasibility, which is established by determining whether the benefits to the national economy exceed annual economic costs. This was demonstrated by an Equimarginal Analysis in previous sections, which identified the NED Plan. The NED Plan was also determined to be the Recommended Plan. The following section outlines the economic analysis specific to the Recommended Plan. The overall study's economic analysis is discussed in detail in the Economics Appendix.

General

324. All benefits and costs are calculated using October 1999 price levels. Average annual benefits and costs have been amortized over a 50-year period of analysis beginning at the anticipated project base year of 2010. Computations use the fiscal year 1999 Federal Discount Rate of 6-7/8%.

Cost Estimates

First Costs

325. Cost estimates for the Recommended Plan were prepared using the MicroComputer Assisted Cost Estimating System (MCACES) and include the appropriate contingencies for each item. Project First Costs include costs arising from the project construction elements as well as the costs of design and construction management. The summary of project costs is provided in Table 26. The detailed estimates include blasting and dredging, placement of dredged and excavated material, replacing and/or stabilizing structures affected by dredging operations, relocation of aids to navigation, utility relocations, and real estate acquisitions. Detailed estimates of the First Costs of the Recommended Plan are presented in the Costs Appendix.

326. The detailed cost basis and summary cost tables of the various channel improvement alternatives are presented in the Costs Appendix. Costs presented are NED costs and do not necessarily reflect the financial costs. Pre-construction Engineering and Design, and Supervision and Administration, and Contingencies are included in the cost analysis.

TABLE 26 Recommended Plan - First Costs (October 1999 Price Level)	
General Navigation Features (cost shared)	**Total Cost**
Dredging and Excavation	$1,485,687,000
Atlantic Salt Bulkhead	1,176,000
Richmond Terrace Bulkhead	3,060,000
Elizabeth Marina Wave Screen & Wharf	2,619,000
Associated General Items	168,000
Engineering & Design (PED)	47,323,000
Construction Management(S&A)	105,863,000
Total General Navigation Features	$1,645,897,000
Non-Federal Responsibility Costs	**Total Cost**
Dredge Berthing Areas	$95,950,000
Relocate Newark Bay Utilities	3,726,000
Relocate Upper Bay Utilities	35,662,000
Total Non-Federal Resp. Costs	$135,338,000
Total First Costs	$1,781,235,000

Annual Costs

327. The annual costs comprise the interest and amortization of the Investment Costs over the life of the project plus the project-related increase in annual Operation and Maintenance (O&M) costs.

Interest During Construction

328. Interest During Construction (IDC) represents the opportunity cost of capital incurred during the construction period. The investment cost of a project, which is the sum of construction and other initial costs plus IDC is the cost incurred from the start of construction to the project base year (2010). Costs incurred during the construction period are increased by adding compound interest at the 6-7/8% discount rate from the date the expenditures are incurred to the base year. For plan formulation, the IDC was

calculated considering costs and construction duration for all pathways included in the alternative being considered. The total NED Investment Costs were calculated using the compound interest for the series of payments over the anticipated construction duration on a pathway-by-pathway basis with consideration of channel elements already constructed. The IDC was calculated on the basis of total alternative costs, including Pre-construction Engineering and Design (PED), Supervision and Administration (S&A), and mitigation. Total IDC is therefore calculated to be $497,233,000.

Operation and Maintenance (O&M) Costs

329. The O&M costs are associated with the maintenance dredging required to maintain the channels at the desired depths. Since the majority of the channels are already maintained at the authorized depth under the Without-Project Condition, the O&M associated with this project are the incremental costs necessary to maintain the deeper channel. The volumes are based on the 2-D modeling results from WES. Similarly, the unit costs for maintenance material are based on estimates for each channel, assuming all sedimentation material will be unsuitable for HARS placement, except for the Ambrose Channel, which is assumed suitable for use at the HARS. Assumptions regarding O&M material suitability are consistent with the DMMP. The estimated O&M costs of the Recommended Plan are $3,401,000.

Summary of Annual Costs

330. Table 27 provides a summary of the annual costs required to implement and maintain the project.

TABLE 27
Recommended Plan – Summary of Annual Costs
(October 1999 Price Level, 6-7/8% Discount Rate, 50-Year Period)

Costs	Total
First Cost	$1,781,235,000
Interest During Construction	497,233,000
Total Investment Cost	2,278,468,,000
Interest and Amortization	162,494,000
Operation and Maintenance	3,401,000
Total Annual Cost	***$165,895,000***

Benefits

General

331. Project benefits are equal to the gains to the National Economic Development (NED) as determined by the difference between the With- and Without-Project Conditions. Specifically, the benefits identified in this analysis are the transportation costs savings realized through the use of larger more efficient vessels and through the increased safety and operational efficiencies resulting from navigation improvements in the Harbor. Reduced transportation costs result in reduced production and distribution costs thereby increasing the net value of the national output of goods and services.

332. Numerous sources of transportation cost savings have been identified through analyses of vessel operations, port and terminal operations, and vessel deployments. The sources of transportation cost savings are discussed in the "Screening of Study Alternatives" section and the Economics Appendix.

333. The economic benefits quantified in the Benefits Model are benefits that can be quantified with a reasonable level of certainty. These benefits are the transportation cost savings resulting from vessel efficiencies for containerships on the Hybrid and Major routes. The reasonableness of quantifying these benefits stems from observed existing practices, upon which the fleet forecasts and benefit calculations are based.

Benefits During Construction

334. As soon as individual portions of the project are completed and provide direct access to a container terminal from sea, transportation costs savings can begin to be realized, resulting in a realization of project benefits. To account for these benefits, compound interest is added to these pre-base year benefits in the same manner that interest was applied to construction costs. Based on the preliminary project schedule, channel improvements will first be completed to the Port Jersey Peninsula/MOTBY by the year 2008, at which time large vessels with benefit-generating cargo loads may begin to call on the Port and project benefits may begin to be realized. No other channel improvements to container terminals in the Port are expected to be completed prior to the base year.

Summary of Annual Benefits

335. Table 28 provides a summary of average annual benefits expected upon completion of the project.

TABLE 28 Recommended Plan – Summary of Annual Benefits (October 1999 Price Level, 6-7/8% Discount Rate, 50-Year Period)	
Benefits	**Total**
Annual Transportation Cost Savings	$238,500,000
Total Annual Benefits	***$238,500,000***

Feasibility

336. Project feasibility is based on comparisons between benefits and costs. As seen in Table 29, project benefits outweigh the project cost. As discussed in the section titled "Identification of the NED Plan", the Recommended Plan, which is the NED Plan, yields the greatest net excess benefits of all project alternatives.

TABLE 29 Recommended Plan – Summary of Annual Benefits and Costs (October 1999 Price Level, 6-7/8% Discount Rate, 50-Year Period)	
Benefits/Costs	**Total**
Annual Benefits	$238,500,000
Annual Costs	$165,895,000
Net Excess Benefits	$72,605,000
BCR	1.4

(THIS PAGE INTENTIONALLY LEFT BLANK)

COORDINATION AND PUBLIC INVOLVEMENT

Required Coordination

337. The District conducted its scoping process, required by the Council on Environmental Quality (CEQ) Guidelines, by inviting public participation to assist in determining significant issues early in the study process. A Notice of Intent to prepare the Final Environmental Impact Statement (FEIS) was published in the Federal Register on Tuesday, 24 March 1998. On 15 April 1998 the Corps issued news releases to 14 newspapers and journals, listed in Table 30. The news release and a public notice informed interested parties that the District was preparing an Environmental Impact Statement (EIS) for the study and intended to hold Public Scoping meetings at various locations throughout the region.

TABLE 30
Newspapers and Journals Sent the Notice of Public Scoping Meetings

Asbury Park Press Middletown, NJ	Home News & Tribune Woodbridge, NJ	ENR Hightstown, NJ
Newark Star-Ledger Newark, NJ	New York Times White Plains, NY	Intermodal Shipping Atlanta, GA
The Wall Street Journal New York, NY	Staten Island Register Staten Island, NY	Journal of Commerce New York, NY
New Jersey Business Magazine Fairfield, NJ	Brooklyn Eagle Brooklyn, NY	Port News Charleston, SC
Jersey Journal Bayonne, NJ	Brooklyn Bridge Brooklyn, NY	Courier Life Publications Brooklyn, NY
Staten Island Advance Staten Island, NY	Brooklyn Papers Brooklyn, NY	Civil Engineering Reston, VA
Maritime Reporter & Engineering News New York, NY	The Waterways Journal St. Louis, MO	Fairplay: International Shipping Weekly Germantown, NY
American Shipper Jacksonville, FL	Civil Engineering Reston, VA	International Dredging Review Fort Collins, CO
World Dredging, Mining & Construction Irvine, CA	WWS/Worldwide Shipping Odessa, FL	Shipping Digest New York, NY
NMU Pilot Jersey City, NJ	Interesting Gazette Brooklyn, NY	

338. Scoping meetings were held in May and June 1998 and are listed in Table 31. All attendees were provided with written materials describing the scope of the feasibility study, the preliminary scope of the EIS, and the study area. Participants were urged to submit written comments at the meeting or via mail, and were provided with questionnaires designed to solicit potential issues. Each scoping session included a poster presentation by the Corps, a presentation with slides describing the project, and an



opportunity for the public to speak. All comments were recorded by video and transcribed for inclusion in the final scoping document.

TABLE 31 Date and Location of Public Scoping Meetings	
5 May 1998 Staten Island Hotel, Staten Island, NY	7 May 1998 Brooklyn Borough Hall, Brooklyn, NY
11 May 1998 Holiday Inn, Elizabeth, NJ	13 May 1998 Borough of Manhattan Community College (BMCC), NY, NY
14 May 1998 Military Ocean Terminal, Bayonne, NJ	27 May 1998 Seamen's Church Institute, Port Newark, NJ
4 June 1998 Staten Island Hotel, Staten Island, NY	

339. The District distributed the Preliminary Scoping Document in May 1998 and made it available at the Public Scoping Meetings. Both the Notice of Intent and the news releases requested comments on the proposed scope of the EIS. In response, several agencies provided comments; the material contained in the Pertinent Correspondence and Public Involvement Appendix summarizes those comments. The FEIS contains additional details of the coordination conducted under NEPA.

340. The US Fish and Wildlife Service provided the District two reports during the course of this study. This first was a Planning Aid Report and later a Fish and Wildlife Coordination Act Report (CAR). The CAR is provided as a separate Appendix to the FEIS. The Endangered Species Act requires the Corps to consult with resource agencies concerning listed and proposed threatened and endangered species that may occur in the study area. As discussed in previous sections, biological assessments were prepared by the Corps to determine whether the proposed project may affect threatened and endangered species and/or their critical habitat. The final Feasibility Report and EIS will include the biological opinions prepared by the resource agencies regarding any potential impacts.

Executive Committee

341. An Executive Committee, comprised of representatives from the State of New York (assisted by the City of New York) and State of New Jersey, the Port Authority of New York and New Jersey and the New York District, was responsible for overall management of the study. The Executive Committee met regularly to discuss the study progress and strategy.

Technical Work Groups

342. Due to the accelerated pace of this study and its inherent complexity, several technical workgroups were formed at the start of the feasibility phase. Four major groups were formed, environmental, engineering, economics and infrastructure/formulation. Each group shared a set of common purposes that included keeping various Federal, State and local agencies informed of the progress of the study, obtain information from the group members for use in the study and to serve as a quality control mechanism. The workgroups met at varying intervals based on the needs of the study. The District led each workgroup and served as the interface between the technical elements and the Executive Committee.

Advisory Group Meetings

343. Two advisory groups were formed in the Reconnaissance Phase as a forum for public involvement and were combined into a single group during the Feasibility Phase. The two groups were the Citizens Advisory Group (CAG) and the Business and Labor Advisory Group (BLG). The purpose of these groups is to create a forum in which the study team can obtain the views of the members of the two groups on what may be an issue in order to resolve it more quickly. The groups also form a basis to obtain support for the findings and recommendations of the feasibility study. Neither group is a decision making body. All decision-making authority remained with the Executive Committee. The Citizens Advisory Group (CAG) is formed by members of various community and environmental interest groups, while the Business and Labor Advisory Group (BLG) is composed of members of the maritime industry who have a direct financial stake in this outcome of this study. The Advisory Group met three times during the course of the study, the first was during the initial project scoping, later to present the study's Without-Project Condition and the most recent to present the Alternative Formulation Briefing (AFB).

Public Meetings

344. Public meetings provide an opportunity for study personnel to share data, information, and study progress with the public and obtain comments from the public. Public meetings were held as part of the scoping process and during the review of the Draft Feasibility Report and Draft EIS. The District used the comments received to complete the final Feasibility Report and EIS.

Newsletters and Project Libraries

345. The study newsletter "*Navigation News: Information on the New York and New Jersey Harbor Navigation Study*" summarized progress of the project and highlighted

important events. The quarterly newsletter provided current information to the public. Each member of the advisory group and other interested parties received copies of the newsletters. Copies of all newsletters and a project fact sheet are available on the District's web site (www.nan.usace.army.mil).

346. Technical materials developed in support of the project are available to the public at six libraries in the study region, listed in Table 32, and at the District office.

TABLE 32
Main Libraries for Harbor Navigation Study Documents

The Newark Public Library 5 Washington Street Newark, NY 07101 (973) 733-7784	Bayonne Main Library 697 Avenue C Bayonne, NJ 07002 (201)858-6980	Elizabeth Public Library 11 South Broad Street Elizabeth, NJ 07202 (980) 354-6060
Brooklyn Central Library Grand Army Plaza Brooklyn NY, 11238 (718)230-2100	St. George Library Center 5 Central Avenue Staten Island, NY 10301 (718)442-8560	New York Public Library 455 5th Avenue New York, NY 10018-000 (212)340-0833

PROJECT IMPLEMENTATION

Overview

347. The implementation process will carry the Recommended Plan through the remaining design phases, preparation of the Project Document Design Report (DDR), development of the Plans and Specifications (P&S), and construction. Funds must be budgeted by the Federal Government and the non-Federal partners to support these activities. A preliminary Project Management Plan (PMP), which will be included as an Appendix to the Final Feasibility Report, will identify the tasks, responsibilities, and financial requirements of the Federal Government and the non-Federal partners.

General

348. The project is anticipated to be authorized in WRDA of 2000. Following congressional authorization, the project would be eligible for construction funding. The project will be considered for inclusion in the President's budget on the basis of national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal partners to fund their share of the project cost, and budgetary constraints that may exist at the time of funding.

Project Cooperative Agreement

349. The Federal Government and non-Federal partners have certain responsibilities in connection with the development and operation and maintenance of general navigation projects which are set forth in Federal law and will be incorporated into a Project Cooperation Agreement (PCA) after the project is authorized. The following provisions describe the responsibilities of the non-Federal partners that will be included as part of the PCA:

a. Enter into an agreement which provides, through the execution of the project cooperation agreement, 25 percent of design costs;

b. Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

c. Provide, during the period of construction, a cash contribution equal to the following percentages of the total cost of construction of the general navigation features (which include the construction of land-based and aquatic dredged material placement facilities that are necessary for the placement of dredged material required for project construction, operation, or maintenance and for which a contract for the federal facility's construction or improvement was not awarded on or before October 12, 1996;):

(1) 25 percent of the costs attributable to dredging to a depth in excess of 20 feet but not in excess of 45 feet;

(2) 50 percent of the costs attributable to dredging to a depth in excess of 45 feet;

(3) 100 percent of the costs of any betterments to the project;

d. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the project, up to an additional 10 percent of the total cost of construction of general navigation features. The value of lands, easements, rights-of-way, and relocations (LERR) provided by the non-Federal partners for the general navigation features, described below, may be credited toward this required payment. If the amount of credit exceeds 10 percent of the total cost of construction of the general navigation features, the non-Federal partner shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of lands, easements, rights-of-way, and relocations in excess of 10 percent of the total cost of construction of the general navigation features;

e. Provide all lands, easements, and rights-of-way, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features (including all lands, easements, and rights-of-way, and relocations necessary for dredged material placement facilities).

f. Provide, operate, maintain, repair, replace, and rehabilitate, at its own expense, the local service facilities and any betterments, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

g. Accomplish all relocations determined necessary by the Federal Government other than those relocations/removals specifically assigned to the Federal Government;

h. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal partners own or control for access to the general navigation features for the purpose of inspection, and, if necessary, for the purpose of operating, maintaining, repairing, replacing, and rehabilitating the general navigation features;

i. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the

project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

j. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of construction of the general navigation features, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

k. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, maintenance, repair, replacement, or rehabilitation of the general navigation features. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the non-Federal partners with prior specific written direction, in which case the non-Federal partnerds shall perform such investigations in accordance with such written direction;

l. Assume complete financial responsibility, as between the Federal Government and the non-Federal partnerds, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features;

m. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

n. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987, and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

o. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army;" and

p. Provide a cash contribution equal to the non-Federal cost share of the project's total historic preservation mitigation and data recovery costs attributable to commercial navigation that are in excess of 1 percent of the total amount authorized to be appropriated for commercial navigation.

q. In the case of a deep-draft harbor, provide 50 percent of the excess cost of operation and maintenance of the project over that cost which the Secretary determines would be incurred for operation and maintenance if the project had a depth of 45 feet;

r. Do not use Federal funds to meet the non-Federal partners' share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

Cost Apportionment

350. The proposed apportionment of first costs between the Federal Government and the non-Federal partners for the recommended plan is in accordance with Section 101 of WRDA 86 and Section 210 of WRDA 96. A copy of the MOU is provided in Appendix B-1.8 of the FEIS. The version provided contains the signatures of the parties as of the printing of this report.

351. The Federal share of the project's total ultimate cost is $743,955,000. This represents 42.0% of the total. The Federal government will design the project, prepare detailed plans and specifications, and construct the project, exclusive of those items specifically required of the non-Federal interests.

352. The non-Federal share of the estimated total ultimate cost of the project is $1,037,280,000. The non-Federal share consists of a number of components including LERR, costs associated with utilities relocation; and a 10% cash contribution of $160,193,000. The non-Federal share represents 45.0% of the total project first costs and 58.0% of the ultimate costs. A breakdown of the Federal and non-Federal cost share is shown in Table 33.

TABLE 33 Cost Apportionment Federal and Non-Federal Responsibilities Recommended Plan			
	Federal Costs	**Non-Federal Costs**	**Total**
Federal Channel	$904,148,000	$741,748,000	$1,645,836,000
Non-Federal Expenses	0	135,339,000	135,339,000
Total First Cost	904,148,000	877,087,000	1,781,235,000
Long-term Repayment	-160,193,000	160,193,000	0
Ultimate Costs	$743,955,000	$1,037,280,000	$1,781,235,000
Percent of First Costs	55.0	45.0	100.0
Percent of Ultimate Costs	42.0	58.0	100.0

Design Cost Sharing

353. The Pre-construction Engineering and Design (PED) phase of the project is also cost-shared between the Federal Government and the non-Federal partners; however, these expenditures are initially cost-shared at a rate of 25% non-Federal and 75% Federal and adjustments are made during construction to bring the cost of PED in line with actual cost sharing of the project.

354. The PED phase is expected to begin in 2000 and will continue until plans and specifications are developed for construction of the first channel improvement; construction is expected to begin sometime after the plans and specifications for deepening Ambrose Channel, Anchorage Channel, the Kill Van Kull, and Newark Bay are completed.

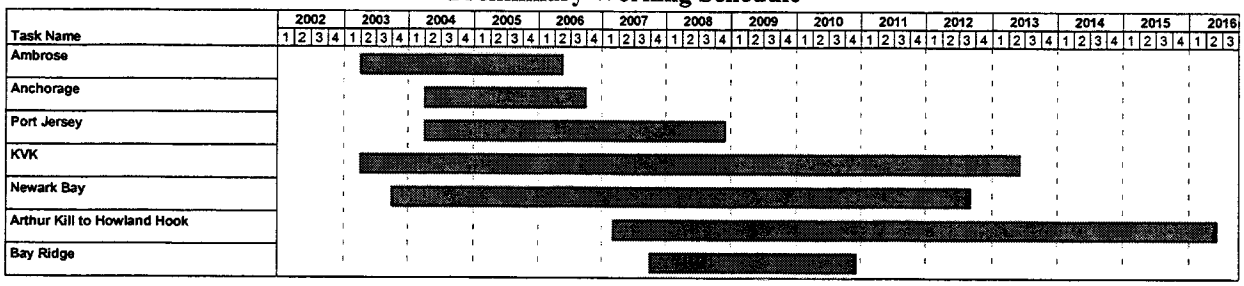
Construction Schedule

355. A preliminary construction schedule was developed for the Recommended Plan and is presented below. It is a planning level schedule, used only to provide an assessment of interest during construction (IDC), economic feasibility and cumulative environmental effects, to ensure that the plan will be viable for Congress to authorize it for construction.

356. The schedule is based on information available to date, predicated on the assumptions listed below. The New York District and Port Authority of New York and New Jersey are working diligently and making every effort to expedite construction to enable the project to accrue national economic benefits as soon as possible and to satisfy the non-Federal partners' desire for early construction of the overall project, including a fifty foot channel to Port Newark and Elizabeth by the end of year 2009.



Preliminary Working Schedule



357. The schedule is based upon currently available data and the following assumptions:

- PED phase will be initiated 2nd quarter of FY 00;
- There may be as many as four drill boats working at one time, with a maximum of two per contract;
- There may be as many as three excavators working at one time, with a maximum of one per contract;
- There may be as many as six clamshells working at one time, with a maximum of three per contract;
- There may be as many as two large (>6,000 CY) hopper dredges, or four medium (4,000-6,000 CY) hopper dredges working at once. There is a maximum of one large or two medium hopper dredges per contract;
- Environmental windows consist only of dredging being prohibited within 1,000 ft of Shooters Island from 1 March to 1 September;
- Adjoining rock contracts will not be dredged at the same time;
- No regulatory compliance testing will be required during construction for material which is unsuitable for placement at the HARS via previous testing;
- Disposal of material unsuitable for HARS placement will be restricted to no barge. Overflow, use of a sealed bucket where possible, and will be disposed at an in-channel cell;
- No placement restrictions/constraints for material disposed at the HARS;
- Rock material will be disposed of at the Atlantic Beach artificial reef in NY and the Sandy Hook artificial reef in NJ;
- Utility relocations will not impact the schedule.

Financial Analysis

358. For purposes of executing a Project Cooperation Agreement (PCA), the Port Authority of New York and New Jersey has stated its intention to seek authorization to act on behalf of the states of New York and New Jersey, as well as itself. Therefore, it is expected that the sole non-Federal partner for PCA purposes will be the Port Authority of New York and New Jersey. In light of this arrangement, the Port Authority of New York and New Jersey has submitted a Statement of Financial Capability and Financial Plan to the District. A package of documents, including the Official Statement of the Port Authority of New York and New Jersey made in connection with the marketing of its latest bond series and a statement of the annual cash contributions required of the non-Federal partner, is attached in Appendix A.

359. The Port Authority of New York and New Jersey is a bi-state agency that operates and derives lease, fare, and toll revenue from a number of large-scale transportation investments. It also maintains reserve funds. Consequently, it controls a reliable stream of revenue of sufficient volume that it enjoys direct access to the capital markets via its ability to issue investment grade (Moody's Investor Service rating A1) debt. Furthermore, as a condition of its acting as the sole non-Federal partner for purposes of executing a PCA, it plans to reach cost recovery agreements with the states of New York and New Jersey. The Port Authority of New York and New Jersey has submitted a statement reciting these facts and expressing its intention to apply its financial capacity to execution of the channel improvement projects described in this Report.

360. In view of the Statement of Financial Capability and Financial Plan made by the Port Authority of New York and New Jersey and the fact that the District has successfully collaborated with this particular non-Federal partner on several projects over a long period of time, it is the assessment of the District that the non-Federal partner has more than adequate financial capability to fund its obligations under the PCA that would carry the recommended plan into implementation.

(THIS PAGE INTENTIONALLY LEFT BLANK)

CONCLUSIONS

361. The following is a summary of the study's conclusions:

- Conclusions regarding improvements to the Harbor's anchorages were deferred pending completion of the separate New York Harbor Anchorages Study, currently entering the Feasibility Phase;

- A range of alternatives was considered. Besides the No Action Alternative, non-structural alternatives, which would allow the design vessels to call on the Port without channel improvements, were considered. These alternatives were dropped from consideration, as they are currently in use in the Harbor and continued reliance on non-structural measures would only exacerbate the problems facing carriers as they attempt to use larger vessels in maritime trade;

- Two structural alternatives, one of which also included channel deepening as an element, were also considered: the Bayonne-Newark Bay Canal and an Off-Shore Island Port. Both of these plans were dismissed from extensive evaluation at the request of the non-Federal partners after the preliminary assessment determined that the plans' disadvantages far outweighed the advantages.

- The alternative to deepen the channels to tanker design vessel depth from sea to the major petrochemical facilities in the Gulfport Reach of the Arthur Kill did not support a Federal interest and was eliminated as a navigation improvement alternative during plan formulation;

- Four structural channel improvement alternatives for the container design vessel were considered that increase maintained channel depths in the Harbor to 46 ft, 48 ft, 50 ft, and 52 ft MLW to improve deep-draft transportation of cargo. These alternatives all have similar dredging equipment and dredged material placement requirements;

- Underwater blasting will be required in portions of the Kill Van Kull, Newark Bay and Arthur Kill for all channel improvement alternatives that were considered;

- With the exceptions of Ambrose Channel and Anchorage Channel, the remaining channels identified for deepening have an estimated 2 feet of

contaminated material (material unsuitable for HARS placement) to be dredged and managed;

- Direct environmental impacts as a result of channel improvements were determined to be minimal, as the recommended project consists of improving existing channels and berths and does not involve new channel and terminal construction. Mitigation measures for unavoidable impacts consist of the restoration of 11 acres of intertidal wetlands, and construction of 7.6 acres of littoral habitat;

- The NED Plan was identified using an equimarginal analysis and consists of improving channels to the existing and proposed container terminals at Port Jersey, Port Newark/Elizabeth, Howland Hook, and South Brooklyn. Construction of the Channel Improvement to South Brooklyn will be subject to commitment to rehabilitate the South Brooklyn marine terminal and transportation infrastructure needed to realize project benefits.

- The construction schedule is based on information available to date, predicated on several assumptions described. The New York District and Port Authority of New York and New Jersey are working diligently and making every effort to expedite construction to enable the project to accrue National Economic Development benefits as soon as possible and to satisfy the non-Federal partners' desire for early construction of the overall project, including a fifty foot channel to Port Newark and Elizabeth by the year 2009.

- In order to expedite the construction of the project, and thereby maximize the value of the Federal investment, the use of innovative measures in its design, management, and execution, including alteration of the types of contracts entered into and the administration of those contracts, will be necessary. Measures that could be taken include the use of a single, consolidated Project Cooperation Agreement to cover construction of the Recommended Plan, and allowing the drilling and blasting of rock for the recommended project to be done in conjunction with currently on-going projects. To address the shortage of equipment for construction, measures such as construction and use of government-owned, contractor-operated equipment and the possibility of providing incentives for the early completion of the construction contracts could also be explored.

362. The New York District has considered all significant aspects of these conclusions. These aspects include environmental impacts, social and economic effects, engineering feasibility, and compatibility of the project with the desires and capabilities of the states

of the New York and New Jersey, the Port Authority of New York and New Jersey, and other interested parties. The study authorized by the Water Resources Development Act of 1996 is complete. However, the analysis of anchorage deepening in New York and New Jersey Harbor has been deferred to a separate study, previously authorized.

(THIS PAGE INTENTIONALLY LEFT BLANK)

RECOMMENDATION

363. I recommend that the selected project for the New York and New Jersey Harbor, as outlined below and fully detailed in this Feasibility Report, be authorized for construction as a Federal project for navigation purposes, subject to such modifications as may be prescribed by the Chief of Engineers.

364. The recommended project in the Feasibility Report consists of the following primary elements:

- Construction of a 53 ft deep MLW navigation channel to deepen the entire length of the existing Ambrose Channel;

- Construction of a 50 ft deep MLW (52 feet in rock or otherwise hard material) navigation channel to deepen portions of the existing Anchorage Channel, from the Narrows to 1000 feet past its juncture with Port Jersey Channel;

- Construction of a 50 ft MLW (52 feet in rock or otherwise hard material) navigation channel to deepen the existing Port Jersey Channel, from its juncture with Anchorage Channel to the Global Terminal and MOTBY facilities;

- Construction of a 50 ft MLW (52 feet in rock or otherwise hard material) navigation channel to deepen the existing Kill Van Kull, from its juncture with Anchorage Channel to the Arthur Kill;

- Construction of a 50 ft MLW (52 feet in rock or otherwise hard material) navigation channel to deepen the existing Newark Bay Channel, from its juncture with the Kill Van Kull to the juncture with the Elizabeth Channel, and including deepening the existing Elizabeth, South Elizabeth, and Elizabeth Pierhead Channels to 50 ft MLW (52 feet in rock or otherwise hard material);

- Construction of a 50 ft MLW (52 feet in rock or otherwise hard material) navigation channel to deepen the existing Arthur Kill, from its juncture with the Kill Van Kull and Newark Bay to the southernmost berth at the Howland Hook Marine Terminal; and

- Construction of a 50 ft MLW (52 feet in rock or otherwise hard material) navigation channel to deepen the existing Bay Ridge Channel, from its juncture with Anchorage Channel to the South Brooklyn Marine Terminal,

subject to commitment to rehabilitate the South Brooklyn Marine Terminal and transportation infrastructure needed to realize project benefits.

- Mitigation measures for unavoidable impacts consist of the restoration of 11 acres of intertidal wetlands, and construction of 7.6 acres of littoral habitat.

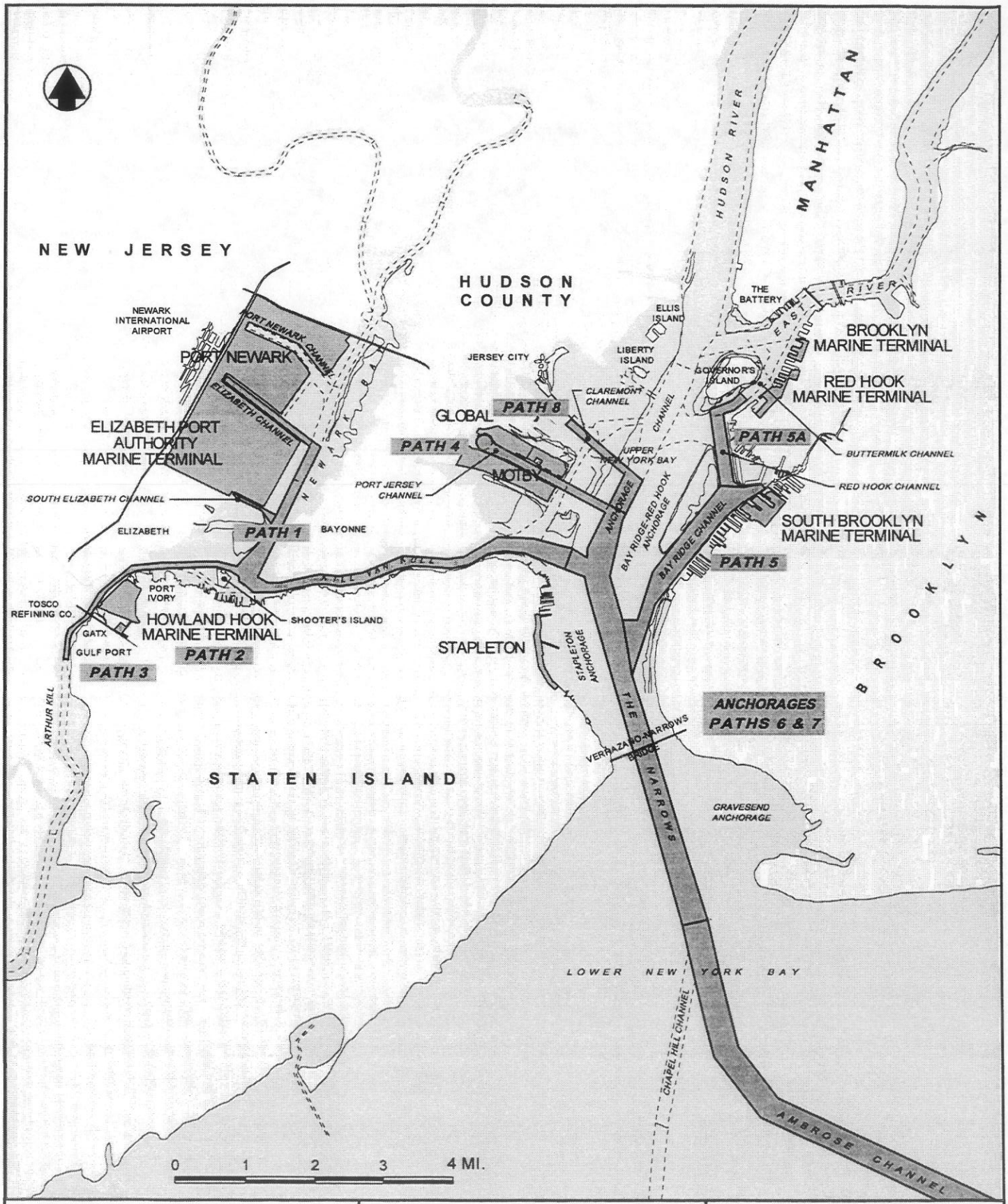
- It is further recommended that the District be granted the authority to utilize innovative measures in its design, management, and execution, including alteration of the types of contracts entered into and the administration of those contracts, as necessary in order to expedite the construction of the project, and thereby maximize the value of the Federal investment. Measures that could be taken include, but are not limited to, the use of a single, consolidated Project Cooperation Agreement to cover construction of the recommended plan, delegation of authority to execute all required agreements, and allowing the drilling and blasting of rock for construction of the recommended project to be done in conjunction with currently on-going projects. To address the shortage of equipment for construction, measures such as construction and use of government-owned, contractor-operated equipment and the possibility of providing incentives for the early completion of the construction contracts could also be explored.

365. The recommended plan has a First Construction Cost of $1,781,234,000, and an Investment Cost of $2,278,468,000, resulting in an Annual Cost, including O&M, of $165,895,000 and yielding annual benefits of $238,500,000. The Benefit Cost Ratio (BCR) is 1.4, with net excess annual benefits of $72,605,000.

366. The recommendations contained herein reflect the information available at this time and current U.S. Army Corps of Engineers 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 or the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified at higher levels. The non-Federal Partners will also be afforded an opportunity to comment further.



William H. Pearce
Colonel, Corps of Engineers
District Engineer

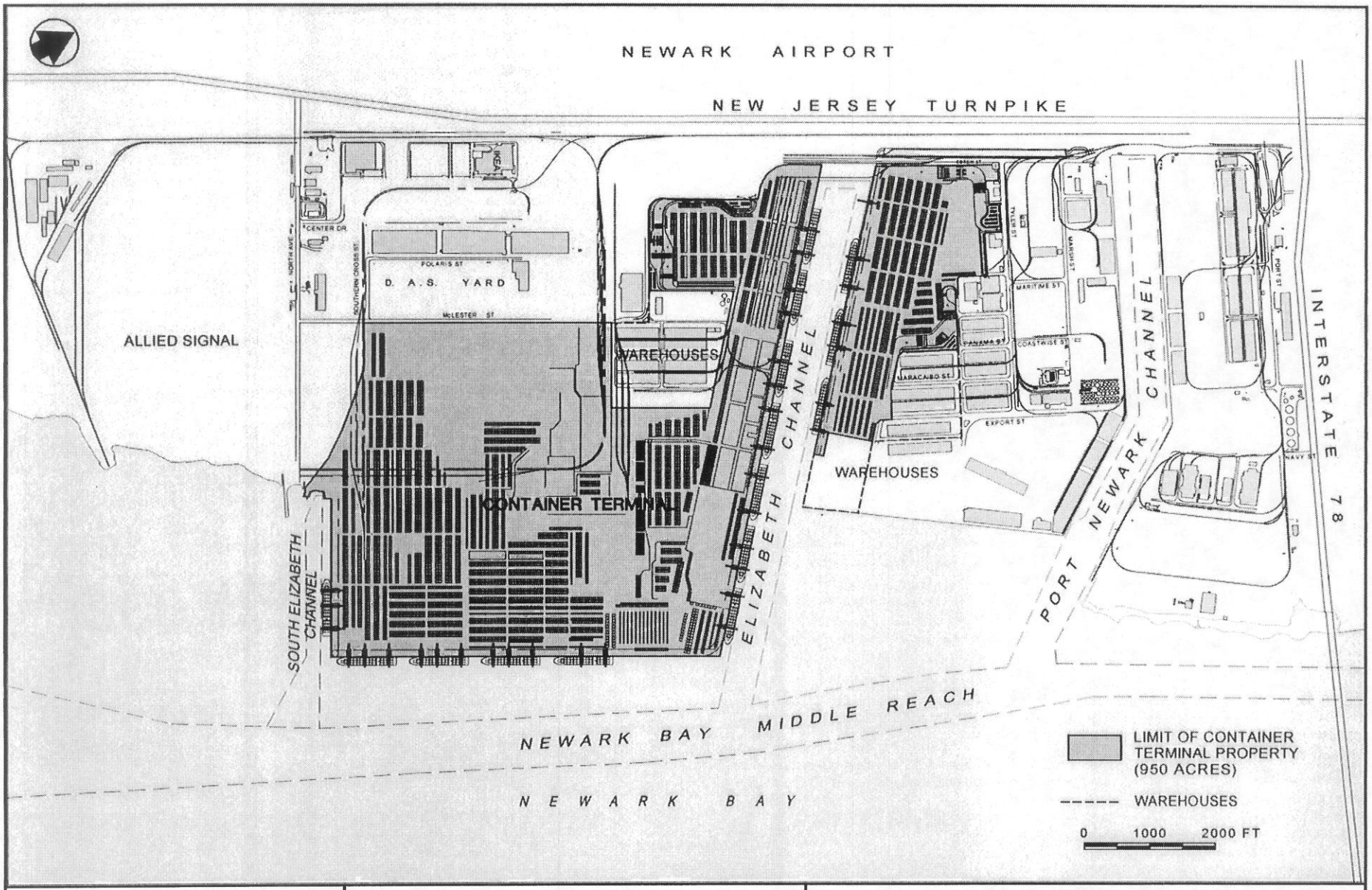


U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY FEASIBILITY REPORT

FIGURE 2

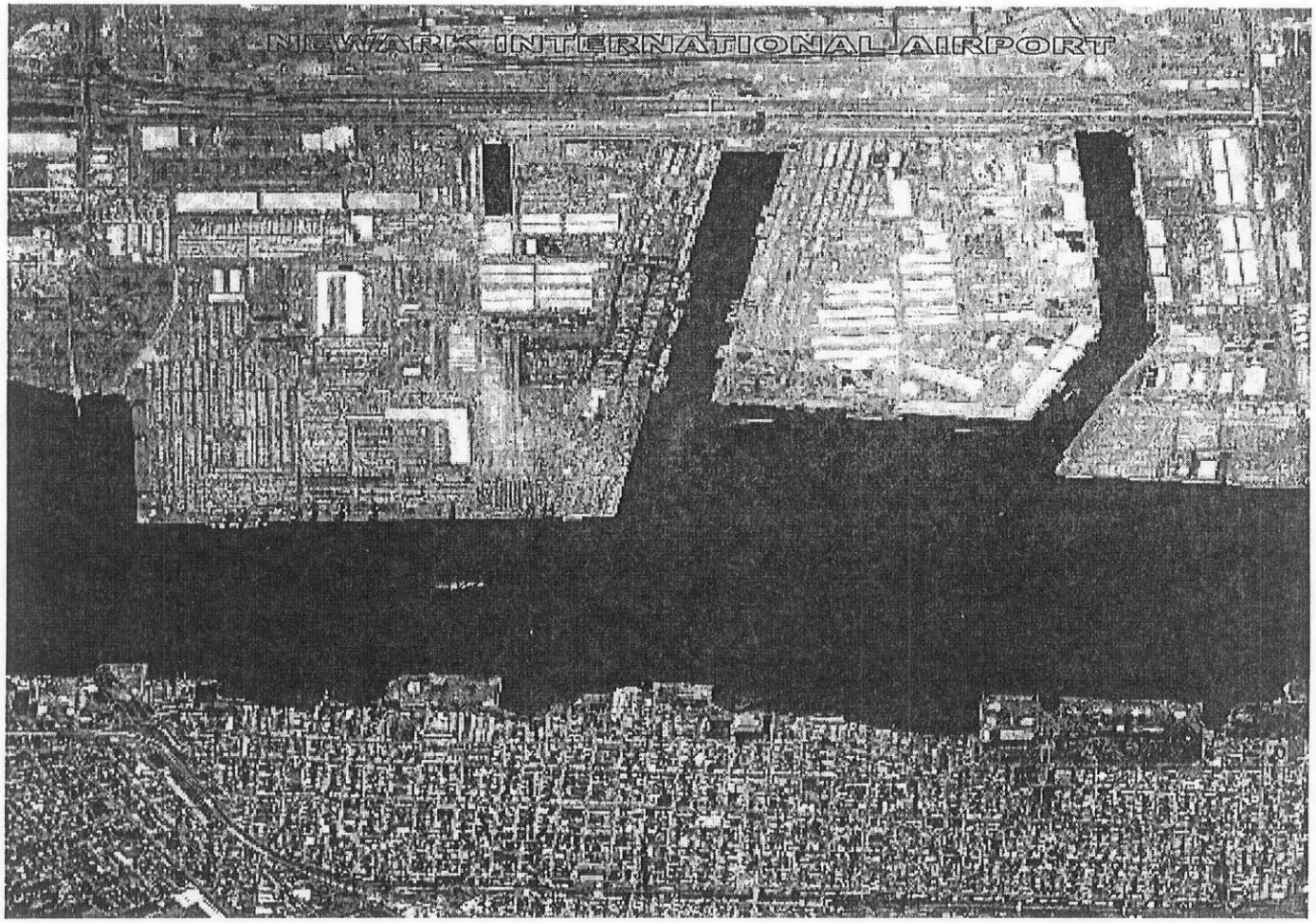
LOCATION MAP OF EXISTING CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY
HARBOR NAVIGATION STUDY
PLAN FORMULATION

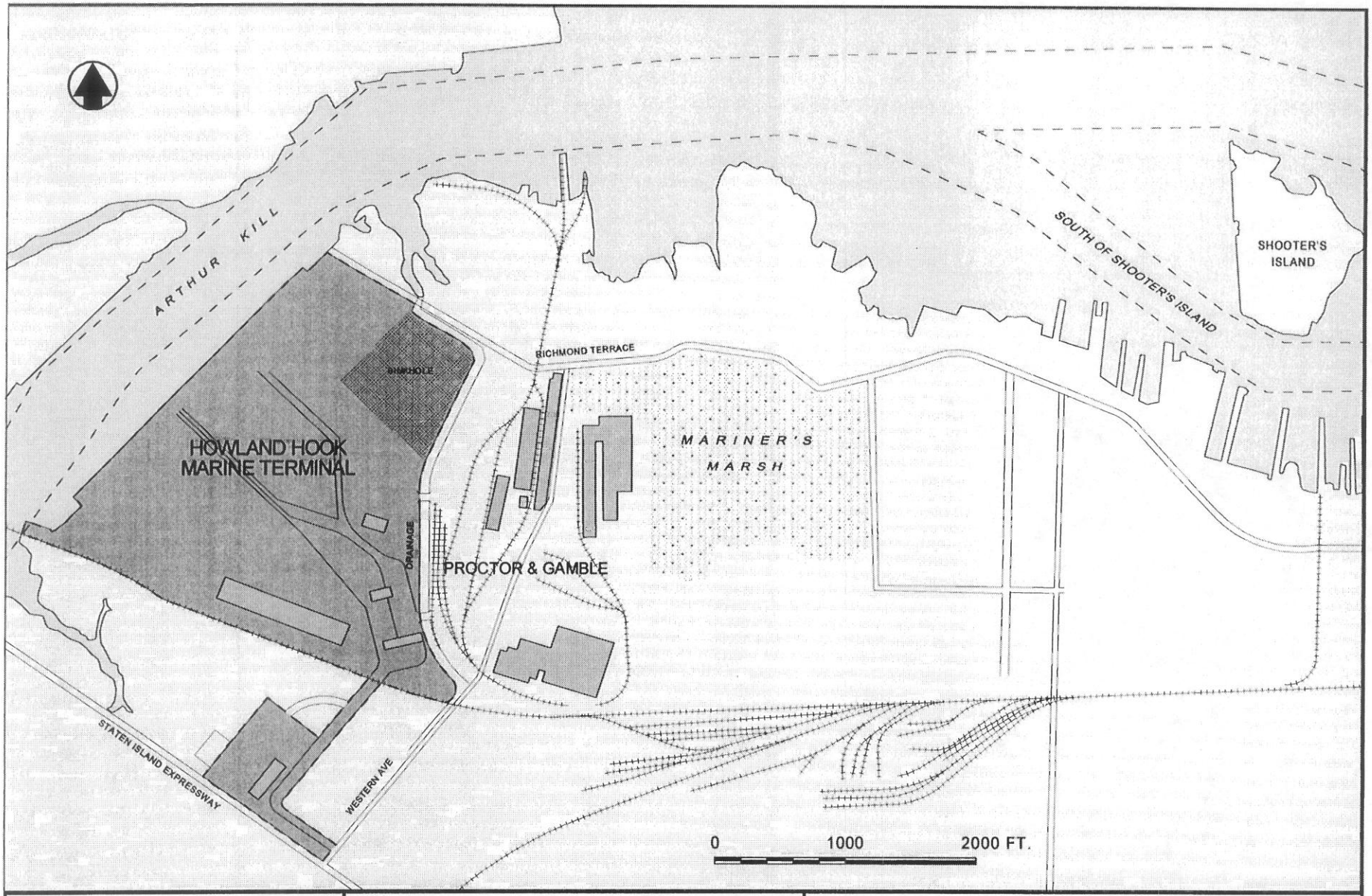
FIGURE 3
PORT NEWARK & ELIZABETH MARINE TERMINALS
EXISTING CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

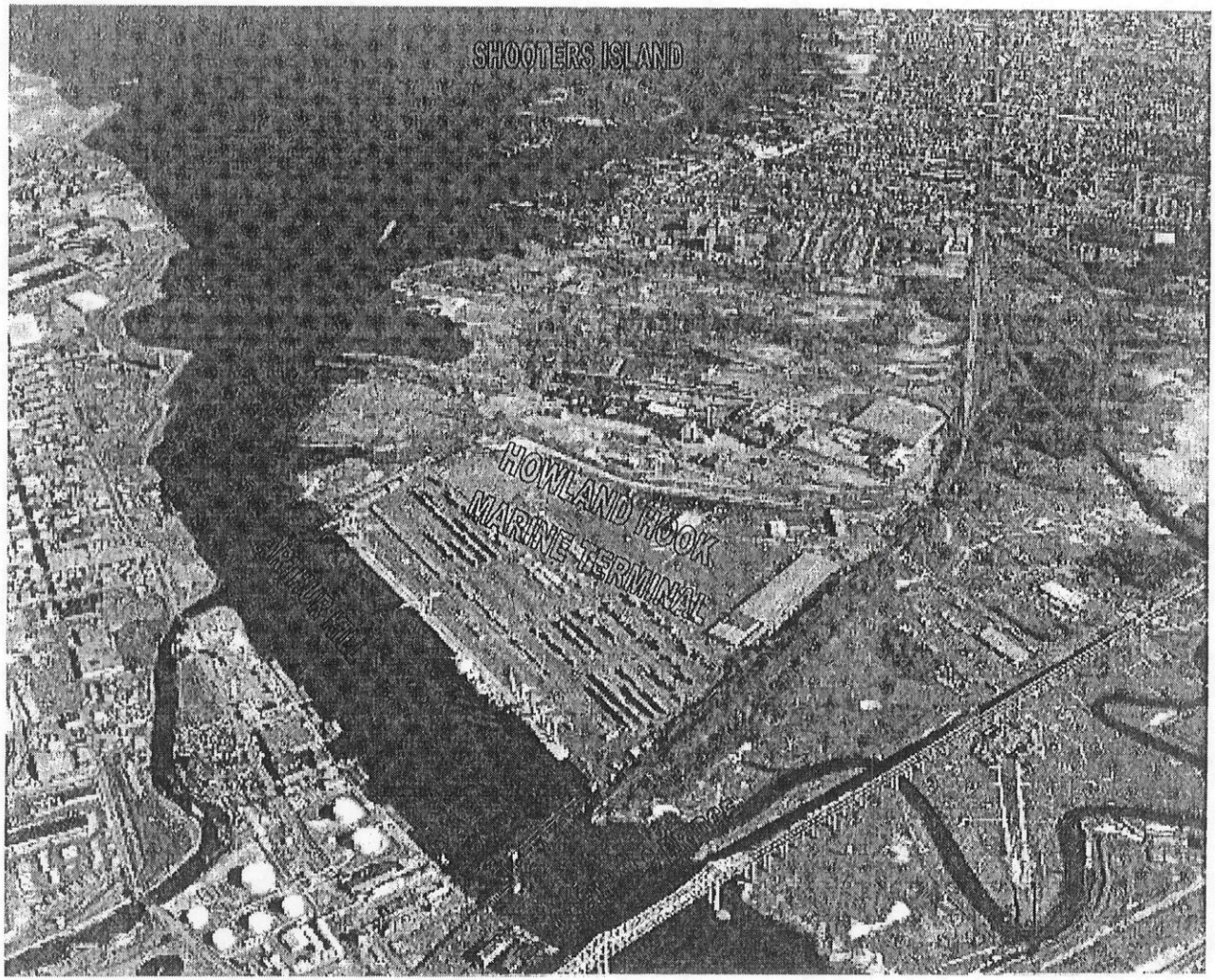
FIGURE 4
PORT NEWARK & ELIZABETH TERMINALS
AERIAL VIEW



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY
HARBOR NAVIGATION STUDY
FEASIBILITY REPORT

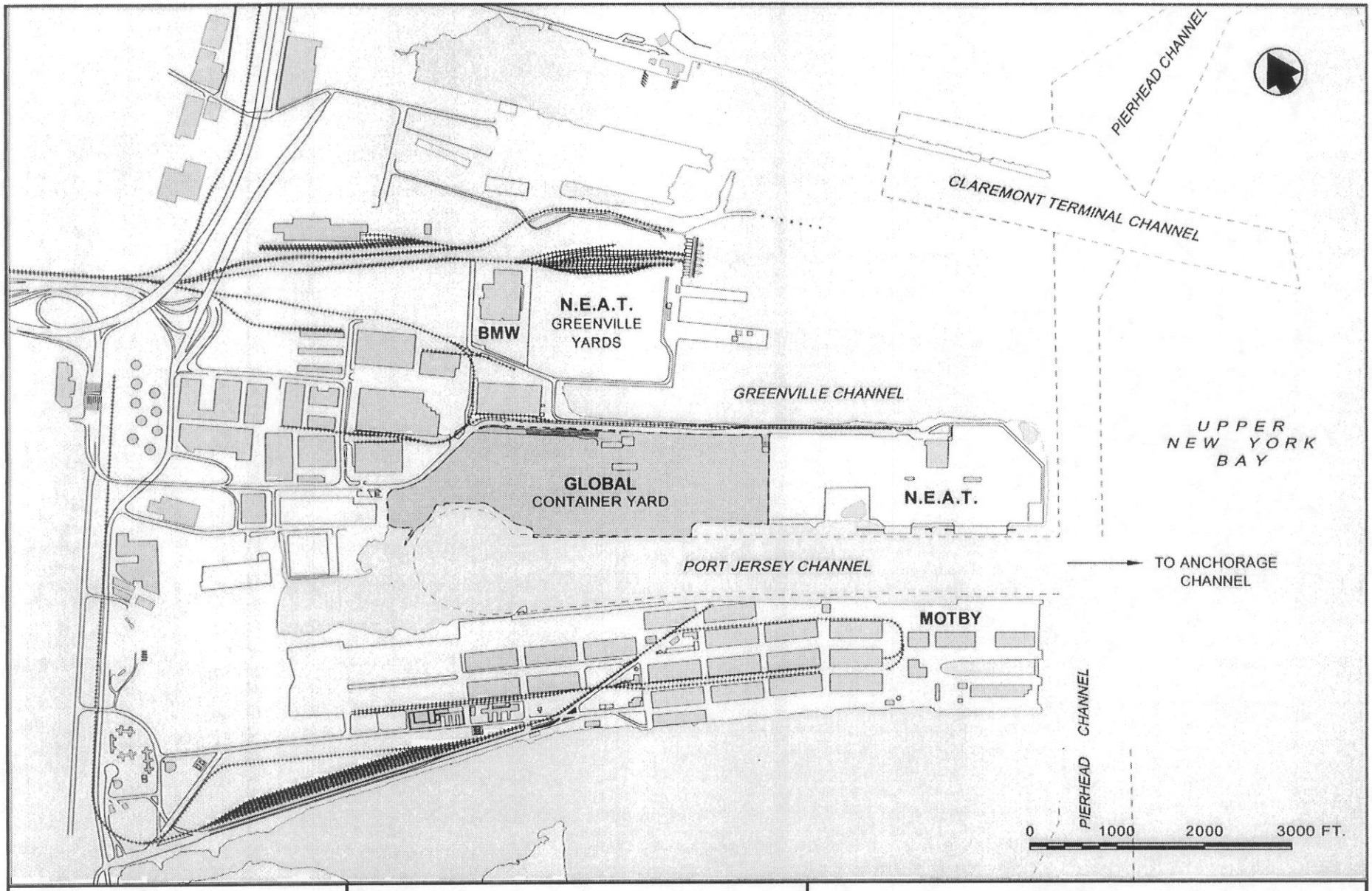
FIGURE 5
HOWLAND HOOK MARINE TERMINALS
EXISTING CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

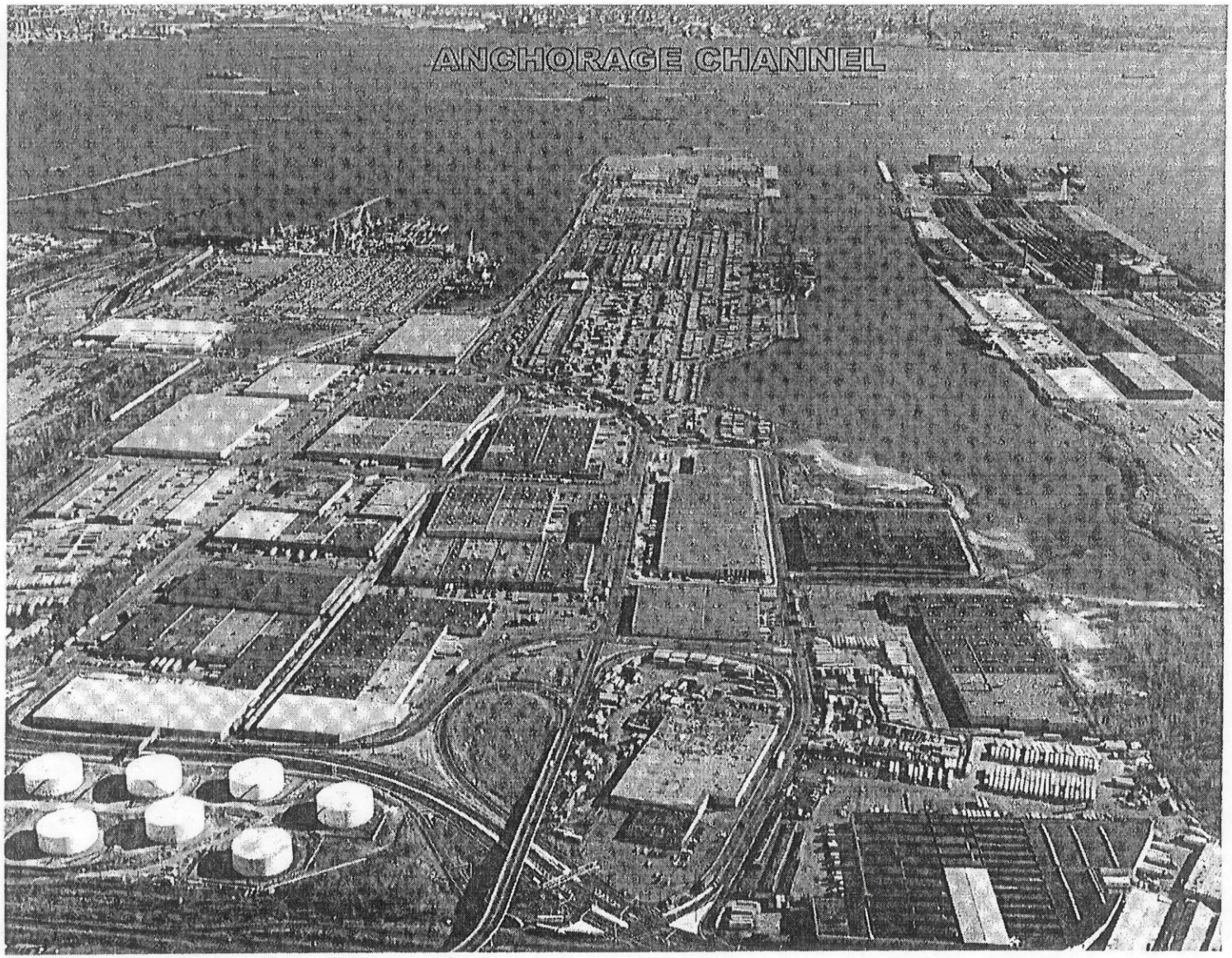
FIGURE 6
HOWLAND HOOK MARINE TERMINAL
AERIAL VIEW



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY
HARBOR NAVIGATION STUDY
FEASIBILITY REPORT

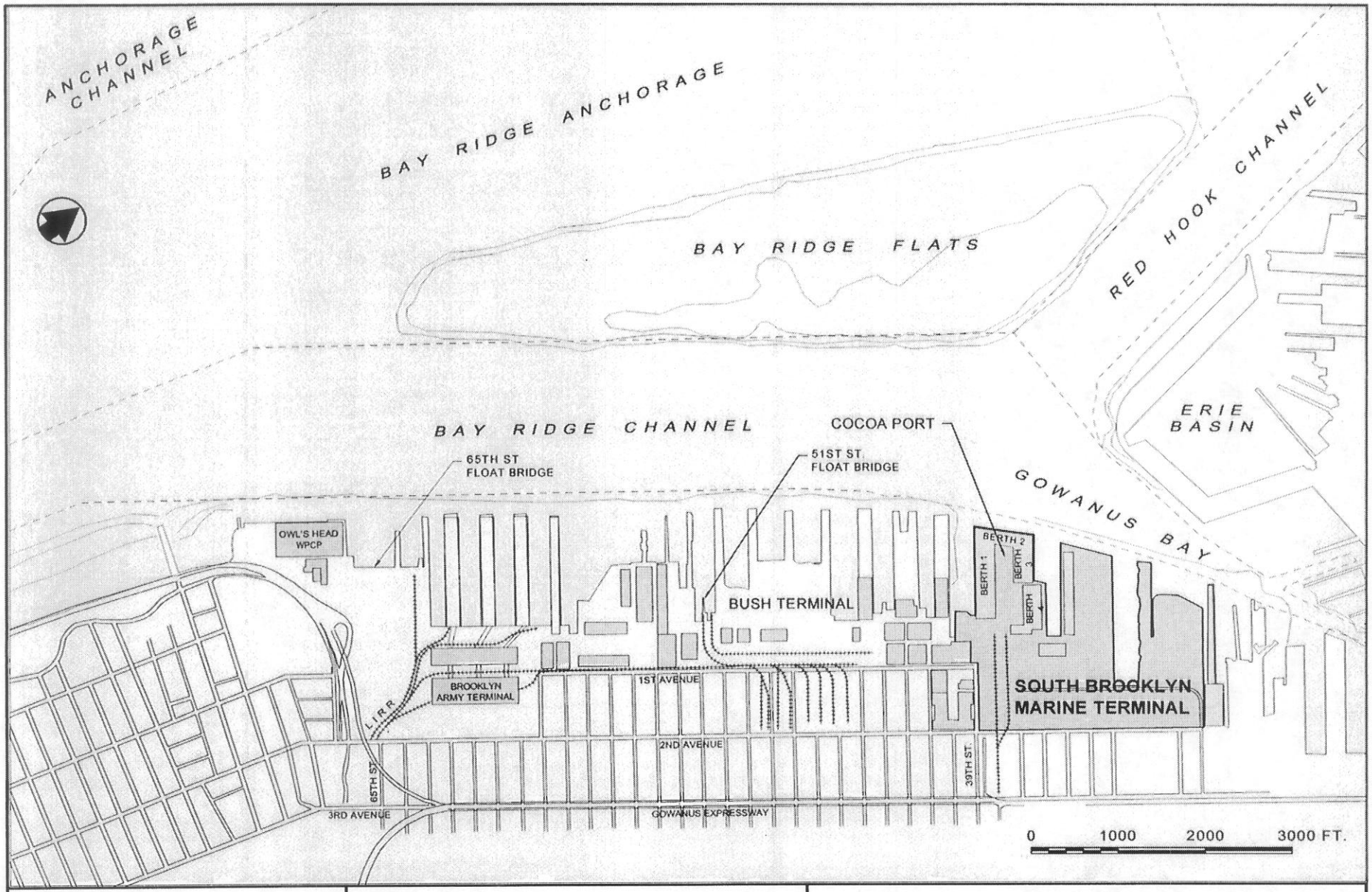
FIGURE 7
PORT JERSEY & MOTBY MARINE TERMINALS
EXISTING CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

FIGURE 8
PORT JERSEY & MOTBY MARINE TERMINALS
AERIAL VIEW



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY FEASIBILITY REPORT

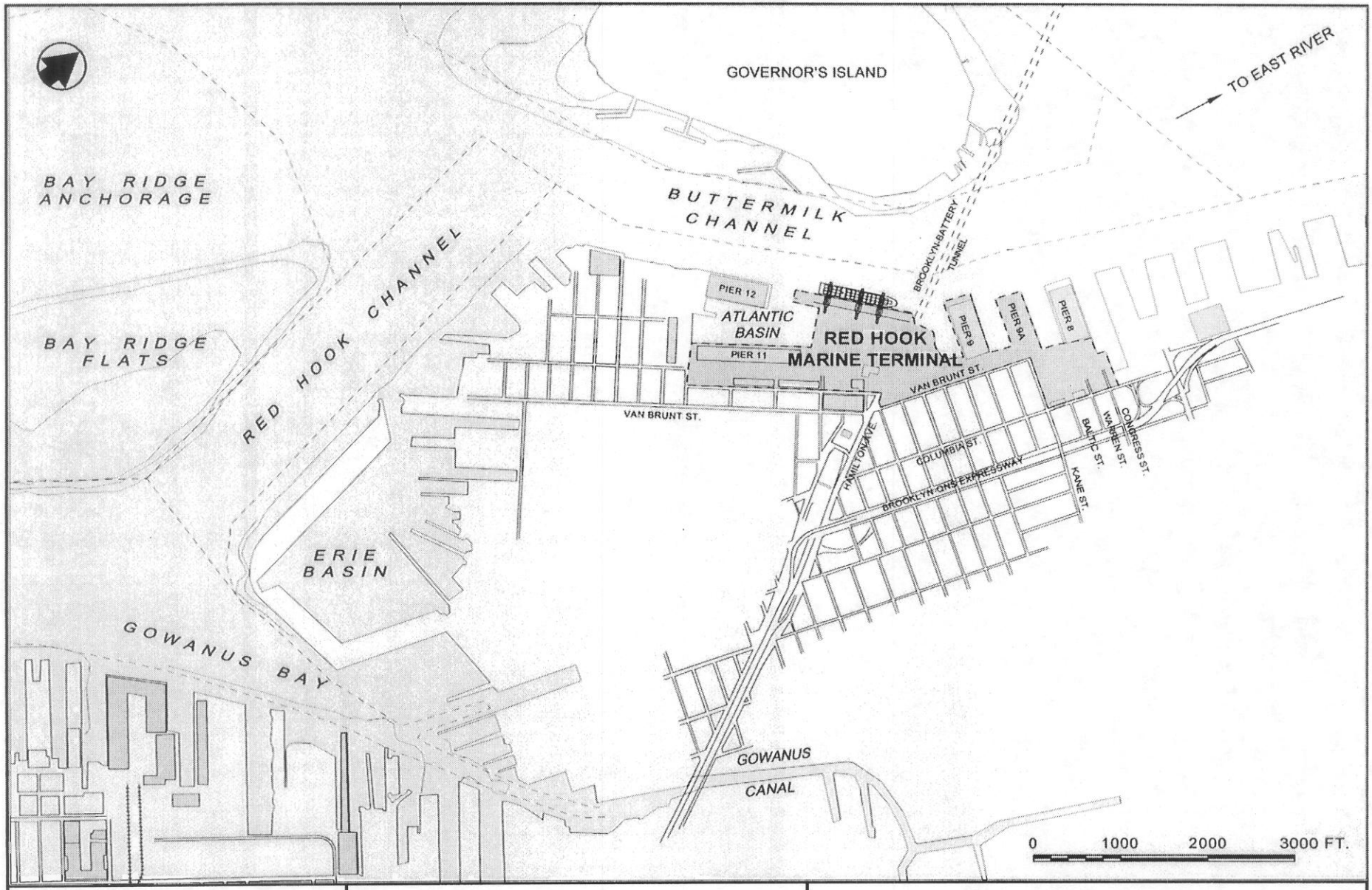
FIGURE 9
SOUTH BROOKLYN MARINE TERMINAL
EXISTING CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

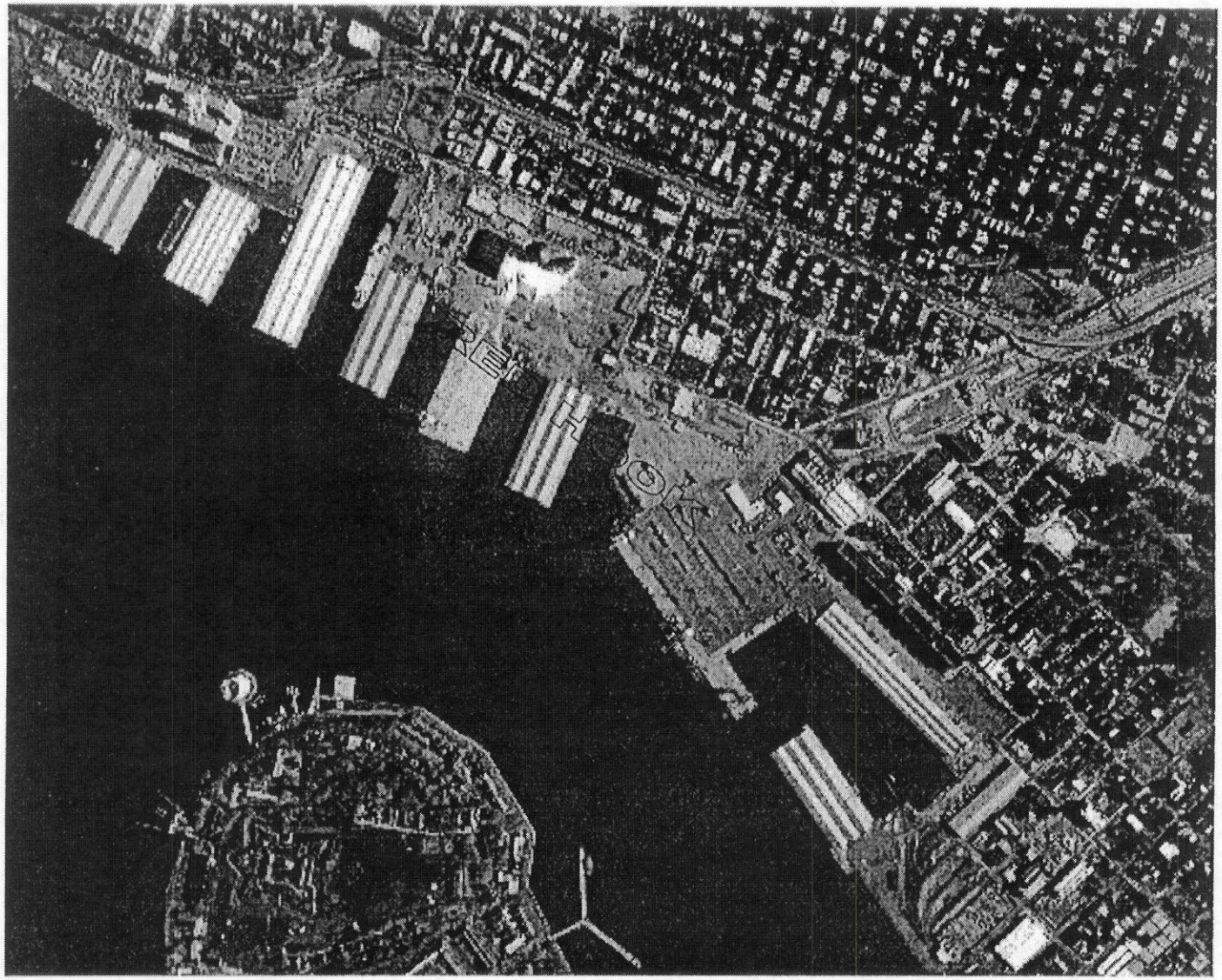
FIGURE 10
SOUTH BROOKLYN MARINE TERMINAL



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY FEASIBILITY REPORT

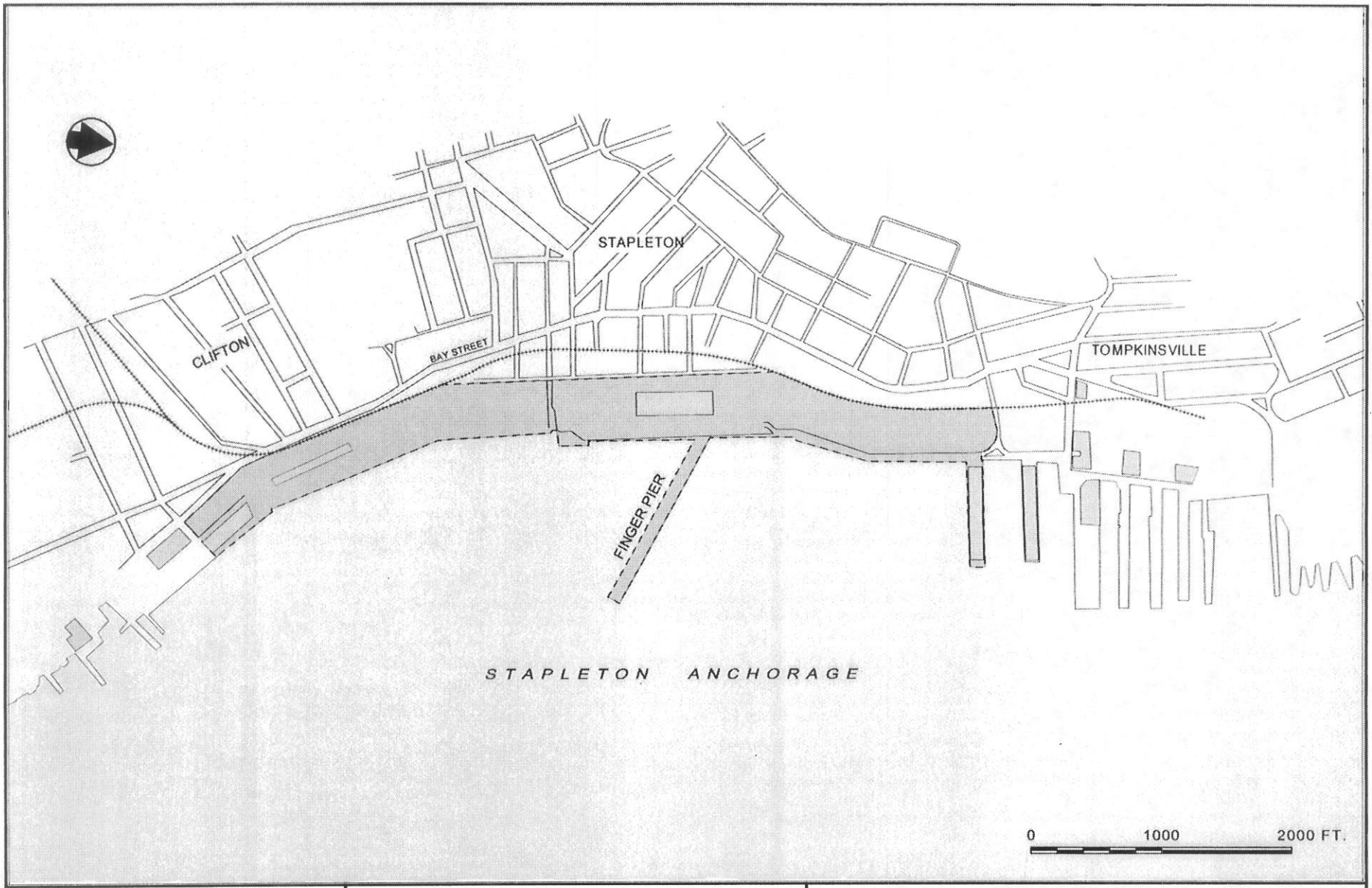
FIGURE 11
RED HOOK MARINE TERMINAL
EXISTING CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

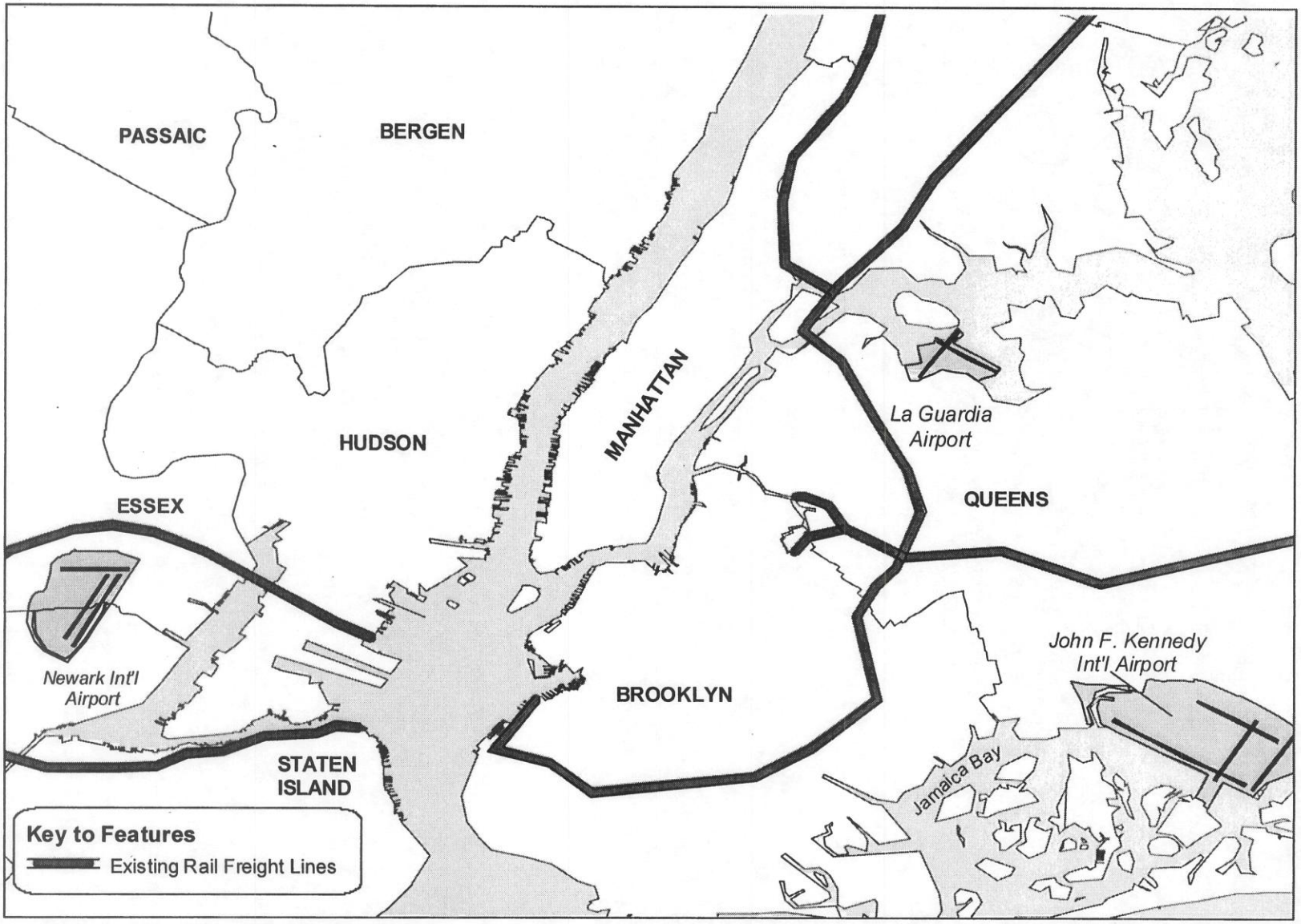
FIGURE 12
RED HOOK MARINE TERMINAL
AERIAL VIEW



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY
HARBOR NAVIGATION STUDY
FEASIBILITY REPORT

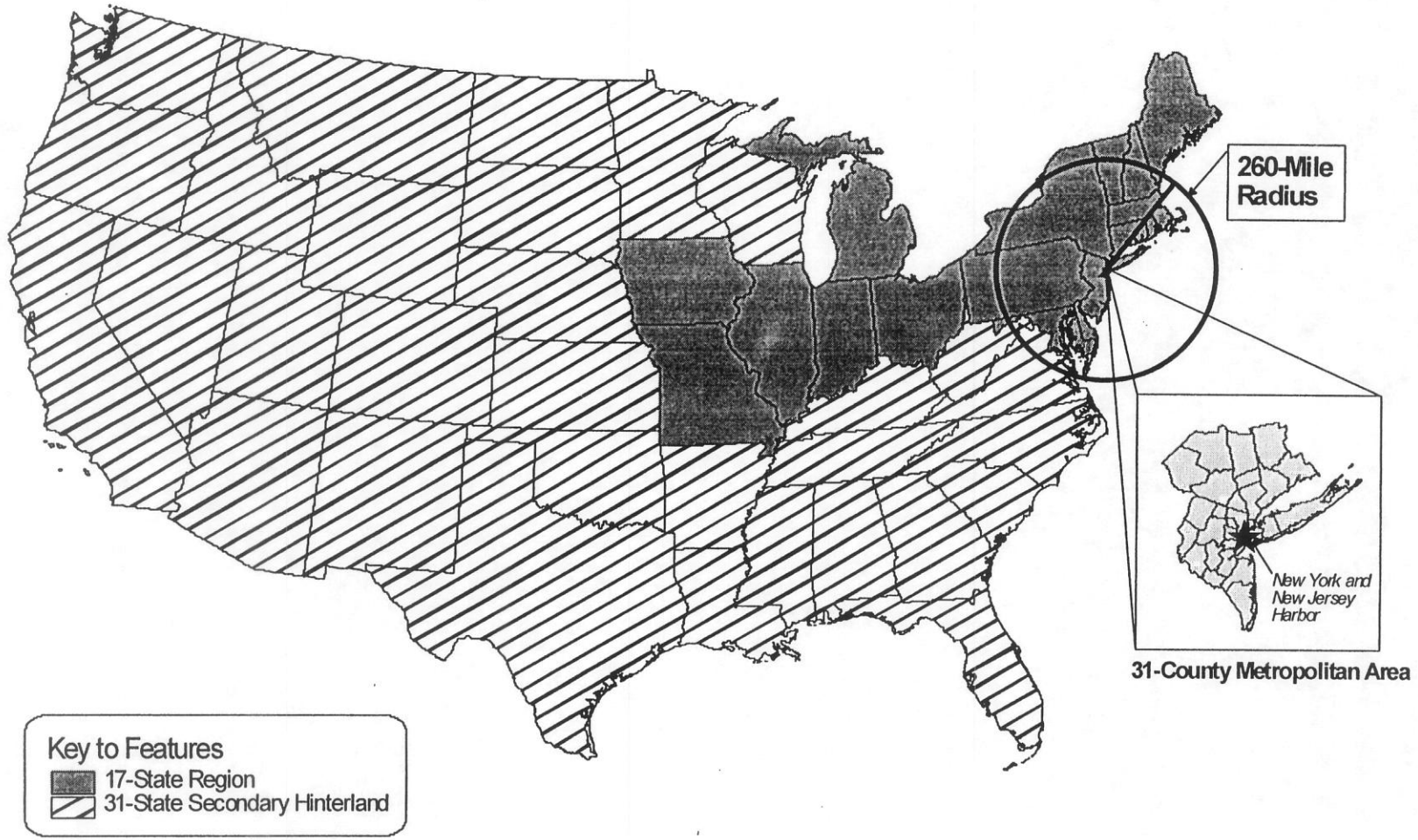
FIGURE 13
STAPLETON SITE
EXISTING CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY FEASIBILITY REPORT

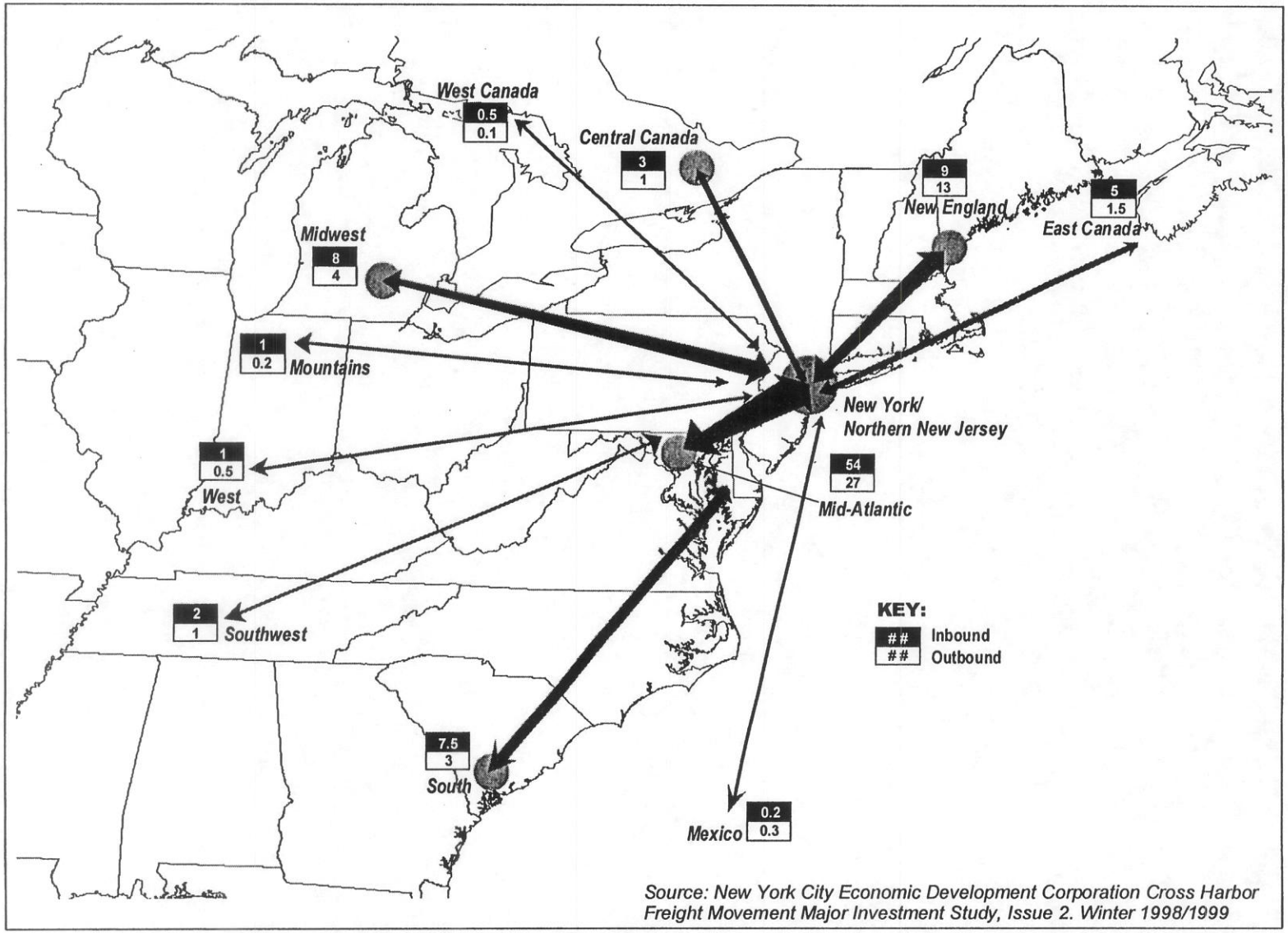
FIGURE 14
Existing Rail Freight Lines



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

FIGURE 15
Domestic Economic Hinterland

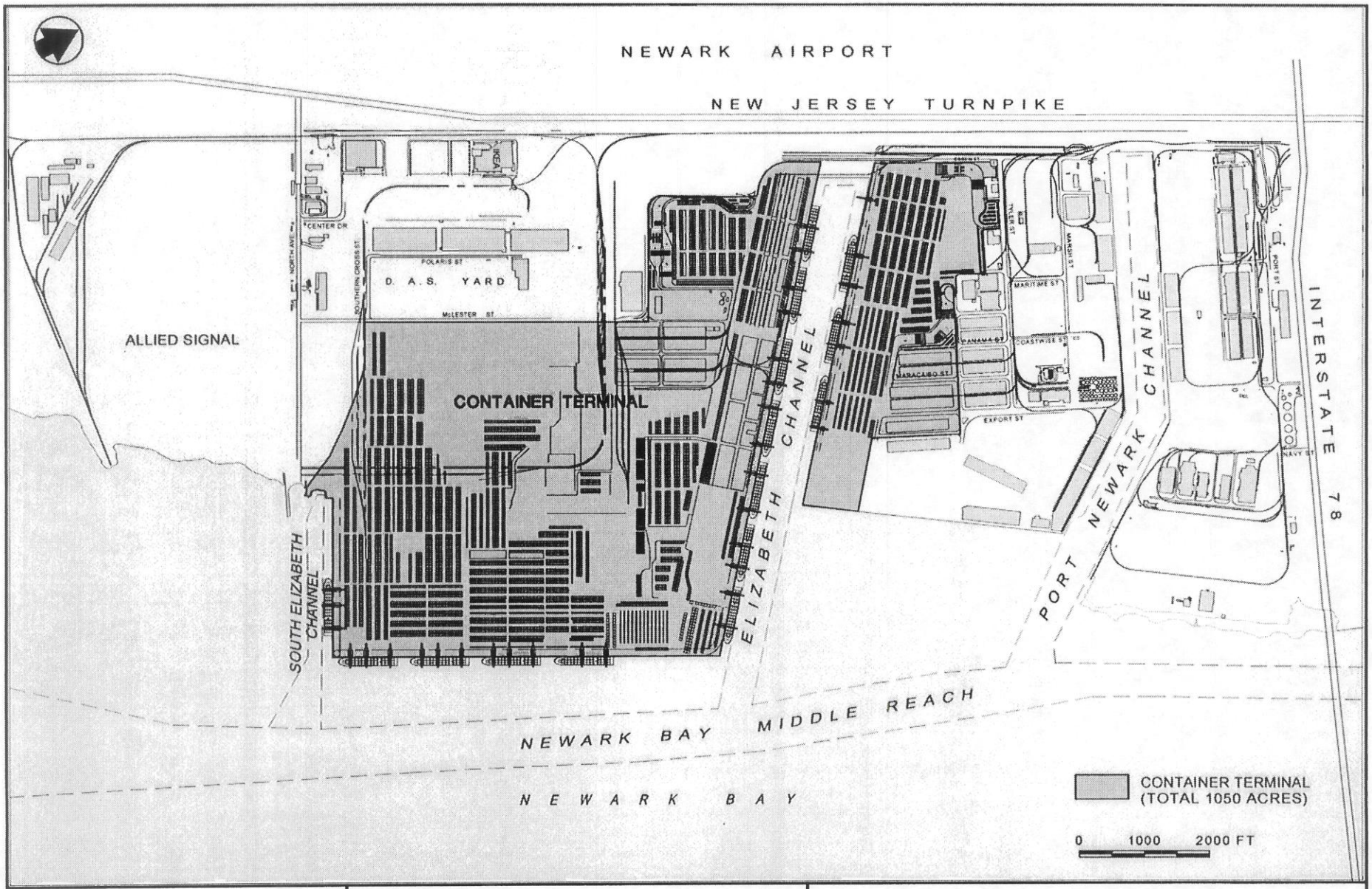


Source: New York City Economic Development Corporation Cross Harbor Freight Movement Major Investment Study, Issue 2. Winter 1998/1999

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY
FEASIBILITY REPORT

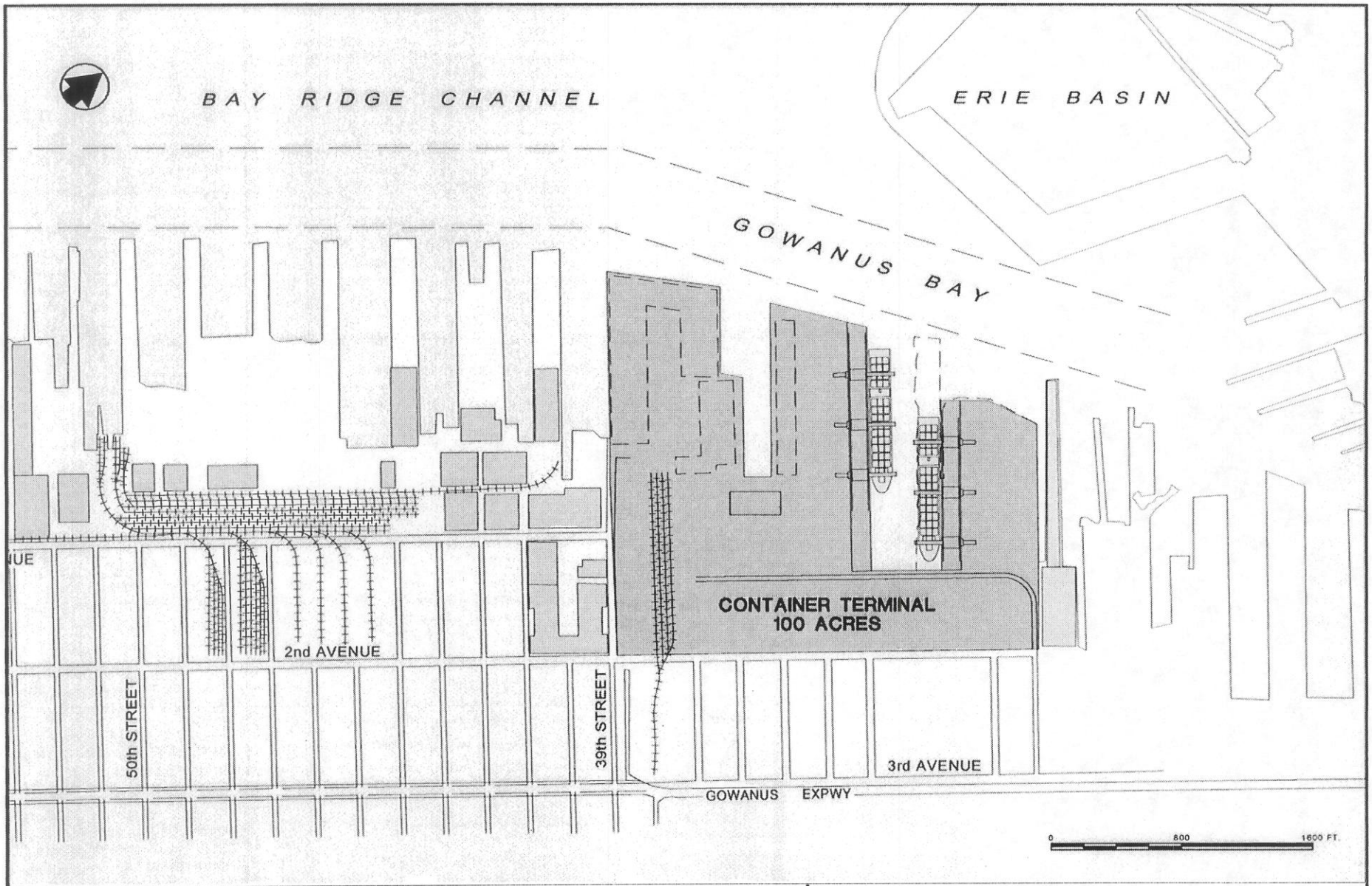
FIGURE 16
Commodity Flows To and From New York Metro Region (in Millions of Tons)



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY
HARBOR NAVIGATION STUDY
FEASIBILITY REPORT

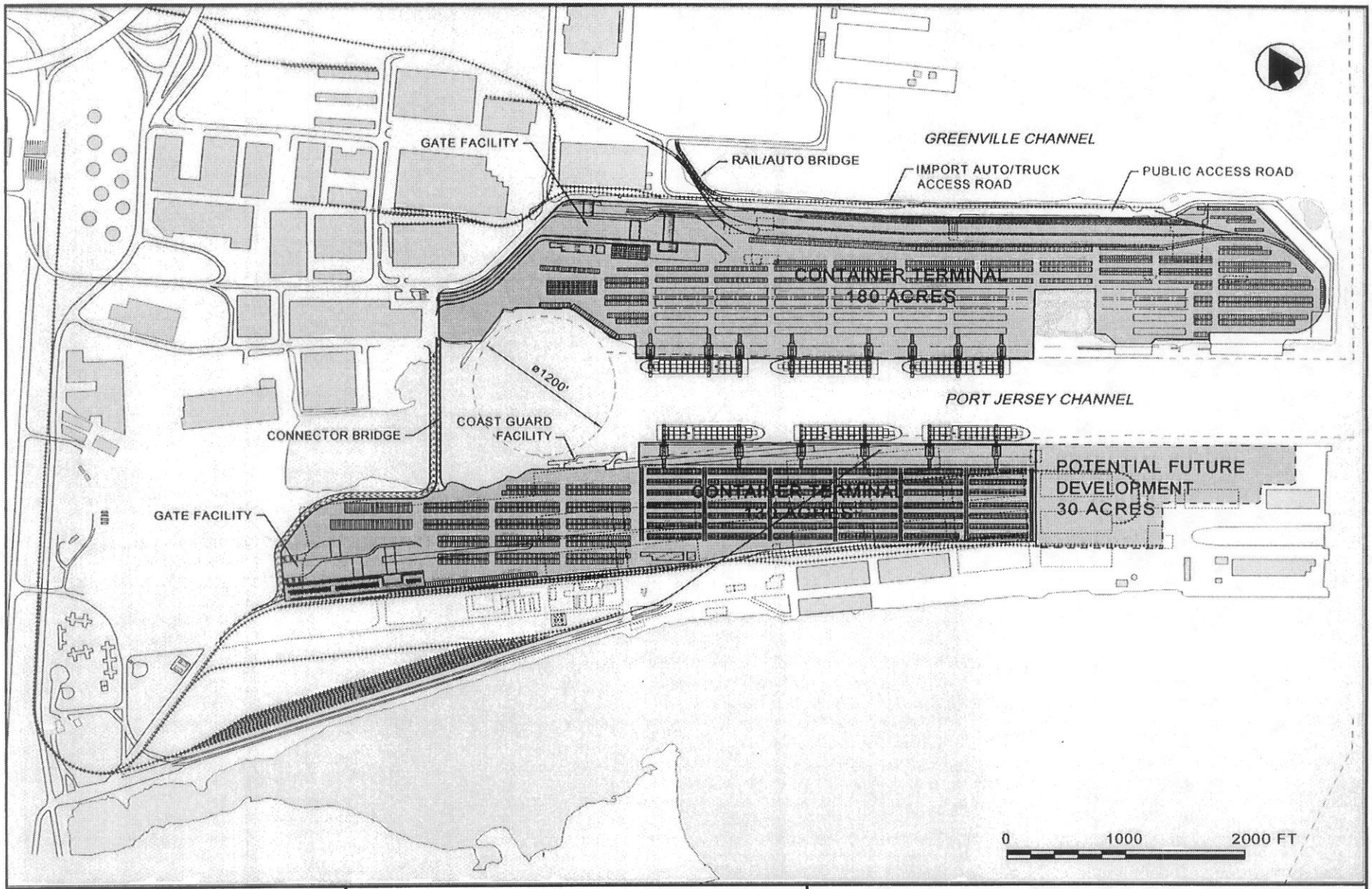
FIGURE 17
PORT NEWARK & ELIZABETH MARINE TERMINALS
WITHOUT-PROJECT CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY
HARBOR NAVIGATION STUDY
FEASIBILITY REPORT

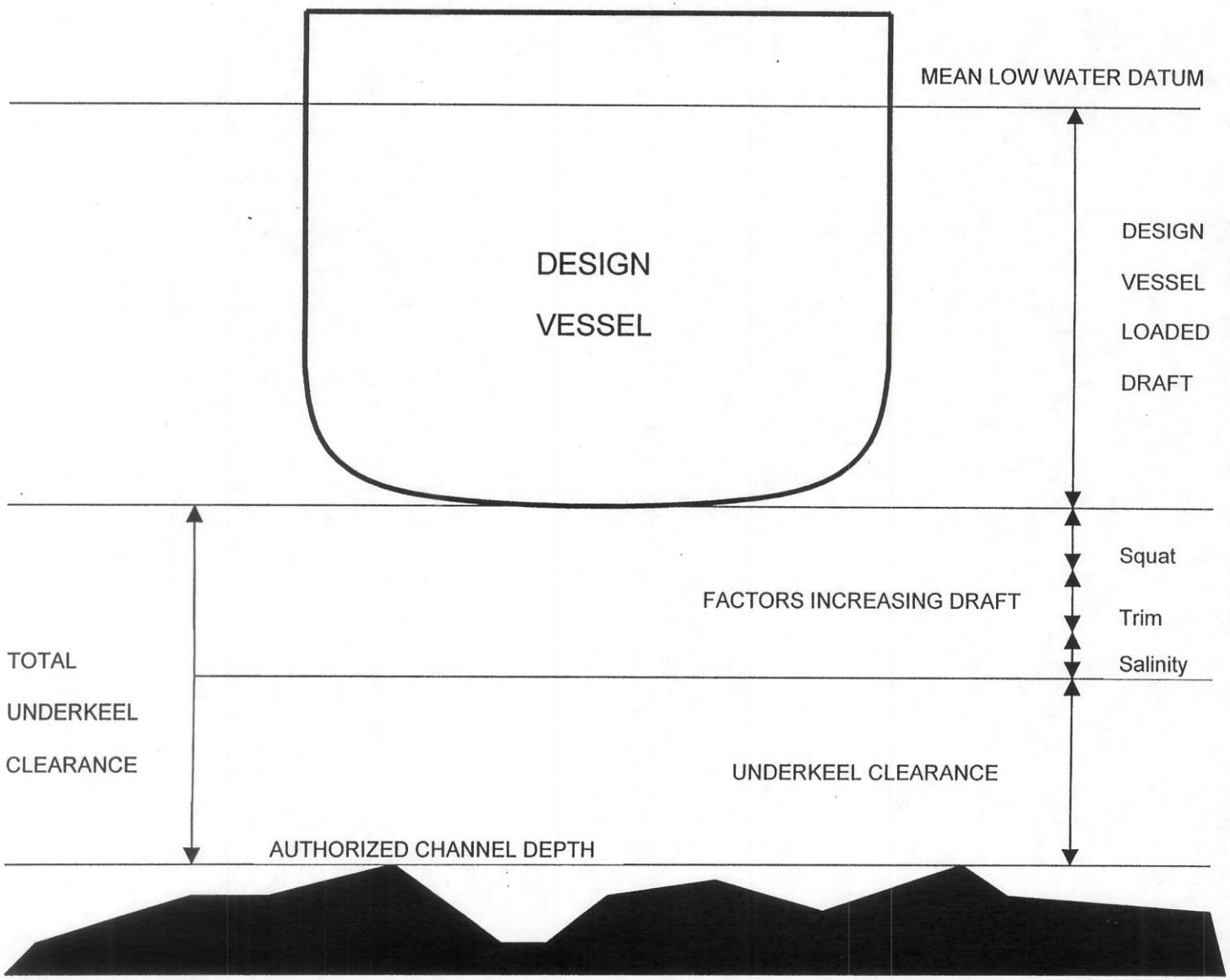
FIGURE 18
SOUTH BROOKLYN MARINE TERMINAL
WITHOUT-PROJECT CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY FEASIBILITY REPORT

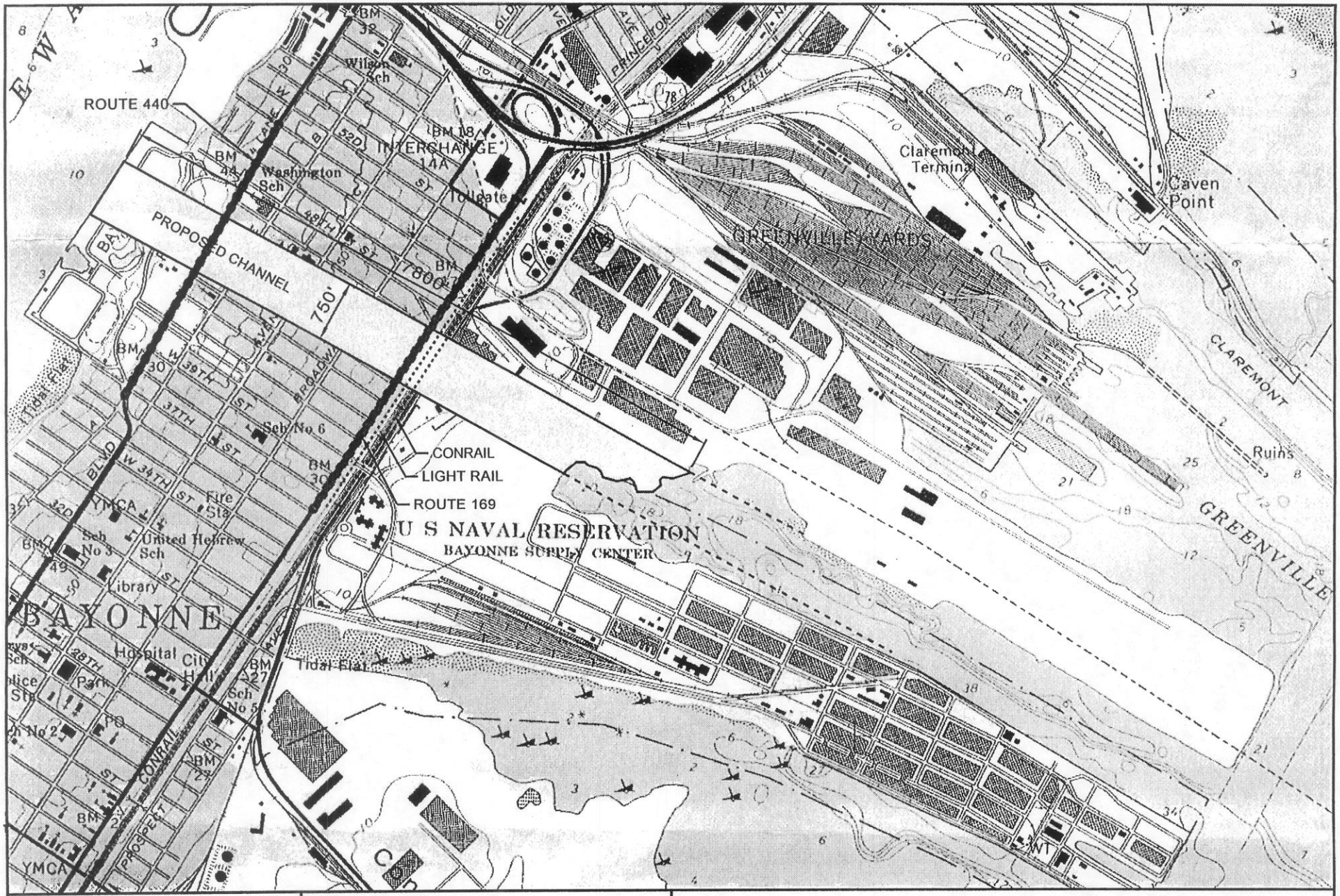
FIGURE 19
PORT JERSEY & MOTBY MARINE TERMINALS
WITHOUT-PROJECT CONDITION



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY
FEASIBILITY REPORT

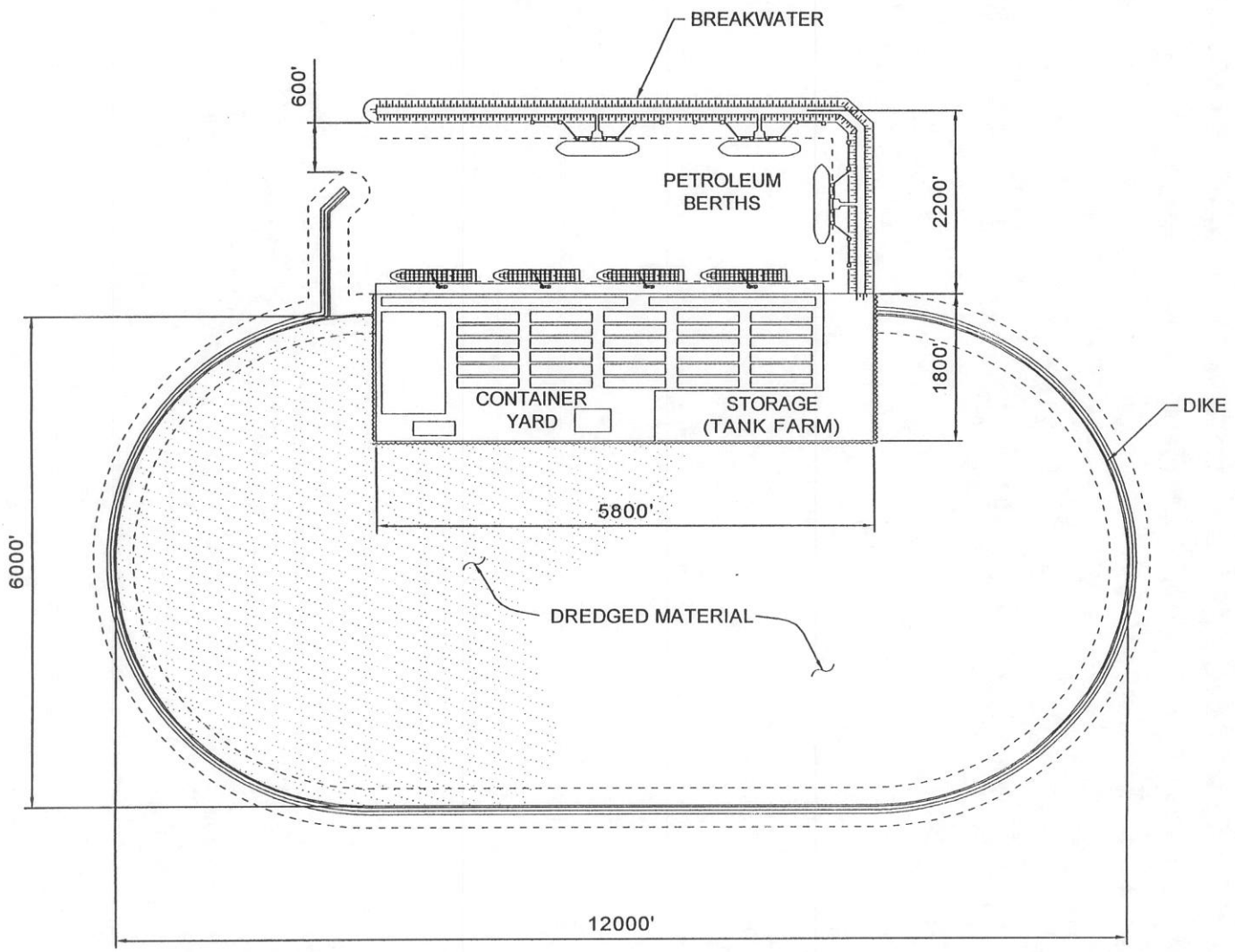
FIGURE 21
DESIGN VESSEL PARAMETERS



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK/NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

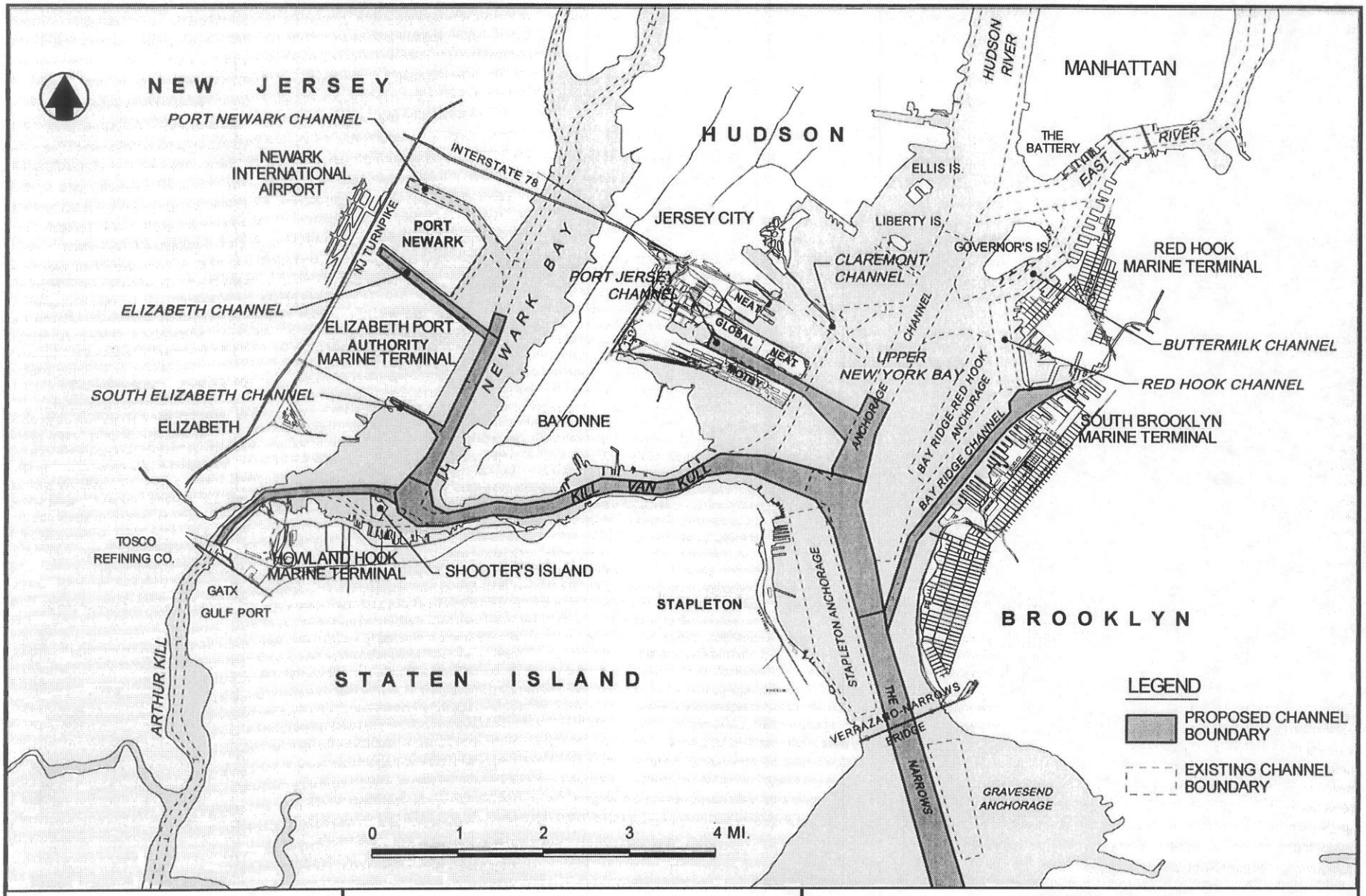
FIGURE 22
BAYONNE - NEWARK BAY CANAL



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY
HARBOR NAVIGATION STUDY
FEASIBILITY REPORT

FIGURE 23
CONCEPT FOR OFFSHORE ISLAND PORT



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

NEW YORK & NEW JERSEY HARBOR NAVIGATION STUDY FEASIBILITY REPORT

FIGURE 25
RECOMMENDED PLAN
PROPOSED CHANNEL ALIGNMENTS

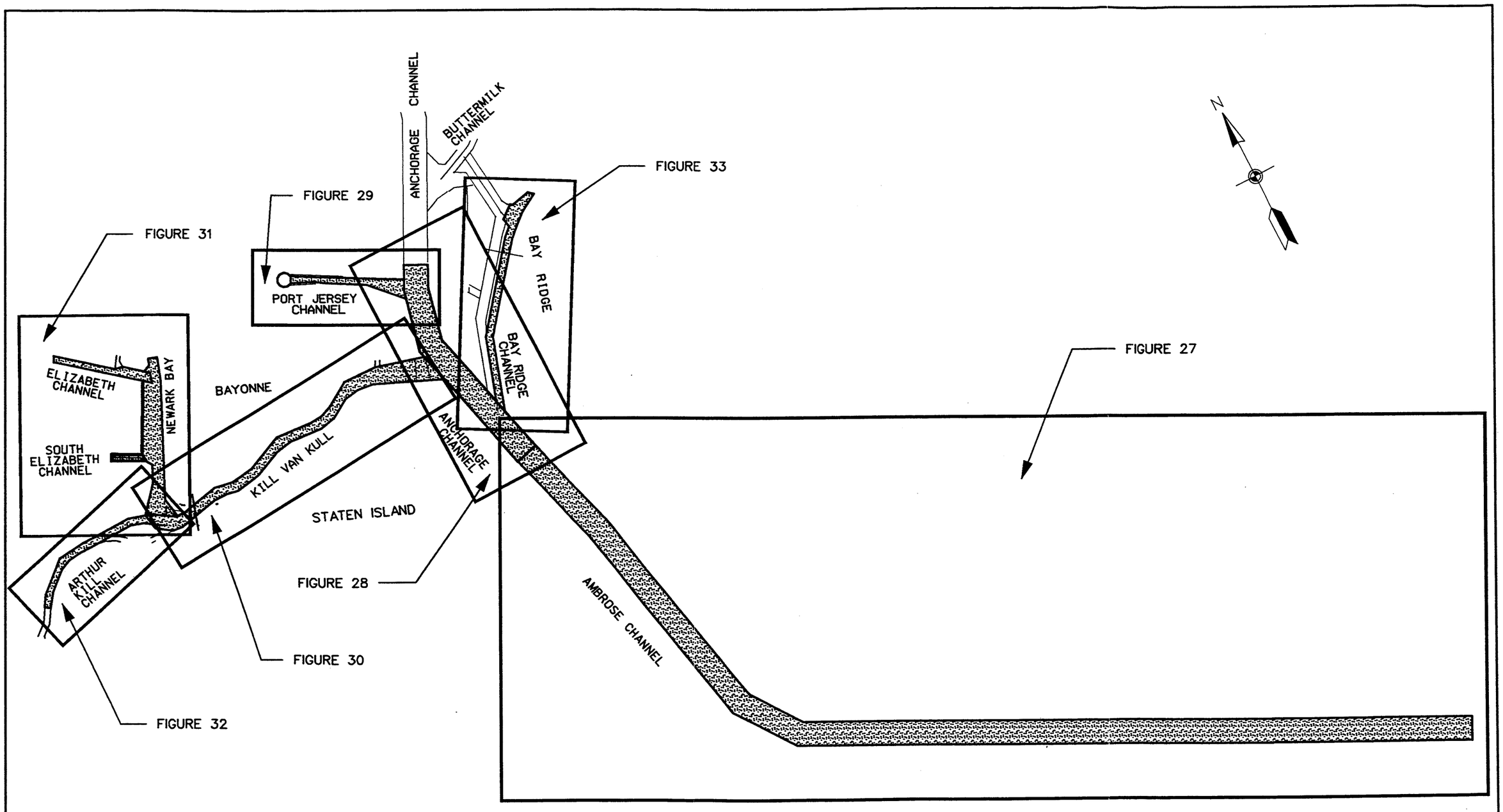


FIG. 26

GRAPHIC SCALE

8000 4000 0 8000 16000FT

SCALE 1 INCH - 8000 FEET

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278

NEW YORK AND NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

RECOMMENDED PLAN

INDEX SHEET

FIGURE 26

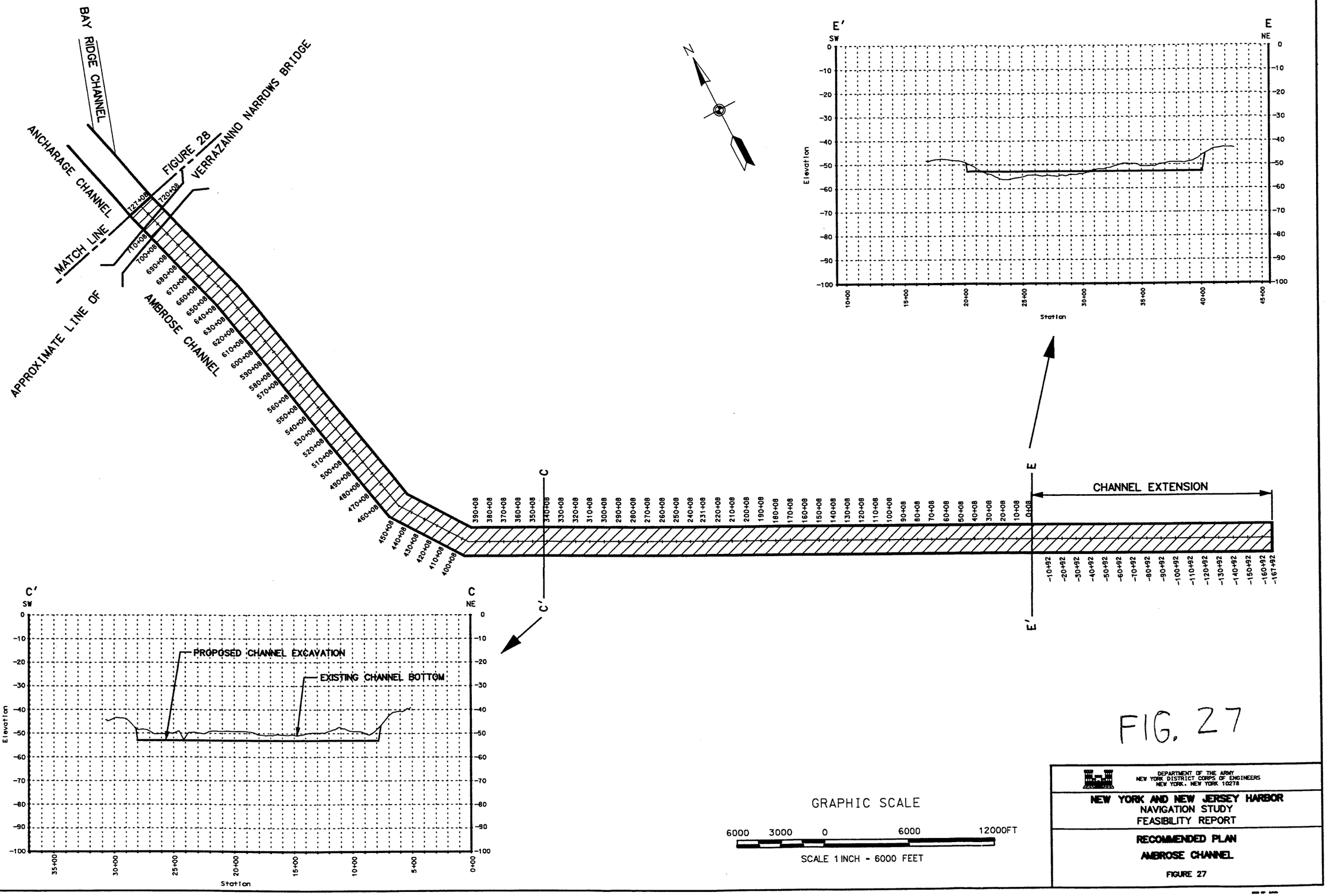


FIG. 27

GRAPHIC SCALE

6000 3000 0 6000 12000FT

SCALE 1 INCH = 6000 FEET

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278

NEW YORK AND NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

RECOMMENDED PLAN
AMBROSE CHANNEL
FIGURE 27

FIGURE 27

MATCH LINE

VERRAZANNO NARROWS BRIDGE

0+00

10+00 20+00 30+00 40+00 50+00 60+00 70+00 80+00 90+00 100+00 110+00 120+00

MATCH LINE

FIGURE 30

130+00 140+00 150+00 160+00

MATCH LINE

170+00 180+00 190+00 200+00 210+00 220+00 230+00 240+00 250+00 260+00 270+00 280+00 290+00 300+00 310+00 312+64

FIGURE 29

ANCHORAGE CHANNEL

ANCHORAGE CHANNEL

MATCH LINE

FIGURE 33

BAY RIDGE CHANNEL

KILL VAN KULL

PORT JERSEY CHANNEL

BUTTERMILK CHANNEL

C

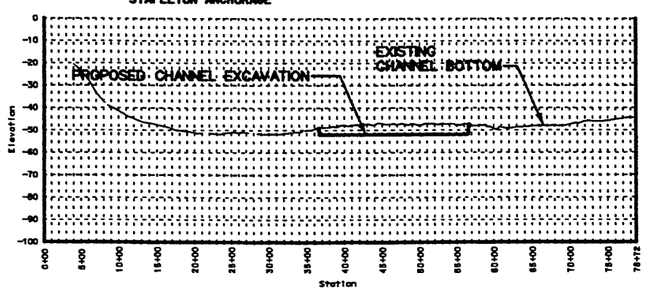
C'

A

A'

N

C' STAPLETON ANCHORAGE C



A' RED HOOK FLATS ANCHORAGE A

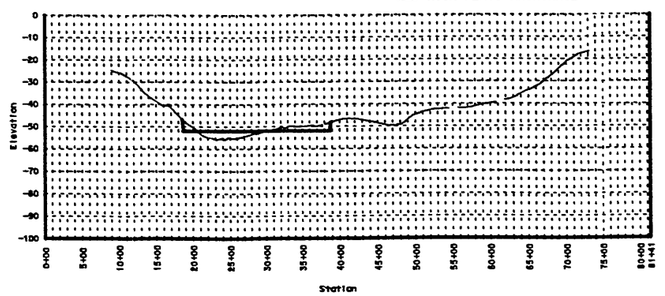


FIG. 28

GRAPHIC SCALE

2000 1000 0 2000 4000FT

SCALE 1 INCH = 2000 FEET

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278

NEW YORK AND NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

RECOMMENDED PLAN
ANCHORAGE CHANNEL

FIGURE 28

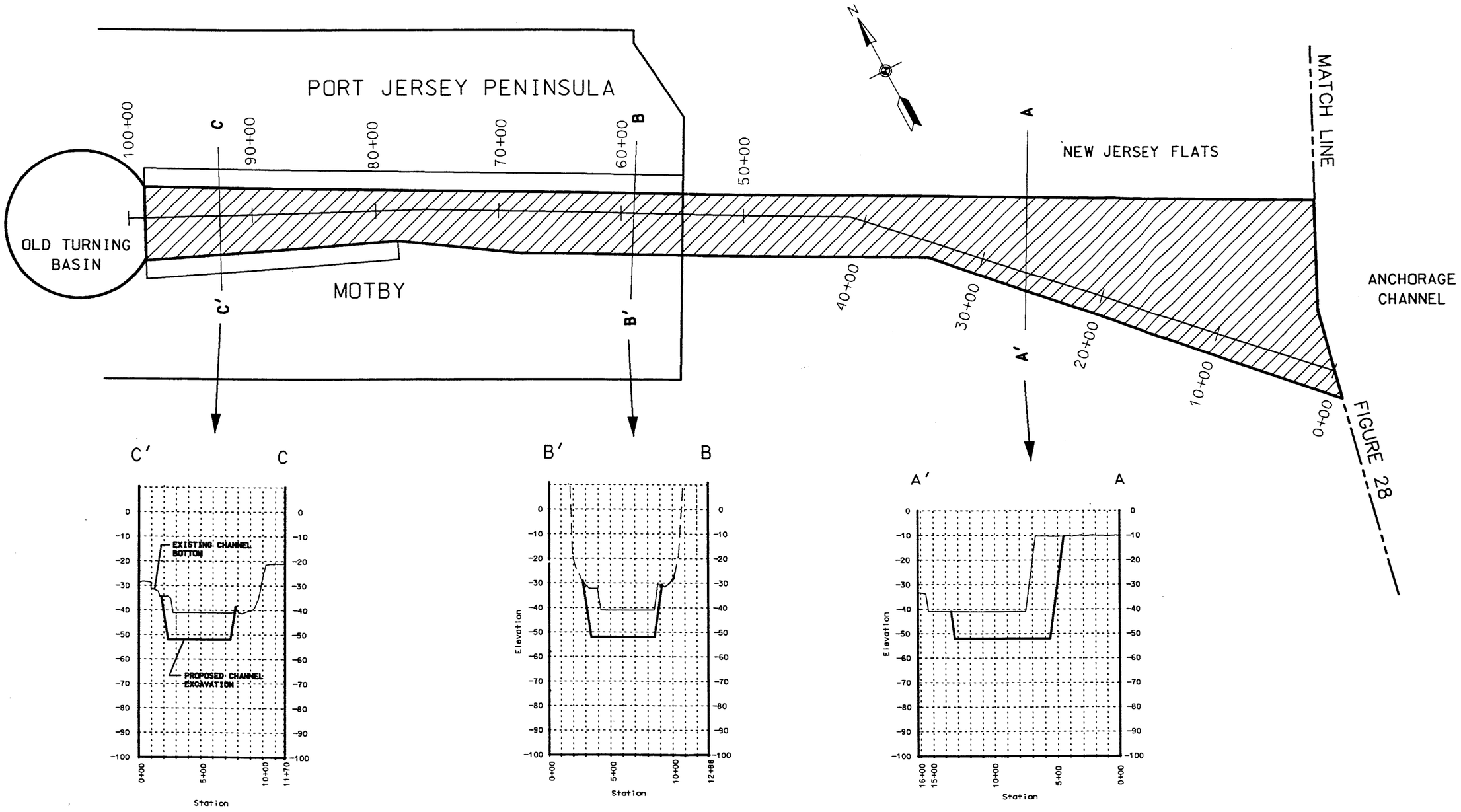


FIG. 29

GRAPHIC SCALE

800 400 0 800 1600FT

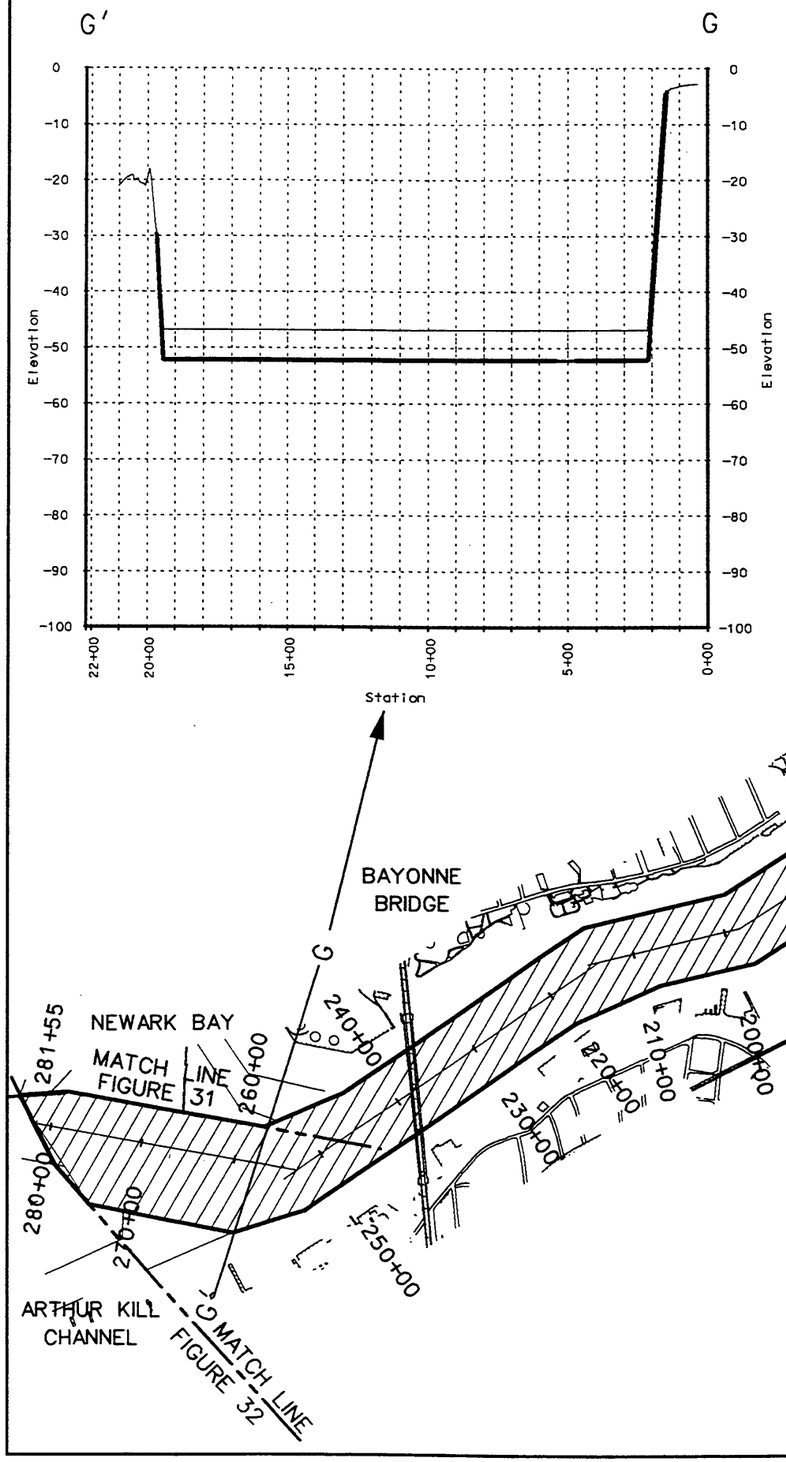
SCALE 1 INCH = 800 FEET

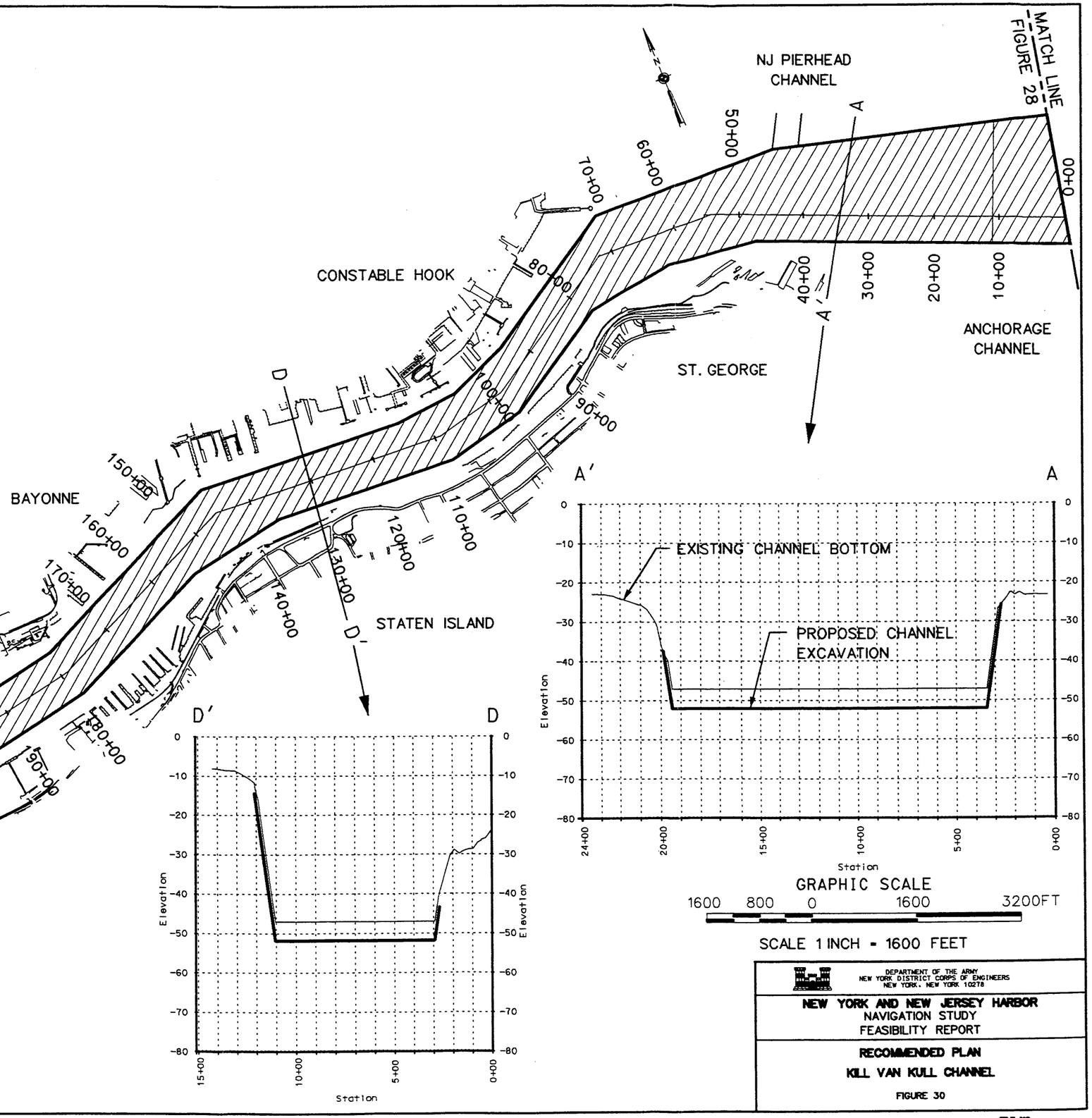
DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278

NEW YORK AND NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

RECOMMENDED PLAN
PORT JERSEY CHANNEL

FIGURE 29





GRAPHIC SCALE

1600 800 0 1600 3200FT

SCALE 1 INCH = 1600 FEET

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278

NEW YORK AND NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

RECOMMENDED PLAN

KILL VAN KULL CHANNEL

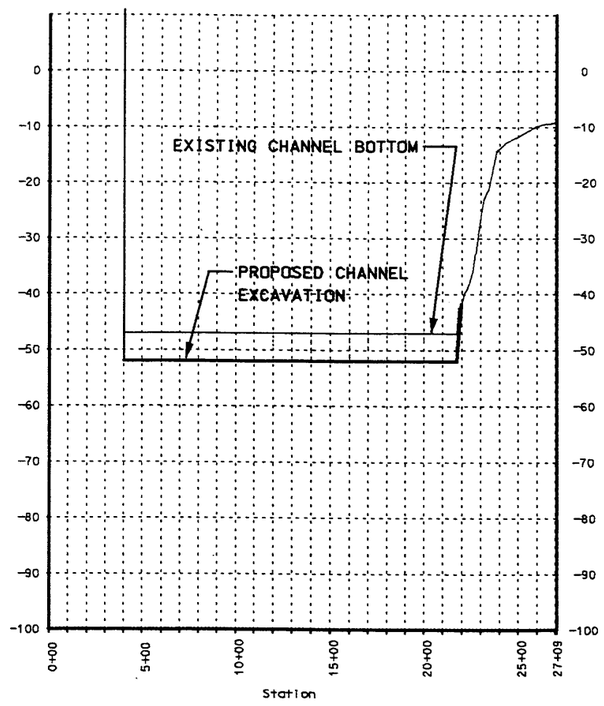
FIGURE 30

FILE NO.

C′

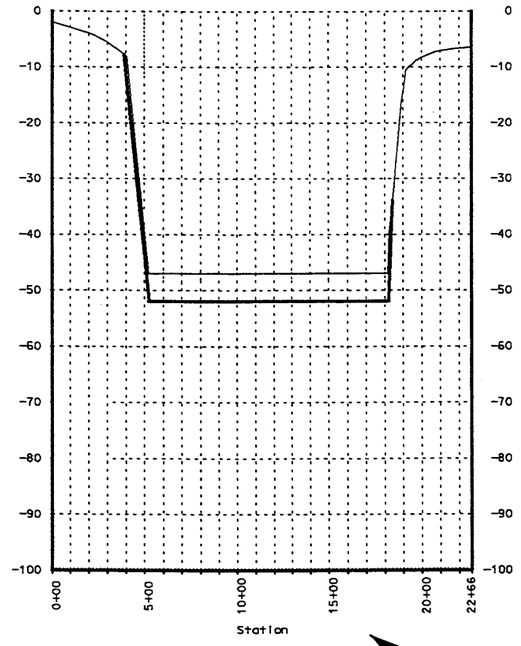
C

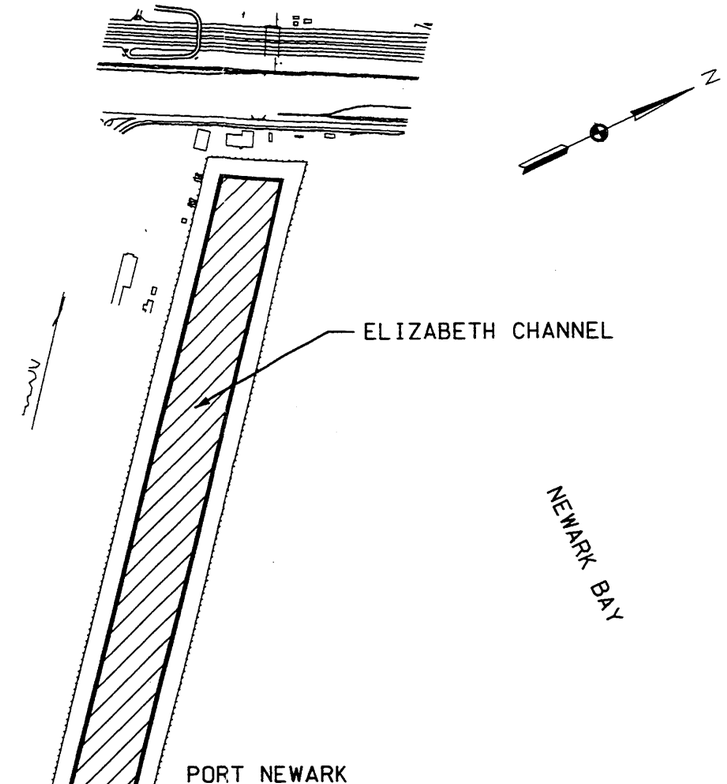
NB 98-34

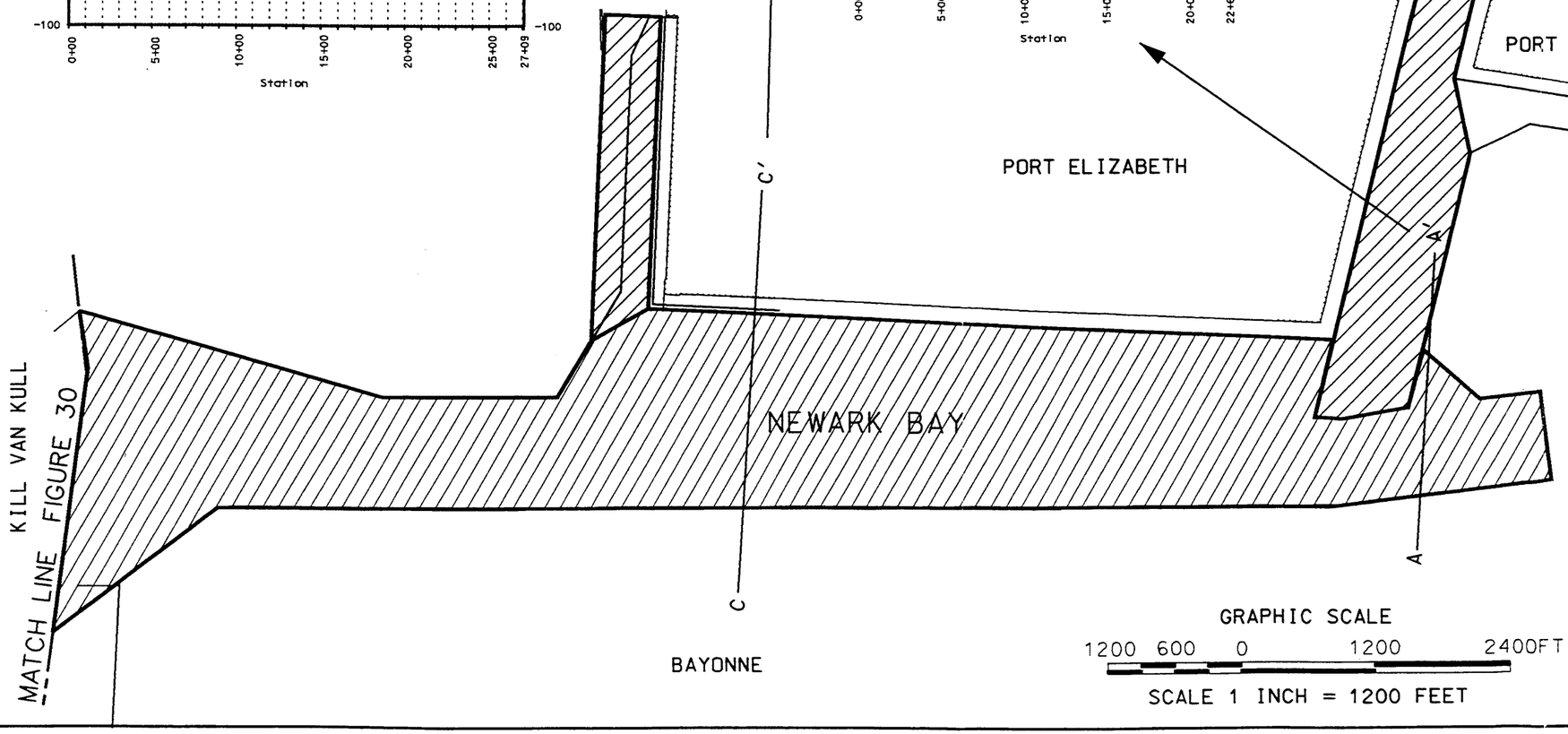


A′

A







GRAPHIC SCALE

1200 600 0 1200 2400FT

SCALE 1 INCH = 1200 FEET

FIG. 31

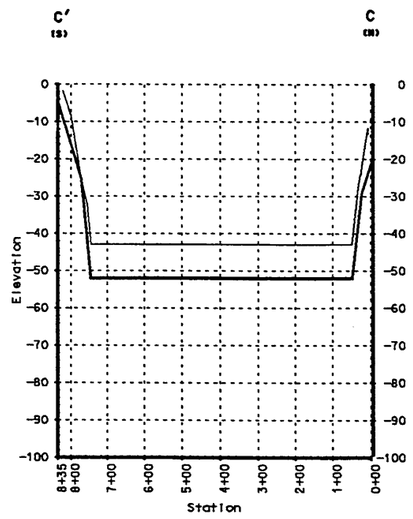
DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278

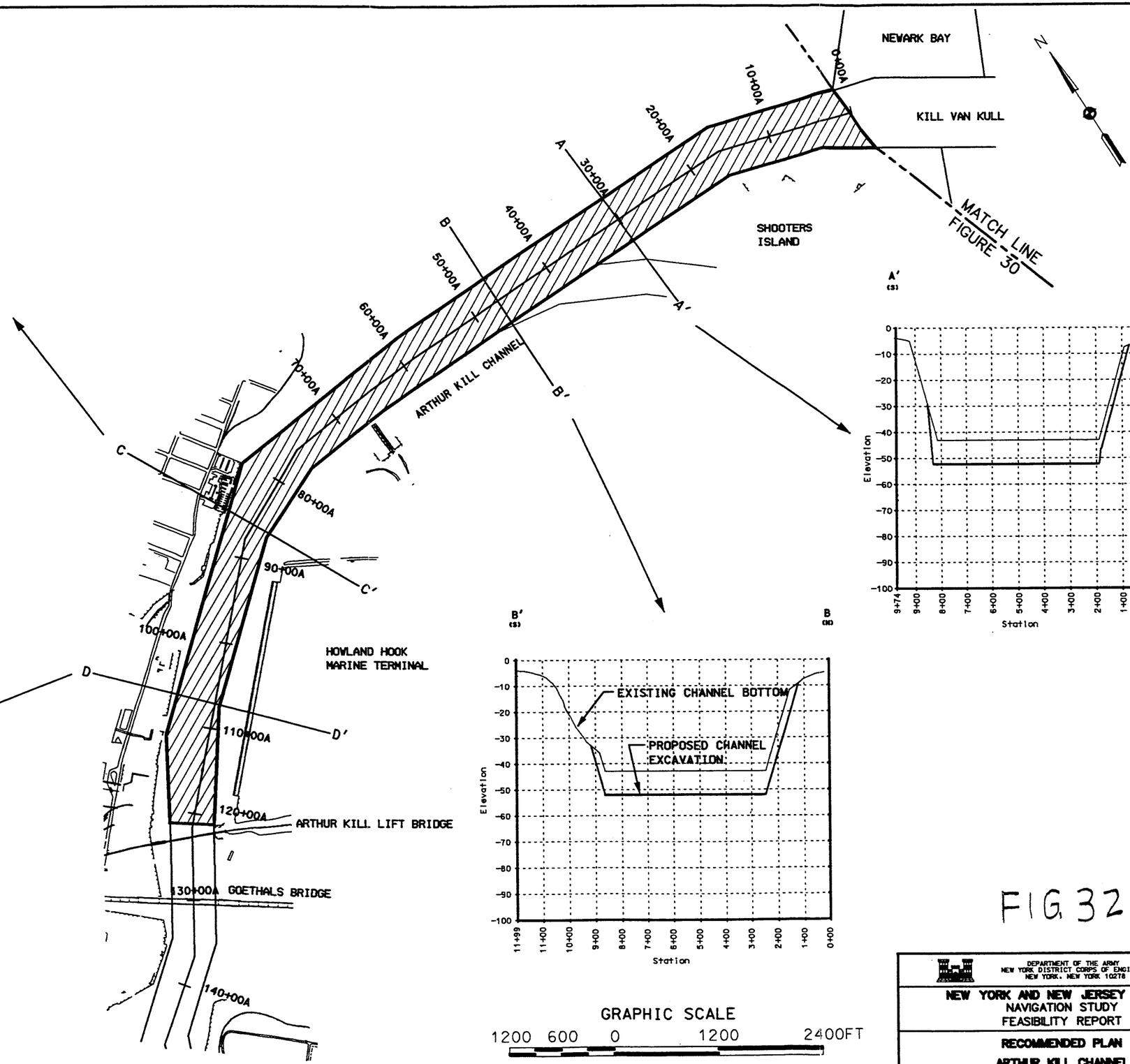
NEW YORK AND NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

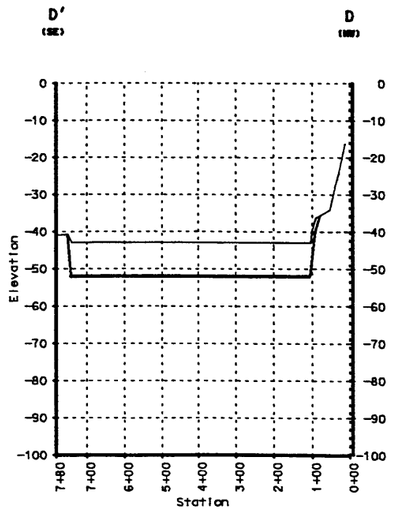
RECOMMENDED PLAN
NEWARK BAY CHANNEL

FIGURE 31

FILE NO.







GRAPHIC SCALE

1200 600 0 1200 2400FT

SCALE 1 INCH = 1200 FEET

FIG 32

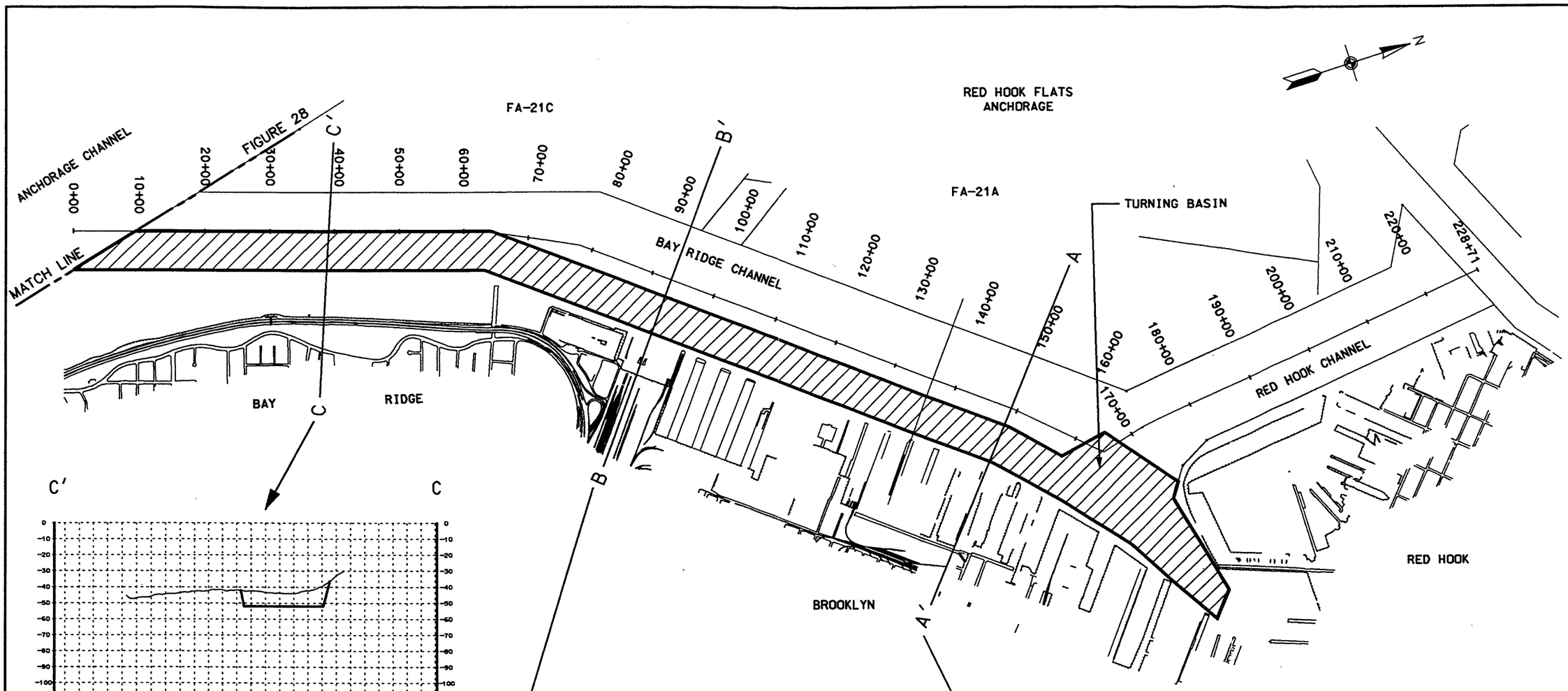
DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278

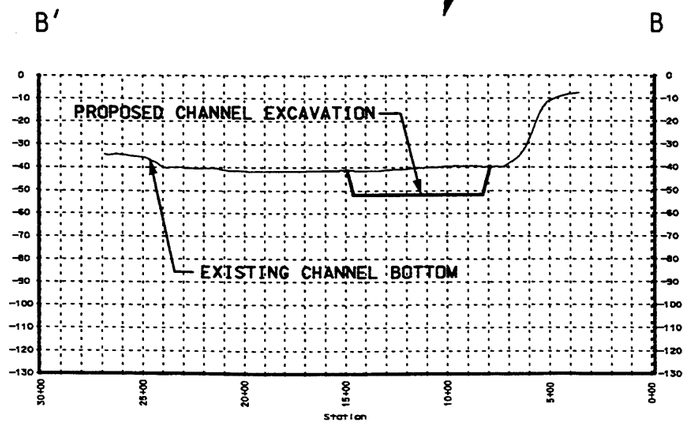
NEW YORK AND NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

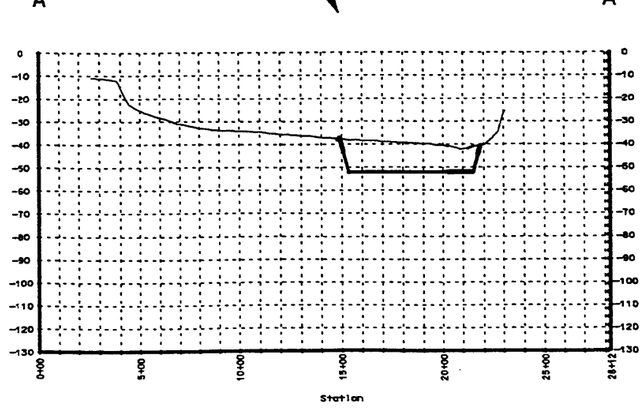
RECOMMENDED PLAN

ARTHUR KILL CHANNEL

FIGURE 32







GRAPHIC SCALE

1600 800 0 1600 3200FT

SCALE 1 INCH = 1600 FEET

FIG. 33

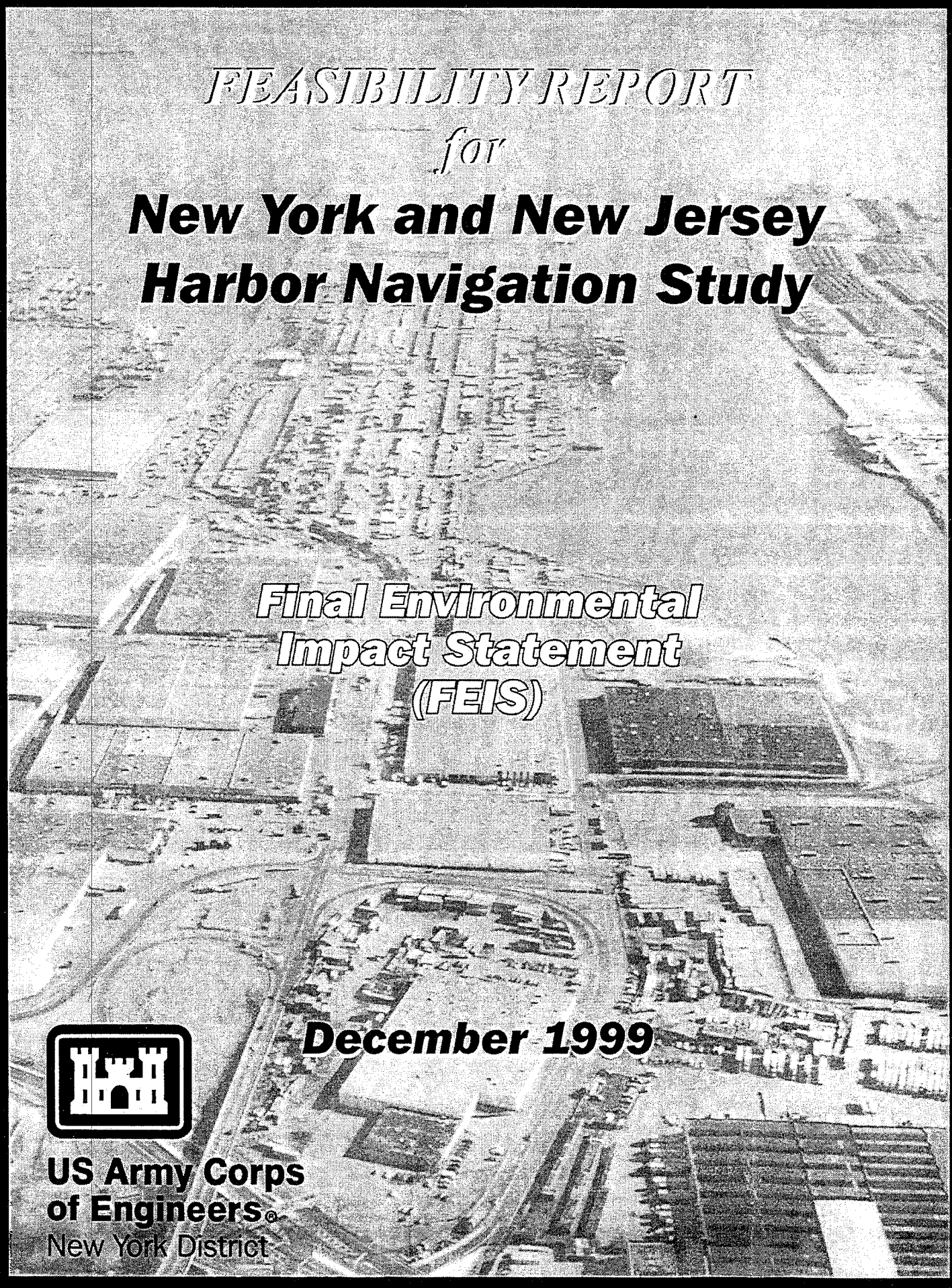
DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278

NEW YORK AND NEW JERSEY HARBOR
NAVIGATION STUDY
FEASIBILITY REPORT

RECOMMENDED PLAN

BAY RIDGE CHANNEL

FIGURE 33



FEASIBILITY REPORT

for

New York and New Jersey Harbor Navigation Study

Final Environmental Impact Statement (FEIS)

December 1999

US Army Corps of Engineers®
New York District

FINAL
ENVIRONMENTAL IMPACT STATEMENT
ON THE
NEW YORK AND NEW JERSEY HARBOR NAVIGATION STUDY

December 1999

Responsible Lead Agency
U.S. Army Corps of Engineers-New York District
Planning Division
Jacob K. Javits Federal Building
26 Federal Plaza
New York, New York 10278-0090

Cooperating Agencies
U.S. Environmental Protection Agency
National Marine Fisheries Service
U.S. Department of Transportation

Abstract:

In accordance with the National Environmental Policy Act (NEPA) and the U.S. Army Corps of Engineers (USACE regulations for implementing NEPA, a Final Environmental Impact Statement (FEIS) has been prepared as part of the New York and New Jersey Harbor Navigation Feasibility Study.

The purpose of the study is to identify, screen, evaluate, and recommend a plan for channel improvements throughout the Port of New York and New Jersey (the Port). Channel improvement (*e.g.*, construction, deepening, widening, realignment, etc.) is an action that can be taken to meet the changing trend toward larger cargo vessels in the world's fleet. The investigation considers the following channels: Ambrose, Anchorage, Bay Ridge, Red Hook, Buttermilk, the Kill Van Kull, Claremont, Port Jersey, Newark Bay (including the Elizabeth and South Elizabeth Channels), and the Arthur Kill to Gulfport, as well as the anchorage areas at Stapleton, Red Hook Flats, and Gravesend Bay.

The Recommended Plan, described in Section 3, provides for navigation improvements to nine channels, which will permit access by larger, deeper-draft vessels to four main container terminals. Improvements consist of channel deepening, channel realignment, turning basin construction, and berth deepening.

No expansion of Port facilities is directly attributable to the recommended plan. Economic forecasts project an increase in Port commerce regardless of whether navigation channel improvements are implemented. These increases will be handled to the extent possible through operational changes and advances in technology with or without channel deepening. No Port facility expansions are attributable to channel modifications.

The database for evaluation of the affected environment and potential impacts included available literature on the environment and habitats of the Harbor, a 3-dimensional hydrographic modeling program, and bathymetric data. The affected environment is described in Section 5 and the potential environmental impacts in Section 6.

The primary adverse environmental consequence of the Recommended Plan is the loss of shallow water habitat. Navigation improvements would disturb existing channel habitat and change some shallow areas to deeper habitats. Section 6 identifies the acres of shallow habitat impacted by each channel deepening. The Recommended Plan would disturb 6.26 acres of littoral zone habitat.

Mitigation planning for the Recommended Plan, described in Section 7, considers both ecological and archeological impacts. The ecological mitigation plan consists of littoral zone restoration/creation and intertidal wetlands restoration.

A preliminary 404 (b)(1) evaluation has been prepared for the Recommended Plan and is included in the FEIS as Appendix B-1.6. The preliminary determination is that the Recommended Plan with mitigation and the alternatives do not represent a significant threat of degradation to the aquatic environment.

Send written comments to:

U.S. Army Corps of Engineers, New York District
Attn: Ms. Jenine Gallo
CENAN-PL-EA
Environmental Analysis Branch
26 Federal Plaza
Jacob K. Javits Federal Building
New York, New York 10278-0090

For further information or additional copies of this document, write to Ms. Gallo at the address above or call her at (212) 264-0912.

Final Environmental Impact Statement (FEIS)
New York and New Jersey Harbor Navigation Study

TABLE OF CONTENTS

LIST OF FIGURES iv

LIST OF TABLES vi

ES EXECUTIVE SUMMARY ES-1

1 PURPOSE AND NEED FOR THE ACTION 1-1

1.1 INTRODUCTION 1-1
1.2 PROCEDURAL HISTORY 1-8
1.3 CONNECTED, CUMULATIVE, AND SIMILAR ACTIONS 1-20

2 ALTERNATIVES 2-1

2.1 CRITERIA FOR EVALUATING ALTERNATIVES AND ALTERNATIVE SELECTION 2-1
2.2 NO ACTION 2-2
2.3 NON-STRUCTURAL ALTERNATIVES 2-2
2.4 STRUCTURAL ALTERNATIVES 2-3
2.5 SUMMARY AND PLAN FORMULATION 2-12

3 RECOMMENDED NEW YORK AND NEW JERSEY HARBOR NAVIGATION CHANNEL IMPROVEMENT PLAN 3-1

3.1 DESCRIPTION OF THE PLAN 3-1
3.2 WATERSIDE ELEMENTS 3-2
3.3 LANDSIDE ELEMENTS 3-11

4 WITHOUT-PROJECT CONDITION 4-1

4.1 GENERAL 4-1
4.2 NON-FEDERAL PARTNERS' COMPREHENSIVE PORT IMPROVEMENT PLAN 4-1
4.3 WITHOUT-PROJECT CONDITION 4-1
4.4 IMPACTS OF THE WITHOUT-PROJECT CONDITION 4-4

5 AFFECTED ENVIRONMENT 5-1

5.1 STUDY AREA 5-1

5.2 NAVIGATION 5-16
5.3 PHYSICAL RESOURCES 5-18
5.4 ECOLOGICAL RESOURCES 5-39
5.5 AFFECTED ENVIRONMENT – LANDSIDE ELEMENTS 5-112
5.6 CULTURAL RESOURCES 5-114
5.7 SOCIOECONOMIC RESOURCES 5-121
5.8 RECREATION 5-125

6 ASSSESSMENT OF EFFECTS ATTRIBUTABLE TO THE RECOMMENDED PLAN 6-1

6.1 DIRECT IMPACTS 6-2
6.2 INDIRECT IMPACTS 6-10
6.3 CUMULATIVE IMPACTS 6-20
6.4 ESSENTIAL FISH HABITAT (EFH) 6-33
6.5 PROTECTED SPECIES 6-47
6.6 CULTURAL RESOURCES 6-52
6.7 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW) 6-56
6.8 ENVIRONMENTAL JUSTICE 6-56
6.9 IMPACTS ASSOCIATED WITH ROCK BLASTING 6-56

7 MITIGATION OF IMPACTS 7-1

7.1 ENVIRONMENTAL MITIGATION CONCEPTS 7-1
7.2 POTENTIAL MITIGATION MEASURES 7-2
7.3 PROJECTED IMPACTS 7-8
7.4 MITIGATION PLANNING 7-10
7.5 CULTURAL RESOURCES MITIGATION PLAN 7-16

8 REQUIREMENTS FOR PROJECT IMPLEMENTATION 8-1

8.1 PROJECT IMPLEMENTATION 8-1
8.2 MANAGEMENT OF DREDGED MATERIAL 8-1
8.3 BEST MANAGEMENT PRACTICES 8-1
8.4 CONSTRUCTION MONITORING AND MANAGEMENT PLAN 8-4

9 STATE PERMITS AND APPROVALS 9-1

9.1 NEW YORK PERMITTING PROGRAM 9-1
9.2 NEW JERSEY PERMITTING PROGRAM 9-3

LITERATURE CITED

BIBLIOGRAPHY

LIST OF PREPARERS

GLOSSARY OF ACRONYMS AND TERMS

CONVERSION TABLE

APPENDICES

A CORRESPONDENCE AND PROJECT COMMENTS

A-1.1 DEIS Comments and Responses
A-1.2 Public Information Meetings Comments and Responses
A-1.3 General Project Correspondence
A-1.4 DEIS Distribution List

B TECHNICAL APPENDICES

B-1.1 Hydrodynamic, Water Quality and Coastal Zone Erosion Modeling
B-1.2 Baseline Biological Monitoring Report
B-1.3 Cultural Resources
B-1.4 Coordination Act Report
B-1.5 Dredged Material Disposal Options
B-1.6 Section 404(b)(1) Guidelines Evaluation
B-1.7 Coastal Zone Management
B-1.8 Memorandum of Understanding
B-1.9 Traffic
B-1.10 Air Quality – Statement of Conformity
B-1.11 Noise
B-1.12 Areas Disturbed by Channel Construction

LIST OF FIGURES

Section 1

1.1-1 Study Area for the New York and New Jersey Harbor Navigation Study.
1.1-2 Project Area for the New York and New Jersey Harbor Navigation Study.

Section 3

3.2-1 Locations of Areas to be Blasted.
3.2-2 Typical Production (Type I) Blasting Plan.
3.2-3 Summary of Blasting Plan – Increase in Depth 47-52 Feet Kill Van Kull Serpentine Rock Area.
3.2-4 Summary of Blasting Plan – Increase in 47-52 Feet Diabase Rock Area, Kill Van Kull.
3.2-5 Summary of Blasting Plan – Increase in 47-52 Feet, Newark Bay and South Elizabeth Channel.
3.2-6 Summary of Blasting Plan – Increase in Depth 47-52 Feet, Port Jersey Channel.
3.2-7 Summary of Blasting Plan – Increase in Depth 47-52 Feet, Arthur Kill.
3.2-8 Summary of Blasting Plan – Increase in Depth 52-62 Feet, Kill Van Kull Serpentine Rock Area.
3.2-9 Summary of Blasting Plan – Increase in Depth 52-62 Feet – Kill Van Kull Diabase Rock Area.
3.2-10 Summary of Blasting Plan – Increase in Depth 52-62 – Arthur Kill.
3.2-11 Summary of Blasting Plan – Increase in Depth 47-62 feet – Kill Van Kull Serpentine Rock Area.
3.2-12 Summary of Blasting Plan – Increase in Depth 47-62 feet – Kill Van Kull Diabase Rock Area.
3.2-13 Summary of Blasting Plan – Increase in Depth 47-62 Feet – Arthur Kill.
3.2-14 Typical Precautionary (Type II) Blasting Plan.
3.2-15 Summary of Blasting Plan – No Blasting Zones.

Section 5

5.1-1 New York and New Jersey Harbor Portion of the Hudson-Raritan Estuary.
5.2-1 Location of New York & New Jersey Harbor Channels and Anchorages.
5.2-2 Vessel Traffic Management System – Remote Stations.
5.3-1 Sediment Characteristics Map of Newark Bay.
5.3-2 Sediment Characteristics Map of Upper New York Bay.
5.3-3 Quality Testing for New York Harbor Navigation Channels.
5.4-1 Aerial Photo Howland Hook Staten Island, NY.

5.4-2 Aerial Photo Port Newark/Elizabeth Essex and Union County, NJ.
5.4-3 Aerial Photo Port Jersey/MOTBY Hudson County, NJ.
5.4-4 Aerial Photo South Brooklyn Marine Terminal, South Brooklyn, NY.
5.4-5 Map of Summarized Squares of EFH Designation of Selected 10' x 10'. Latitude and Longitude squares for the Project Area.
5.4-6 Commercial Fisheries Current Pound New Locations.
5.5-1 Howland Hook Open Space/Recreational Facilities.
5.5-2 Port Newark/Elizabeth Community Facilities Map.
5.5-3 Port Jersey/MOTBY Study Area and Land Use Map.
5.5-3a Port Jersey/MOTBY Study Area and Land Use Map Legend.
5.5-4 Port Jersey/MOTBY Community Facilities.
5.5-5 South Brooklyn Community Facilities.
5.7-1 New York and New Jersey Harbor – Surrounding Area African American Population by Census Tract, 1990.
5.7-2 New York and New Jersey Harbor – Surrounding Area Hispanic Population by Census Tract, 1990.

Section 7

7.4-1 Incremental Cost per Additional Habitat Unit.

LIST OF TABLES

Section 1

1.2-1 Regulatory Compliance.
1.2-2a Newspapers and Journals Sent the Notice of Public Scoping Meetings New York and New Jersey Harbor Navigation Study.
1.2-2b Newspapers Sent the Notice of Public Information Meetings New York and New Jersey Harbor Navigation Study.
1.2-3 Dates and Focus of Environmental Work Group Meetings New York and New Jersey Harbor Navigation Study.

Section 2

2.4-1 Estimated Disturbed Areas by Channel and Depth.

Section 3

3.1-1 Recommended Channel Depths
3.2-1 Estimated Minimum Distances from Detonation Point to Various Peak Particle Velocities in Diabase.
3.2-2 Estimated Minimum Distances from Detonation Points to Various Peak Particle Velocities in Serpentinite and Sandstone/Shale.

Section 4

4.2-1 Federally Authorized and Maintained Channels and Anchorages in New York and New Jersey Harbor.
4.4-1 Proposed Traffic Improvement/Harbor Improvement Projects and Potential Adverse Impacts.

Section 5

5.1-1 Population and Age Distribution in the Study Area Counties.
5.1-2 Employment and Annual Wages in Bergen, Essex, Hudson, Middlesex, Monmouth and Union Counties, 1995.
5.1-3 Income for Counties in New York and New Jersey That Fall Within the Study Area.
5.2-1 Navigation Channels in the New York and New Jersey Harbor.
5.4-1 Special Water Areas As Defined Under the New Jersey Coastal Zone Management Program.
5.4-2 Summary of Federally Managed Species with EFH Designations in the Hudson-Raritan Estuary and Sandy Hook Bay.
5.4-3 Summarized Locations of EFH Within the Project Area. Life Stage and EFH Locations (10' x 10' latitude and longitude square).

5.4-4 Summary of General Habitat Parameters for those Species and Life Stages for which EFH has been Designated in the Project Area
5.4-5 Habitat Preferences of Macroinvertebrates Collected in New York and New Jersey Harbor Complex
5.4-6 New York and New Jersey Harbor Sediment Type Recorded at Sampling Station
5.4-7 Marine Mammals Reported from Offshore Areas That Could Occur in the New York and New Jersey Harbor
5.4-8 Bird Species Identified in the New York and New Jersey Harbor Area
5.4-9 Amphibians and Reptiles Found at Selected Locations in the New York and New Jersey Harbor Area
5.4-10 Terrestrial Mammals Likely to be Found in the New York and New Jersey Harbor Study Area
5.4-11 Endangered and Threatened Species Occurring Within the New York and New Jersey Harbor Study Area
5.7-1 Estimated Employment Characteristics of the Port Hinterlands Thousands of Jobs (% change since 1998)
5.7-2 New York and New Jersey Buffer Area Population Breakdown by Income and Race
5.7-3 Summary of Buffer Area Population and Racial Breakdown
5.8-1 Marinas in the New York and New Jersey Harbor
5.8-2 Park Areas Bordering the New York and New Jersey Harbor

Section 6

6.1-1 New York and New Jersey Harbor Navigation Study Recommended Plan Estimated Disturbed Areas by Channel and Depth

Section 7

7.2-1 Disturbed Areas by Depth
7.4-1 Results of the Incremental Cost Analysis

EXECUTIVE SUMMARY

ES.1 The U.S. Army Corps of Engineers (USACE) New York District (NYD) is conducting the New York and New Jersey Harbor Navigation Study. The purpose of the study is to identify, screen, and select navigation channel improvements. This Environmental Impact Statement (EIS) evaluates those alternatives and the Recommended Plan.

ES.2 Alternatives considered included no action, non-structural alternatives, and structural alternatives. Structural alternatives include deepening plans for anchorages and Federal navigation channels. Nonstructural and structural alternatives are described in Section 2. The no-action alternative is described in Section 4, Without-Project Conditions. Non-structural alternatives and the no-action plan do not improve navigation in the Port. Deepening channels to individual destinations, improves navigation for vessels calling at those destinations.

ES.3 The Recommended Plan provides for navigation improvements to nine channels, which will permit access by larger, deeper-draft vessels to four main container terminals. Improvements consist of channel deepening, channel realignment, turning basin construction, and berth deepening.

ES.4 No expansion of Port facilities is directly attributable to the recommended plan. Economic forecasts project an increase in Port commerce regardless of whether navigation channel improvements are implemented. These increases will be handled to the extent possible through operational changes and advances in technology with or without channel deepening. No Port facility expansions are attributable to channel modifications.

ES.5 Projections of the volume of commerce passing through the Port over the planning period (2010-2060) exceed the Port's capacity, with or without channel improvements. The non-Federal partners have expressed an interest in expanding the Port's facilities to accommodate the projected commerce in order to maximize market share. They are currently establishing a framework for the environmental assessment of these improvements (collectively known as the Comprehensive Port Improvement Plan (CPIP)).

ES.6 Impact assessments relied on available literature and data sources as well as Harborwide reconnaissance and sampling programs conducted to provide data on existing conditions.

Major Conclusions

ES.7 The primary adverse environmental consequence of the Recommended Plan is the loss of shallow water habitat. Navigation improvements will disturb existing habitat and change some shallow areas to deeper habitats. Section 2 identifies those habitats impacted by deepening and improving each channel as acres disturbed. The Recommended Plan, described in Section 6, will disturb 6.26 acres of littoral zone habitat. Of this total, 3.23 acres are in the Arthur Kill near Howland Hook; 2.72 acres are adjacent to the Newark Bay channel; 0.25 acres are south of the Elizabeth channel; and 0.06 acres are in Kill Van Kull. This habitat will not be permanently lost

as in a fill activity. A portion of the disturbed area will be permanently deeper and will no longer meet the definition of littoral zone habitat.

ES.8 Losses of sublittoral (6 to 15 ft) habitat include 12.35 acres in the Jersey Flats near Port Jersey; 1.41 acres in the Kill Van Kull; 3.22 acres in the Arthur Kill near Howland Hook; 7.79 acres in Newark Bay; 15.84 acres south of Port Elizabeth; and 1.42 acres south of the Elizabeth channel. The total area of disturbed sublittoral habitat is estimated to be 42.03 acres.

ES.9 Construction of the full, Recommended Plan or any alternative comprised of channel deepening will impact benthic fish and invertebrate species in the immediate construction area (i.e., footprint). Those animals unable to move out of the construction area may be lost. Repopulation of the area will occur rapidly; thus much of the loss is temporary. Permanent changes in species composition may occur in areas where habitat types are permanently altered.

ES.10 Hydrodynamic and water quality modeling indicate that the proposed future with-project deepening will produce minor changes in water surface elevations under low flow conditions (i.e., maximum difference in tidal range is less than 1.6 inches). The changes in salinity between with- and without-project conditions are small with a maximum average change of 0.7 ppt. The largest relative change occurred near Howland Hook and the maximum average salinity change in the remaining areas of the study area is 0.4 ppt or less. Overall, the average differences in dissolved oxygen between future and baseline conditions are very small. The maximum reduction in New York and New Jersey Harbor dissolved oxygen was 0.18 mg/L. Aquatic life is not expected to be adversely impacted by any predicted changes in Harbor water quality.

Mitigation

ES.11 Mitigation planning for the Recommended Plan, Section 7, considers both ecological and archeological impacts. The littoral areas disturbed by channel construction were evaluated during a field survey using a functional assessment technique developed for this project. The functional assessment determined the ecological value (in Habitat Units, or HUs) of the disturbed littoral zone areas. The ecological mitigation plan was formulated such that the HUs that will be lost as a result of channel construction will be replaced by mitigation, and that no less than a ratio of one acre of mitigation per one acre of littoral habitat disturbed is achieved. The final recommended mitigation plan for the ecological impacts consists of littoral zone restoration/creation and intertidal wetlands restoration.

Areas of Controversy

ES.12 Areas of concern have been articulated by various members of the public, environmental groups and government agencies at public scoping information meetings, advisory group meetings and work group meetings. These concerns have been addressed by developing best management practices (BMPs), mitigation planning and monitoring programs for the Recommended Plan.

ES.13 Representatives from natural resource agencies have expressed their desire for a comprehensive assessment of port planning issues and the preparation of a mitigation plan to address the associated impacts.

ES.14 A number of citizens expressed concern over dredged material placement options. NYD is in the process of finalizing the Dredged Material Management Plan (DMMP). As part of the DMMP study, dredged material placement alternatives were developed to manage dredged material generated by the Recommended Plan. The impacts associated with the placement options were evaluated in the DMMP-EIS.

Issues to be Resolved

ES.15 Non-federal Project Sponsors have advanced the concept of capturing additional commerce, which will require expansion of existing terminal areas. Their proposed facility expansions and the environmental impacts associated with each will be addressed in a Comprehensive Port Improvement Plan. Insufficient information on the likely components of this plan is available to assess its impacts at this time. A Memorandum of Understanding (MOU) between the Environmental Protection Agency (EPA), the New York District Army Corps of Engineers, and the non-Federal partners establishing procedures to address the land-side impacts associated with the non-Federal partners' Comprehensive Port Improvement Plan, or CPIP, is included in Appendix B-1.8. A separate EIS will be developed in connection with the CPIP.

1 PURPOSE AND NEED FOR THE ACTION

1.1 Introduction

Study Objectives

1.1 The U.S. Army Corps of Engineers, New York District (USACE-NYD), is the Federal agency responsible for conducting the New York and New Jersey Harbor Navigation Study. The purpose of the study is to identify and evaluate navigation channel modification alternatives and to prepare a National Economic Development (NED) Plan that would handle the projected growth in cargo deliveries to the region in an efficient, safe, and environmentally sound manner. Macroeconomic theory predicts growth in trade seeking passage through the port by 2060. This predicted increase in volume is independent of channel deepening. Since all or part of this expected growth will arrive by ship, the non-Federal partners expect to increase productivity and expand terminal yard area with or without channel deepening. Yet the world fleet of cargo ships is undergoing a change to larger, deeper-draft vessels, and the port lacks sufficient depth to serve fully loaded ships of the latest design. A long-term, environmentally acceptable means of accommodating this fleet of larger ships is needed. This Environmental Impact Statement (EIS) was prepared to evaluate the alternatives described in the Main Report for accommodating larger ships. A more detailed engineering and design phase may follow this feasibility phase. This more detailed engineering and design phase would be followed by construction of whichever project alternative may be selected.

1.2 The environmental analyses conducted as part of this study have focused on impacts associated with navigation improvements and on requirements for mitigation planning purposes. The study evaluated navigation channels and anchorages, as well as port facilities adjacent to such navigation channels and anchorages. Three types of environmental analyses have been carried out: (1) evaluation of impacts directly associated with navigation channel improvements; (2) evaluation of impacts of land-based facility improvements directly related to navigation channel improvements; and (3) analyses required for mitigation planning. The EIS also includes evaluation of possible indirect or secondary impacts, such as those associated with port facility improvements or incremental infrastructure modifications required by intermodal transportation networks, and evaluation of cumulative impacts. The overall study area for the EIS, which encompasses sections of the lower Hudson River, the upper and lower East River, Upper and Lower New York Bay, and Newark Bay, is illustrated in Figure 1.1-1. The project area, which includes the navigation channels, anchorages and berthing areas under evaluation for deepening, is illustrated in Figure 1.1-2.

1.3 The depths of the Harbor's navigation channels, anchorages, and berthing areas are presently insufficient to allow the safe and timely passage of containerships and liquid bulk vessels (tankers) that are loaded in an economically efficient manner and that are capable of calling on regional container terminals, bulk cargo facilities, or, in particular, on the oil refineries and terminals concentrated along the Arthur Kill. The next generation of containerships, now coming into service, will require even deeper channels. The current mode of operation calls for

tankers to lighter in anchorages or at sea, then to proceed at reduced operating draft to their terminal during high tides. The newer containerships must sail without a full load, or partially off-load at deeper-draft ports prior to calling on the Harbor. Higher unit costs are incurred when cargo vessels are forced to operate at less than capacity loading. These costs take the form of higher shipping costs per ton of cargo carried, additional vessels required to deliver the same amount of cargo, and increased channel traffic congestion, leading to uneconomic delays and increased potential for maritime accidents. Cost increases are also experienced in anchorages, where petroleum tankers must lighter before entering the channels. Crowded anchorages increase the potential for marine accidents and consequent environmental degradation.

Related Projects

1.4 Since the late 1800s, a number of studies have been undertaken to examine the channels and anchorages that make up the New York and New Jersey Harbor system. The first study, in 1884, resulted in authorization of a project to improve the port's entrance channels. Since then, channel deepening, extensions and additions have been studied and authorized on a regular basis. The Main Report includes a list of previous channel studies pertinent to the New York and New Jersey Harbor.

1.5 While previous studies have looked at the need to improve individual channels, the current study is unique in that it examines New York Harbor as a whole. This study focuses on navigation improvements to the pathways (consisting of both channels and anchorages) that ships take from the ocean to various port facilities located throughout the Harbor. Because the impacts of navigation improvements are evaluated on a harborwide basis, the project presents opportunities for environmental enhancement, beneficial use, and compensatory mitigation that have not been associated with individual channel projects constructed to date.

1.6 The most recently approved feasibility studies have been for the Kill Van Kull and Newark Bay Channels (House Document 99-129, 18 November 1985), Arthur Kill-Howland Hook Marine Terminal (October 1985), Claremont Terminal Channel (September 1986), and Port Jersey Channel (December 1987). All feasibility study reports recommended navigation improvements that have been authorized for construction. All channels except the Port Jersey and Claremont Channels are Federal navigation projects. Ongoing harbor navigation studies are described below.

USACE-NYD: Deepening of the Kill Van Kull/Newark Bay Channels, Arthur Kill Channel, and the Port Jersey Channel/Claremont Terminal Channels

1.7 USACE-NYD recently completed the Limited Reevaluation Report (LRR) and Final Environmental Assessment (EA) and Findings of No Significant Impact for the Kill Van Kull-Newark Bay Channels, Phase II Deepening Project (USACE-NYD 1997). The authorized Phase II deepening project calls for deepening of the Kill Van Kull and Newark Bay Channels from a depth of 40 ft MLW to a depth of 45 ft MLW (47 ft MLW in rock). The Harbor Navigation Study evaluation of deeper channel depths for the Kill Van Kull and Newark Bay assumes that the channels will be at a depth of 45 ft MLW.

1.8 The berthing area of the Howland Hook Marine Terminal, located on the northwestern shore of Staten Island on the Arthur Kill, was dredged to a depth of 40 ft MLW in 1995. The Arthur Kill Channel from the Kill Van Kull/Newark Bay junction to Raritan Bay (the southern entrance) is maintained at 35 ft MLW. The deepening and realignment of the Arthur Kill Channel from the Kill Van Kull to the Howland Hook Marine Terminal to a depth of 41 ft MLW and deepening the channel to a depth of 40 ft MLW from Howland Hook to Gulfport was approved in 1986. However, since the terminal operator at Howland Hook went into bankruptcy and the terminal was closed until 1996, the project was placed in a deferred status. With the announcement of the terminal's reopening, USACE-NYD completed an LRR and Final Supplemental Environmental Impact Statement (FSEIS) for the deepening of the Arthur Kill Channel-Howland Hook Marine Terminal in December 1997. The LRR reaffirmed the economic and environmental viability of the 1986 feasibility report and updated the project costs. In response to concerns raised in the FSEIS, USACE-NYD recently completed a final mitigation plan and is finalizing the Record of Decision so that a project cooperation agreement can be executed and construction initiated. The New York and New Jersey Harbor Navigation Study assumes that the Arthur Kill Channel from the Kill Van Kull to Howland Hook will be at a depth of 41 ft MLW prior to the construction of deeper channels.

1.9 The Port Jersey Channel extends from the Upper Bay's Anchorage Channel to the Global Marine Terminal and the Military Ocean Terminal in Bayonne (MOTBY), New Jersey. Most of the Port Jersey Channel is currently maintained at a depth of 35 ft MLW. A short section (to the Global facility), however, is maintained at a depth of 38 ft MLW and a width of 200 ft. The Harbor Navigation Study assumes that the Port Jersey Channel will be dredged to a depth of 41 ft MLW prior to construction of any alternatives related to the Harbor Navigation Study.

Study of the Arthur Kill South of the Gulfport Reach

1.10 Investigation of the Arthur Kill South of Gulfport was not originally included in the Harbor Navigation Study. As the study got underway, however, the State of New Jersey and oil terminal/refinery owners and operators expressed an interest in expanding the study to include this reach. It was nevertheless determined that expansion of the project scope at that point in the process would delay the Harbor Navigation Study's completion, and a decision was therefore made to carry out a separate study. The House of Representatives Committee on Transportation and Infrastructure passed a resolution on 6 May 1998 authorizing study of further deepening of the Arthur Kill south of the Gulfport Reach (Arthur Kill, Morses Creek to Perth Amboy, New Jersey Reconnaissance Study). USACE-NYD found in its reconnaissance study that there was no Federal interest in further studies and forwarded its finding to Head Quarters, US Army Corps of Engineers, for information only, in September 1999. The study is still being coordinated for this area in September 1999, found that there was no Federal interest in pursuing further studies.

Anchorages Study

1.11 A previous study, authorized by resolution of the Senate Committee on Environment and Public Works, and adopted 5 December 1980, was funded by the Federal Government to investigate the feasibility of providing more deep-water anchorage area in Upper and Lower New York Bay. Although USACE-NYD completed a reconnaissance study in 1999, the study did not proceed into the feasibility phase due to a lack of a non-Federal sponsor. The Port Authority of New York and New Jersey (PANYNJ) recently indicated its willingness to cost-share the feasibility study and requested that the USACE-NYD limit its evaluation to the Red Hook Anchorage area. USACE-NYD, currently negotiating the feasibility cost-sharing agreement, anticipates proceeding into the feasibility phase.

New York and New Jersey Harbor Dredged Material Management Plan (DMMP)

1.12 The New York and New Jersey Harbor DMMP was initiated pursuant to USACE policy (described in EC-1165-2-200), which requires each district to prepare a long-term (not less than 20-year) plan for maintaining Federal navigation channels. The study emphasizes the dual imperatives of economically dredging the naturally shallow port and implementing environmentally suitable and cost-effective alternatives to the historic practice of ocean placement at the Mud Dump Site. Placement of dredged material from navigation channel improvements proposed by the New York and New Jersey Harbor Navigation Study will be in accordance with the DMMP (see Appendix B-1.5).

Port Authority of New York and New Jersey: Port Strategic Investment Options Analysis

1.13 PANYNJ, a non-Federal partner of the New York and New Jersey Harbor Navigation Study, conducted a study to identify the range of investments needed to maintain or upgrade port facilities to service the needs of maritime commerce through 2040. PANYNJ found that fundamental changes are occurring in both the shipping industry and the world economy that could provide significant opportunities for the port. Trade forecasts indicating that the port's cargo volumes should grow by 3 to 5% per year mean that current volumes would at least double by 2015. The port's existing marine facilities and related transportation infrastructure (roadway and rail systems) would require improvement to handle these new cargo volumes. The Port Strategic Investment Options Analysis provides the analytical framework for making decisions regarding which port development opportunities would provide the greatest return to the region.

1.14 PANYNJ's analysis will address marine terminal development activities and landside access issues, including rail and highway capacity. Public access to the waterfront will be an important consideration in design alternatives.

Strategic Plan for the Redevelopment of the Port of New York

1.15 The New York City Economic Development Corporation (NYCEDC) is currently in the process of developing strategies for improving and developing port facilities at three locations: Red Hook and Sunset Park (South Brooklyn Marine Terminal) in Brooklyn, and Howland Hook on Staten Island. The purpose of the study is to outline a series of targeted investments to develop marine cargo terminals, public access to the waterfront, improved highway and rail access, improved navigation channels, and environmental-impact mitigation over the period 1999-2020. Each site is being conceptualized as a "stand-alone" development with no dependence on implementation at the other sites.

Cross-harbor Freight Movement Major Investment Study (MIS)

1.16 The New York City Economic Development Corporation (NYCEDC), along with the Federal Highway Administration (FHWA), is funding this MIS. The MIS is a more detailed study, based on recommendations of a 1997 Intermodal Goods Movement Study. The MIS is aimed at determining effective cross-harbor freight movement alternatives (e.g., increased cross-harbor barge service) with regard to engineering, environmental, economic, and financial factors. The final product will be the recommendation of a preferred alternative for implementation. The study is scheduled to be completed by April 2000.

Comprehensive Port Improvement Plan

1.17 As described in the Main Report and in Section 4 of this EIS, only a portion of the growth projected to seek entrance to the port can be accommodated by the configuration described in the with- and without-project condition. The non-Federal partners have indicated their desire to expand the port. A group consisting of PANYNJ, the New York City Department of City Planning, New Jersey State Maritime Resources, the New York State Empire State Development Corporation, and NYCEDC prepared a Memorandum of Understanding (MOU) with the United States Environmental Protection Agency (USEPA) and USACE-NYD that calls for the development and environmental assessment of a Comprehensive Port Improvement Plan (CPIP).The purpose of the CPIP will be to integrate the non Federal partners improvement plans into a single process to ensure that environmental impacts of the landside improvements are fully addressed. A copy of the MOU is provided in Appendix B-1.8. The version provided contains the signatures of the parties as of the printing of this report.

Historic Importance of the Ports

1.18 The documented history of the Port of New York extends back to the early seventeenth century. Trade, bolstered by a well-protected natural harbor, prompted the development of New York City. Maritime commerce began in the New York area in the early 1600s, and, by the close of the eighteenth century, New York was the country's leading seaport. After the War of 1812, the Port of New York became a center of the sailing packet industry, both as a packet-building site and as a harbor for sending and receiving goods on them (James and Duncan 1999).

From the 1820s to 1870, the port consolidated its position as the premier commercial destination in the country. Dramatic increases in population and industry, the development of an extensive canal and rail network, and the expansion of port facilities in Manhattan, Brooklyn, and along the Hudson River in New Jersey made New York the country's center of trade with Europe and the pivot for much of the nation's interstate commerce (Raber et al. 1996).

1.19 By the 1870s railroads began to shape the movement of goods through the port. Almost all rail lines terminated in New Jersey, requiring the development of an extensive lighterage system of small boats and barges to carry goods across the Hudson River to New York and between railroads, ships, and other modes of transportation within the harbor (James and Duncan 1999). By 1900 the waterfront was dominated by wharves, piers, ferry terminals, and water and land traffic. The immense volume of trade that fueled the economy of the cities and towns surrounding the waterfront made New York Harbor, with its extended facilities in Manhattan, Brooklyn, and New Jersey, one of the world's major ports (Betts 1997, Mysak and Schiffer 1997).

1.20 During the late nineteenth century, the New York City waterfront was placed under the jurisdiction of the New York City Department of Docks, but this agency was unable to control the port's shipping and development (Betts 1997). The lighterage system had led to the development of floating sidings and specialized terminals for coal, grain, bananas, and other perishable goods. By the twentieth century's second decade, the intense traffic on both water and land not only led to delay and damage of cargo but also took up a large amount of waterfront property (James and Duncan 1999). With the advent of World War I, New York Harbor became almost unmanageably congested. During the early twentieth century, the port handled 40% of the country's foreign trade and by 1920 it was handling nearly half of all foreign commerce entering the country (Mysak and Schiffer 1997, James and Duncan 1999).

1.21 In 1921 a compact between the states of New York and New Jersey (agreed to by Congress) created the Port of New York Authority, with a mandate to modernize and develop the entire port district within a 1,500-square-mile area (Mysak and Schiffer 1997). To address the problems of congestion for commuters, the Port Authority built four bridges between New York and New Jersey: the Outerbridge Crossing (1928), the Goethals Bridge (1928), the Bayonne Bridge (1931), and the George Washington Bridge (1931). It also took over control of the Holland Tunnel in 1931 and of Newark, LaGuardia, and Idlewild (now John F. Kennedy) airports in 1947 and 1948; it opened the Lincoln Tunnel in 1935 (Mysak and Schiffer 1997).

1.22 During World War II, the Port Authority saw to it that shipping, which included a third of the country's war tonnage and half its troops, moved smoothly through the port. After the war, improvements continued to be made within and around the harbor. PANYNJ developed specialized marine terminals at Port Newark, Red Hook, Howland Hook, and Elizabeth Port Authority Marine Terminal that became models worldwide. In 1956 Malcolm McLean introduced the world's first containership, the *Ideal X*. Six years later, PANYNJ opened the first all-containerized port in the world at Elizabeth (Mysak and Schiffer 1997). In the mid-1930s USACE began construction of a 35-ft-deep, 600- to 1,000-ft-wide channel in the Arthur Kill adjacent to Staten Island, which it completed about 1949 and which remains the current channel.



By 1957 tanker traffic through this channel carried over 60% of the tonnage moving through the port (Raber et al. 1996). The port is the largest container port on the East Coast and a critical component of the economy of the New York region (Mysak and Schiffer 1997).

Economic Benefits of the Project

1.23 Several economic benefits are associated with channel deepening and other related improvements to New York and New Jersey Harbor. These are discussed in the Main Report.

Containerized Cargo

1.24 As the volume of waterborne commerce has grown, it has become possible for shipping lines to realize the economies of scale offered by ships with larger carrying capacity. The composition of the world's fleet of containerships is undergoing rapid change. Based on known orders for containerships as of March 1997, 302 vessels of at least 4,000-TEU capacity, and with a design draft in excess of 40 ft, are presently in service. [A TEU is a Twenty-foot Equivalent Unit.] While these ships account for 34% of the world fleet capacity, they account for only 18% of the hulls. The world's containership fleet is therefore moving to a new composition, with a higher proportion of larger vessels. At their design drafts, the newer ships cannot reach most container-handling facilities in the port. In order for such ships to make use of existing port facilities, they must be light-loaded, time their arrival to coincide with or await favorable tides, call on a deeper port and transship all or part of their cargo on smaller ships of shallower draft (or by road or rail), or use some combination of these techniques. All available options require the operator to surrender some or all of the potential economies of scale relative to smaller ships. The same considerations apply to tankers and bulk cargo carriers. The problem, therefore, is that, in the near future, ships using the port must either be of relatively inefficient design or of efficient design operated in a non-cost-effective manner. Both constraints result in more frequent trips for small vessels, or alternative transportation via truck or rail, potentially resulting in greater environmental and navigation-related impacts and increased harbor congestion. Overall effect: reduced desirability of calling on the port.

Adapting to Changing Industry Needs

1.25 The container-shipping industry currently shows two significant trends. The first is that ships have been getting larger than the navigational capacity of most North American ports. This trend has been accelerating in recent years and is expected to continue well into the future. The second trend is that shipping lines, terminal operators, and shipping agencies are consolidating into intermodal alliances. The consolidation of the container-shipping industry, coupled with the increase in vessel sizes, places new demands on ports to adapt to industry needs. The economically efficient operation of the containership industry requires that ports make the necessary navigational improvements and reconfigure landside facilities to accommodate consolidated intermodal operations. One of the most important aspects of the new demands is the shipping lines' requirement for dedicated terminals.

1.26 The navigation improvements proposed in the NED plan accommodate both these industry trends. The first trend (larger ships) is addressed directly by channel deepening. The second trend (consolidation) is addressed by selectivity of pathways to be deepened. Consolidation has the environmental advantage of focusing commerce in areas that are already committed to shipping with an in-place transportation system capable of distributing cargo, rather than converting new areas throughout the region to port commerce.

1.2 Procedural History

Congressional Authorization

1.27 This study is authorized by Section 435 of the Water Resources Development Act (WRDA) of 1996. The Section reads:

> The Secretary shall conduct a comprehensive study of navigation needs at the Port of New York-New Jersey (including the South Brooklyn Marine and Red Hook Container Terminals, Staten Island, and adjacent areas) to address improvements, including deepening of existing channels to depths of 50 ft or greater, that are required to provide economically efficient and environmentally sound navigation to meet current and future requirements.

Relationship to Environmental Statutes and Regulation

1.28 The New York and New Jersey Harbor Navigation Study is a comprehensive evaluation of port navigation channels, berthing areas, and anchorages. The comprehensive nature of the project results in the need to address and comply with numerous Federal, state, and local environmental statutes. Table 1.2-1 lists the environmental statutes that have been evaluated for applicability to the evaluation of the project alternatives and to the proposed plan. The compliance status for each regulation is shown in Table 1.2-1. A brief discussion of the major Federal and state statutes is presented below.

Federal Laws and Regulations

National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4341 *et seq.*)

1.29 This Act requires that environmental consequences and project alternatives be considered before a decision is made to implement a Federal project. NEPA established requirements for preparation of an EIS for projects potentially having significant environmental impacts. This EIS has been prepared on the proposed project, as discussed in Council on Environmental Quality regulations on implementing NEPA (40 C.F.R. §1500-1508). The document presents sufficient information regarding the generic impacts of the proposed deepening and selective widening of navigation channels in New York Harbor to guide future studies. This document will be used in connection with later activities, and with subsequent environmental documents for site-specific projects included within the general framework of this project. All project

alternatives presented in the EIS were developed in accordance with the goals specified in Section 101 of the Act.

Coastal Zone Management Act of 1972, as amended, (16 U.S.C.1456 *et seq.*)

1.30 The Coastal Zone Management Act of 1972 (16 U.S.C. 1451-1464) was enacted by Congress to balance the demands for growth and development with the competing demands for protection of coastal resources. This Act requires that Federal activities affecting land or water resources located in the coastal zone be consistent to the maximum extent practicable with the Federally approved state coastal zone management plans. This Act is regulated in New York by the New York State Department of State's Division of Coastal Resources and in New Jersey by the New Jersey Department of Environmental Protection (NJDEP). The Coastal Zone Act Reauthorization Act Amendments of 1990 strengthened the Act by requiring the state programs to focus more on controlling land use activities and on the cumulative effect of activities in coastal zones. The New York and New Jersey Harbor Navigation Study Coastal Zone Management Policies for the states of New York and New Jersey are presented in Appendix B-1.7.

1.31 The City of New York has adopted its own Local Waterfront Revitalization Program (LWRP), which has been approved by the New York State Secretary of State and the Office of Ocean and Coastal Resources of the National Oceanic and Atmospheric Administration (NOAA). The New York City of Office of City Planning administers the New York City LWRP. Because the local program only advises on the New York State Coastal Management Plan, the New York State Department of State (NYSDOS) makes the final determination on Coastal Zone Consistency in New York State. The New York City Waterfront Revitalization Program policies related to the New York and New Jersey Harbor Navigation Study are presented in Appendix B-1.7.

Clean Air Act of 1977, as amended, (42 U.S.C. 7401 *et seq.*)

1.32 The objective of the Clean Air Act (CAA), administered by USEPA, is to protect and enhance the quality of the nation's air resources, and to promote public health and welfare and the productivity of its population. Under this Act, the USEPA administrator has established a set of Ambient Air Quality Standards, but the primary responsibility for the prevention and control of air pollution is left to the states. For areas where the Ambient Air Quality Standards are not met, the state must include measures in the State Implementation Plan (SIP) that will achieve the standards as expeditiously as possible.

1.33 Section 118 (a) of the CAA provides that all Federal agencies, including USACE, are subject to all Federal, state, and local requirements regarding the control and abatement of air pollution in the same manner and to the same extent as any non-governmental entity. This provision specifically applies to both substantive and procedural requirements. Section 176(c) of the Act provides that no Federal agency shall engage in any activity that does not conform to an approved SIP. A CAA Statement of Conformity, which indicates that the proposed project would not lead to adverse air emissions as compared to the no-action alternative and thus would

comply with Section 176(c)(1) of the CAA is presented in Appendix B-1.10. It should be noted that all necessary air quality permits will be obtained from the states of New York and New Jersey prior to construction. The CAA as related to the proposed project is addressed in Sections 4.3, 5.3 and 6.3 of this EIS.

Clean Water Act of 1977, as amended (33 U.S.C. 1251 *et seq.*)

1.34 The objective of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Specific sections of this Act control the discharge of pollutants and wastes into freshwater and marine environments.

1.35 The major section of the CWA that applies to dredging activities is Section 401, which requires certification that the permitted project complies with the state Water Quality Standards for actions within the waters of the state. Under Section 301, states must establish Water Quality Standards for all state waters, including the territorial sea. Dredging or disposal of dredged material may not cause the concentrations of chemicals in the water column to exceed state standards. To receive state water quality certification, a permit applicant must demonstrate that these standards will not be contravened.

1.36 Section 404 of the CWA (33 U.S.C. 1344) prohibits the discharge of dredged or fill material into navigable waters of the United States without a permit from USACE. Two commonly confused terms used to describe areas under USACE jurisdiction are "navigable waters of the United States" and "waters of the United States." "Navigable waters of the United States" are those waters that are subject to the ebb and flow of the tide shoreward to the mean high water mark and/or are presently used, or have been used in the past, or may be susceptible to use in the future to transport interstate or foreign commerce. Once a determination of navigability has been made, it remains in effect even if subsequent actions impede or destroy the former navigable capacity. Thus, the waters in the project area are navigable waters in the traditional sense where permits are required for certain activities pursuant to Section 10 (33 U.S.C. 403) of the Rivers and Harbors Act. Section 10 prohibits the obstruction of, or alteration of, or work in, navigable waters of the United States without a permit from USACE. "Waters of the United States" is a broader term that includes adjacent wetlands and tributaries to navigable waters of the United States and other waters where their destruction or degradation could affect foreign or interstate commerce. "Waters of the United States" applies to both tidally influenced and nontidal wetlands.

1.37 Section 404 (b) of the CWA, as amended in 1977, requires that USACE evaluate the impact of the discharge of dredged or fill material into waters of the United States in order to make specified determinations and findings. Subpart A, Section 230.1(c) of the Section 404(b)(1) Guidelines states the following: "Fundamental to the guidelines is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it is demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." Although Sections 401 and 404 (b) of the CWA apply, by their own terms, only to applications for Federal permits, USACE has made a policy decision to apply

them to their own projects. This policy is set forth in USACE regulations (33 C.F.R. §336). Section 336.1 (a) of that regulation states "Although the Corps does not process and issue permits for its own activities, the Corps authorizes its own discharges of dredge or fill material by applying all applicable substantive legal requirements, including public notice, opportunity for public hearing, and application of the Section 404 (b) (1) guidelines". The Section 404(b)(1) evaluation for the New York and New Jersey Harbor Navigation Study is presented in Appendix B-1.6.

Archaeological and Historic Preservation Act of 1974, (16 U.S.C. 469 *et seq.*)

1.38 The Archaeological and Historic Preservation Act (AHPA) amended the Reservoir Salvage Act of 1960. The AHPA provides for the preservation of historic and archaeological data that might otherwise be lost or destroyed as a result of any Federal construction project or Federally licensed or assisted undertaking. The AHPA authorizes the lead Federal agency of a project, or the Secretary of the Interior, to undertake recovery or preservation of such data. Federal project funds up to one percent of the project cost may be used, or the agency may request the Secretary of the Interior to implement the desired measures. Historic and Archaeological resources are discussed in Section 5.6 (Cultural Resources) of this EIS.

Executive Order 11593, Protection and Enhancement of the Cultural Environment, (36 C.F.R. §8921, May 13, 1971)

1.39 Executive Order 11593 requires Federal agencies to (1) inventory the cultural resources on lands under their jurisdiction, (2) outline measures to actively protect and preserve these cultural resources, (3) nominate to the National Register of Historic Places those inventoried cultural resources considered significant, and (4) initiate measures to ensure that their policies contribute to the protection and preservation of non-Federally owned cultural resources.

National Historic Preservation Act of 1966, as Amended, (16 U.S.C. 470 *et seq.*)

1.40 The National Historic Preservation Act (NHPA) established the National Register of Historic Places, which is a listing of sites, districts, structures, and objects significant in American history, including architecture, archaeology, engineering, and culture. Archaeological sites, historic buildings, and other cultural resources may be determined eligible for inclusion in the National Register on the basis of local, regional, state, or national significance. Section 106 of the NHPA requires Federal agencies to "take into account" the effects of a proposed project on such sites and structures which are listed, or which have been determined eligible for listing, on the National Register. The taking into account of effects involves (1) consultation between USACE and the State Historic Preservation Officer to determine whether identified sites or structures in the Area of Potential Effect (APE) are of National Register quality and to analyze possible project-induced impacts, and (2) affording the Advisory Council on Historic Preservation an opportunity to comment on the consultation findings. USACE must satisfy the Section 106 provisions prior to the expenditure of Federal funds for construction of a proposed project. As mentioned above, Historic and Archaeological Resources are discussed in Section 5.6 (Cultural Resources) of this EIS.

Fish and Wildlife Coordination Act of 1958 (16 U.S.C. *et seq.*)

1.41 The Fish and Wildlife Coordination Act requires that whenever any body of water is proposed or authorized to be impounded, controlled (i.e., diverted), or modified (i.e., deepened), the lead Federal agency must consult with the U.S. Fish and Wildlife Service (USFWS) and with the state agency exercising administrative authority over wildlife resources. In New York, the state agency would be the New York State Department of Environmental Conservation (NYSDEC) and in New Jersey the state agency would be NJDEP. For projects affecting marine fisheries, the National Marine Fisheries Service (NMFS) should be consulted. Section 662(b) of the Act requires the lead Federal agency to consider the recommendations of USFWS and other agencies. The recommendation may address wildlife conservation and development, any damage to wildlife attributable to the project, and any measures proposed for mitigating or compensating for these damages. The USFWS Fish and Wildlife Coordination Act Section 2(b) Report is included in Appendix B-1.4. Correspondence with NMFS, NYSDEC, and NJDEP is presented in Appendix A.

Endangered Species Act of 1973. as amended, (16 U.S.C. 1531 *et seq.*)

1.42 The Endangered Species Act protects threatened and endangered species by prohibiting Federal actions that would jeopardize the continued existence of such species or that would result in the destruction or adverse modification of any critical habitat of such species. Section 7 (a) of the Act requires consultation with the Secretary of the Interior (through USFWS and/or NMFS), prior to project implementation, to determine whether any endangered or threatened species may be present in the area of a proposed USACE action, and to ensure that the action will not jeopardize the continued existence of a species or destroy or adversely modify the designated critical habitat of such species. During the project planning process, USFWS and NMFS evaluated the potential impacts of all aspects of the project on threatened or endangered species. Correspondence with USFWS and NMFS relative to threatened and endangered species in the New York and New Jersey Harbor is presented in Appendix A.

Executive Order 11990, Protection of Wetlands (42 Fed. Reg. 26961, 25 May 1977)

1.43 Under Executive Order 11990, Federal agencies are directed to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial qualities of these lands. Federal agencies are also required to avoid undertaking or providing support for new construction located in wetlands unless (1) no practicable alternative exists, and (2) all practical measures have been taken to minimize harm to wetlands.

Estuary Protection Act, (16 U.S.C. 1221 *et seq.*)

1.44 This Act requires all Federal agencies to give consideration to estuaries and their natural resources, and to their importance for commercial and industrial developments, in planning for the use or development of water and land resources. The Act also requires all project reports

affecting estuaries that are submitted to Congress to contain a discussion and recommendations by the Secretary of the Interior regarding the project effects on estuaries and their resources. Compliance with this Act will be achieved through coordination with the Department of the Interior under the Fish and Wildlife Coordination Act and NEPA, primarily through review and comment on the DEIS and FEIS.

State Laws and Regulations

New York

Tidal Wetlands Act

1.45 This Act (Article 25 ECL) is designed to "preserve and protect" tidal wetlands, which are defined as coastal fresh marshes, intertidal marshes, coastal shoals, bars and flats and littoral zone, high marshes and salt meadows, and formerly connected tidal wetlands (those in which normal tide flow is restricted by manmade causes.) The Act allows NYSDEC to regulate activities within tidal wetlands and adjacent upland areas up to 300 ft (150 ft in New York City) in width adjoining such wetlands.

1.46 The principal wetland categories in the study area located in New York State are defined and mapped by NYSDEC as "IM" (Intertidal Marsh), "HM" (High Marsh), "SM" (Coastal Shoals, Bars, and Mudflats), "FC" (Formerly Connected Tidal Wetlands), and "LZ" (Littoral Zone). The wetland categories are defined by vegetation type in Section 661.4 (Tidal Wetlands - Land Use Regulations) of the Codes, Rules, and Regulations of New York (NYCRR). Formerly Connected tidal wetlands are areas in which the normal tidal flow is restricted by manmade causes. The loss of tidal flushing typically results in detrital accumulation, a decrease in salinity, and a plant community dominated by common reed. Littoral wetlands in New York are mapped by NYSDEC. By definition, the littoral zone is restricted to those subtidal waters less than or equal to 6 ft MLW. The most recent ocean survey maps, prepared by NOAA, "shall be rebuttable presumptive evidence of such six-foot depth." The principal wetland categories mapped by National Wetlands Inventory (NWI) in the study area are Estuarine, Intertidal, Vegetated Wetland (E2EM); Estuarine, Intertidal Flat (E2FL); and Estuarine, Subtidal, Open Water, Unknown Substrate (E1OW).

1.47 NYSDEC also regulates the upland buffer zone, or adjacent area, upgradient of intertidal wetlands. Buffer zone definitions and regulations are described in Section 661.4 of NYCRR. Intertidal wetland adjacent areas extend 300 ft upland of the wetland boundary outside the City of New York and 150 ft upland of the wetland boundary within the City of New York. Any work adjacent to the waterfront or wetlands is subject to review and permit by the respective state agencies (NYSDEC and NJDEP) and USACE. Agencies typically involved in the approval process for work within or adjacent to intertidal wetlands include the U.S. Coast Guard, USFWS, USEPA, and NMFS.

Water Quality Certification

1.48 As a condition of all activities regulated under authority of Section 404 of the CWA, Section 401 (Federal Water Pollution Control Act; 33 U.S.C. 1341) of the Act requires authorized states to certify that a Federal permit meets state water quality standards. Any applicant for a Federal license or permit to conduct any activity including but not limited to construction or operation of facilities that may result in any discharge into navigable waters as defined in Section 502 of the Federal Water Pollution Control Act (33 U.S.C. 1362) must apply for and obtain a Water Quality Certificate from NYSDEC. NYSDEC typically administers §401 Water Quality Certification as a component of the Protection of Waters program.

Waterfront Revitalization of Coastal Areas and Inland Waterways Act

1.49 Under this Act (Executive Law Sections 910-921), the New York State Department of State (NYSDOS) administers the coastal program that contains legislatively enacted coastal area policies to which state agencies must conform. The Act also authorizes the state to encourage local governments to adopt waterfront revitalization programs that are consistent with the state's coastal area policies. These policies in general require a balance between economic development and preservation that prevents the loss of natural resources as well as encourages the use of existing infrastructure and public services. The City of New York has adopted its own Local Waterfront Revitalization Program (LWRP), approved by the New York State Secretary of State and the Office of Ocean and Coastal Resources of NOAA. The New York City Office of City Planning administers the New York City LWRP. New York City LWRP policies are addressed in Appendix B-1.7.

Protection of Waters Program

1.50 This program (Article 15, Title 5 ECL) regulates activities occurring in or near designated protected waters. The program regulates three categories of activities: disturbance of the bed or banks of a protected stream or other watercourse, including adjacent wetlands; construction and maintenance of dams; and excavation and/or filling in navigable waters. The intent of the Protection of Waters program is to prevent undesirable activities on water bodies by establishing and enforcing regulations that are compatible with the preservation, protection, and enhancement of the present and potential values of the water resources, that protect the public health and welfare, and that are consistent with the reasonable economic and social development of the state. The New York and New Jersey Harbor Navigation Study EIS addresses the requirements of the New York State Protection of Waters Program.

State Environmental Quality Review Act (SEQRA)

1.51 The provisions of the Uniform Procedures Act require that applications for NYSDEC permits cannot be considered complete unless certain requirements of SEQRA (6 NYCRR Part 617) have been satisfied. This initially involves the filing by the applicant of a completed environmental assessment form (EAF). More complex projects or those having a potentially

significant impact may require a more lengthy and detailed EIS. The New York and New Jersey Harbor Navigation Study EIS addresses the SEQRA requirements.

New Jersey

1.52 The New Jersey Land Use Regulation Program is responsible for the oversight and management of the state's tidal waters. The Land Use Regulation Program exercises its authority and responsibility through implementation of different state laws. The specific laws are: The Waterfront and Harbor Facilities Act of 1914 ("Waterfront Development Law"), the Coastal Wetlands Act of 1970, the Coastal Area Facility Review Act, the Freshwater Wetlands Protection Act, Shore Protection laws, Tidelands Statutes, the Ninety-Day Construction Permit Law, and the Harbor Clean-Up Bond Issues of 1977 and 1980. These laws will be examined below under the headings of wetlands and coastal zone management.

Wetlands

1.53 USEPA has delegated the delineation/permitting associated with freshwater wetlands to NJDEP. Dual jurisdiction is exercised by NJDEP and USACE, the former under the Freshwater Wetlands Protection Act (N.J.S.A. 13.9.13) and the latter under Section 404. Projects involving tidally influenced waters or wetlands within 1,000 ft of tidal waters require both USACE and NJDEP permits. Thus any wetlands-associated permitting for the navigation study will be through both agencies. USACE uses the 1987 *Wetlands Delineation Manual* (Technical Manual Y-87-1) for the identification and delineation of wetlands. NJDEP uses the 1989 *Federal Interagency Manual for Identifying and Delineating Jurisdictional Wetlands*, as mandated by the New Jersey Freshwater Wetlands Protection Act. Three parameters (soil, vegetation, and hydrology) are used to delineate the wetland/upland interface. In general, the intertidal wetland boundaries in the project area are fairly distinct, represented by the spring storm high-tide line, by an abrupt change in plant species or dominance, or by a manmade boundary such as a railroad grade or highway embankment. In some areas, old unmaintained riprap structures or breakwaters have been breached, and pockets of tidal wetlands have formed on the landward side of the structures.

Coastal Zone Management

1.54 New Jersey's coastal zone management program derives its authority from three state statutes: The Waterfront and Harbor Facilities Act of 1914 (N.J.S.A. 12:5-3), the Wetlands Act of 1970 (N.J.S.A. 13:9A), and the Coastal Area Facility Review Act (N.J.S.A. 13:19). The Waterfront and Harbor Facilities Act, also known as the Waterfront Development Law, provides regulatory authority over any in-water activity located below the mean high water line (MHWL). Consequently, all dredging in tidal waters of New Jersey is regulated pursuant to this statute. In addition, in the area not regulated pursuant to the Coastal Area Facility Review Act (CAFRA), the Waterfront and Harbor Facilities Act also regulates an upland area extending at least 100 ft but not more than 500 ft inshore of the MHWL along any tidal water body. The New Jersey Coastal Zone Consistency policies are presented in Appendix B-1.7.

1.55 The Wetlands Act of 1970 regulates development in the state's tidal wetlands. The Act requires that a regulatory upper wetland boundary be drawn and adopted on promulgated maps. Nearly any activity, with the exception of certain mosquito control actions, is regulated in tidal wetlands.

1.56 CAFRA regulates upland development in the "coastal area" as defined in the statute. The geographic jurisdiction under CAFRA extends from the Raritan Bay shore in Middlesex County south along the Atlantic seaboard to Cape May and then northward along the Delaware Bay shore to Salem County. Regulated thresholds under CAFRA vary with distance from tidal waters. The first use inshore of the MHWL is regulated regardless of size, but as distance from the MHWL increases so does the size of the development necessary to trigger jurisdiction.

1.57 The regulations derived from these three statutes are packaged into two comprehensive sets of rules: the administrative rules known as the Coastal Permit Program Rules (N.J.A.C. 7:7) and the enforceable policies known as the Rules on Coastal Zone Management (N.J.A.C. 7:7E). This latter set of rules sets forth permitting requirements, dealing comprehensively with special areas, such as shellfish beds, submerged aquatic vegetation, wetlands, beaches, and dunes, as well as with development impacts such as dredging, filling, intensity of development, and traffic. In addition to these rules, New Jersey has developed a dredging technical manual entitled, *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters*. The manual is designed to provide additional guidance regarding sediment sampling and testing and acceptable uses of dredged material.

1.58 The technical manual requires that NJDEP issue an Acceptable Use Determination (AUD) for all dredging projects. An AUD is the agency's certification that dredged material from a given dredging project is acceptable for a particular beneficial use or disposal option, given its physical and chemical characteristics. An AUD is similar to a Beneficial Use Determination used to regulate the recycling of solid wastes in the state. However, New Jersey does not consider dredged material to be a solid waste. Dredged material is soil, which has been eroded from uplands throughout the watershed feeding the estuary. For this reason, dredged material is seen as a resource which can and should be put to various beneficial uses wherever and whenever possible. Clearly, because of the variability of grain size of the material and its potential to adsorb contaminants from the water body, the use of dredged material presents several challenges. The AUD process is intended to ensure that dredged material is suitable for its intended purpose, that the proposed use of the material will be protective of the environment and human health, and that Best Management Practices (BMPs) are employed.

1.59 In addition to the direct authority over dredging projects provided by state statutes, two Federal statutes also provide for state regulatory oversight: the Federal Coastal Zone Management Act (16 USC 1451 et seq.) and the Federal Water Pollution Control Act (33 USC 1251 et seq.). Section 307 of the Coastal Zone Management Act requires that Federal actions be consistent with the states' approved coastal zone management programs. Federal actions include direct actions, such as Federal navigation channel improvements and Federal financial assistance and permit decisions. Similarly, Section 401 of the Water Pollution Control Act requires that the states issue a certification that water quality standards will not be contravened by a proposed

activity requiring a Federal permit under Section 404 of that Act. [Section 404 requires that a Federal permit be secured prior to any discharge of dredged or fill material into waters of the United States.] Essentially, both a Federal consistency determination and a water quality certificate are required from the State of New Jersey before Federal permits for dredging and dredged material disposal can be issued. In New Jersey, these approvals and an AUD are consolidated into the Waterfront Development Permit issued pursuant to the Waterfront and Harbor Facilities Act of 1914. New Jersey Coastal Zone Consistency policies are presented in Appendix B-1.7.

Office of Dredging and Sediment Technology

1.60 Dredging in the State of New Jersey directly affects the viability and sustainability of New Jersey's ports and waterways. Port and recreational uses of the state's tidal waters add significantly to the state economy. The challenge facing New Jersey is to manage dredging and dredged material in a manner protective of both the environment and human health, while promoting economic prosperity. The complex issues surrounding dredging projects and dredged material management historically have required the involvement of several offices within NJDEP. The Office of Dredging and Sediment Technology was formed in May 1998 pursuant to Administrative Order 1998-06. The Office was created to focus on and coordinate the increasingly varied concerns surrounding dredging in New Jersey's tidal waters. The Office's primary mission is to administer the regulatory processes for permitting dredging projects in the state's tidal waters and to assist in the development of innovative solutions for dredged material management. The Office is responsible for coordinating other departmental programs and divisions, such as the Site Remediation Program, Division of Fish, Game and Wildlife, and Marine Water Monitoring Element, to ensure a comprehensive and efficient review of dredging applications. In addition, the Office has regulatory authority over various other port and maritime commerce development projects. The creation of a single-purpose office has streamlined the regulatory process for dredging projects.

Public Involvement and Interagency Coordination

Public Involvement

1.61 In accordance with procedures established under NEPA, USACE determined that an EIS was necessary for this Federal project. The decision was based on (1) the determination that significant impacts would likely result from the proposed action, and (2) on public concerns over the disposal of dredged material resulting from navigation-channel deepening.

1.62 USACE published the Notice of Intent (pursuant to 40 C.F.R. §1508.22) for the New York and New Jersey Harbor Navigation Study in the Federal Register on 24 March 1998. In accordance with NEPA, and 40 C.F.R. §1501.7 (Scoping), USACE-NYD held public scoping meetings to determine the scope of issues to be addressed in the EIS and to identify significant issues related to the proposed action. The public scoping process started in May 1998, when notice of the public scoping meetings was sent to the newspapers and journals listed in Table 1.2-2a. The news release introduced the New York and New Jersey Harbor Navigation Study

and identified the time, date, and location of public scoping meetings. The dates and locations were as follows:

Date and Location of Public Scoping Meetings New York and New Jersey Harbor Navigation Study	
5 May 1998 Staten Island Hotel, Staten Island, NY	7 May 1998 Brooklyn Borough Hall, Brooklyn, NY
11 May 1998 Holiday Inn, Elizabeth, NJ	13 May 1998 Borough of Manhattan Community College (BMCC), New York, NY
14 May 1998 Military Ocean Terminal, Bayonne, NJ	27 May 1998 Seamen's Church Institute, Port Newark, NJ
4 June 1998 Staten Island Hotel, Staten Island, NY	

1.63 In addition, affected Federal, state, and local agencies and political officials, as well as environmental groups, were notified in writing of the meetings. All persons attending the meetings were given the preliminary scoping document and handouts identifying the study area. Participants were urged to submit written comments either at the meetings or via mail.

1.64 The public scoping meetings were split into two two-hour sessions, the first session running from 3:00 to 5:00 p.m. and the second from 6:00 to 8:00 p.m. During each session, the public was invited to speak to USACE and non-Federal sponsor representatives. In addition, information on the proposed study was distributed in posterboard format, throughout the meeting room. Midway through each session, USACE representatives presented a summary of the proposed study . Following the presentation, the public was given the opportunity to make oral comments, which were videotaped. Written and videotaped comments from all seven meetings were included in the appendices to the DEIS.

1.65 People attending the public scoping meetings who provided their addresses were included on the Navigation Study mailing list, and were sent copies of newsletters. The newsletters addressed studies and issues that related to the New York and New Jersey Harbor Navigation Study.

1.66 The draft New York and New Jersey Harbor Navigation Study EIS (DEIS) was submitted for public review and comment on 1 October 1999. For the purpose of presenting the information in the DEIS and to receive written and oral comments, three public information meetings were held following the release of the DEIS. Notice of the Public Information Meetings was sent to the newspapers and journals listed in Table 1.2-2b. The news release described the Recommended Plan and identified the time, date, and location of the Public Information Meetings. The dates and locations of the Public Information Meetings are presented in the table below:

Date and Location of DEIS Public Information Meetings New York and New Jersey Harbor Navigation Study	
3 November 1999 Holiday Inn/North, Newark, New Jersey	8 November 1999 Brooklyn Borough Hall, Brooklyn, New York
4 November 1999 The Staten Island Hotel, Staten Island, New York	

1.67 In addition, Federal, state, and local agencies and political officials, as well as environmental groups, were notified in writing of the meetings. All persons attending the meetings were given handouts related to the DEIS. Participants were urged to submit written comments either at the meetings or via mail.

1.68 The public information meetings were split into two two-hour sessions, the first session running from 3:00 to 5:00 p.m. and the second from 7:00 to 9:00 p.m. During each session, the public was invited to speak to USACE and non-Federal sponsor representatives. In addition, information on the proposed study was distributed in posterboard format throughout the meeting room. At the beginning of each session, a summary of the Navigation Study was presented by a USACE representative. Following the presentation, the public was given the opportunity to make oral comments, which were recorded by a stenographer. Written and recorded comments from the three public information meetings are included in Appendix A.

Interagency Coordination

1.69 USACE and the non-Federal sponsors took the initiative in early 1998 to organize an Environmental Work Group (EWG) to address potential environmental issues arising from the New York and New Jersey Harbor Navigation Study. Scheduled EWG meetings and meeting focus are presented in Table 1.2-3. The meetings assisted the project team in clarifying technical issues, in designing appropriate data collection studies, and in identifying pre-permitting activities. The EWG meetings have played an important role in the development of the Navigation Study.

1.70 Various Federal agencies, namely, the U.S. Department of Transportation (USDOT), NOAA/NMFS, and USEPA, served as cooperating agencies

1.71 Coordination between USFWS, NMFS, and USACE is required for the identification of potential environmental impacts to both fish and wildlife. USACE initiated Fish and Wildlife Coordination Act Report (FWCAR) and Endangered Species Act (ESA) consultation with USFWS by letter dated 9 March 1998. In this letter, USACE requested a Planning Aid Report (PAR) while the project was still in the early phases of plan formulation, in order to identify any biological or environmental concerns. USFWS provided this report in August 1998. ESA Section 7 consultation was also conducted between USACE and NMFS. Additionally, consultation under the provisions of Essential Fish Habitat (EFH) within the Magnuson-Stevens

Fisheries Management and Conservation Act has been initiated. The lead Federal agency is required, under EFH, to identify important spawning, nursery, migration, feeding, and other seasonal concentration areas used by fishery resources, marine wildlife, and their forage. In addition to letters and oral communication, a meeting was conducted between NMFS and USACE on 26 January 1999 at the NMFS office in Sandy Hook, New Jersey.

1.3 Connected, Cumulative, and Similar Actions

1.72 Cumulative impacts result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) undertakes these other actions (40 C.F.R. §1508.7). For the New York and New Jersey Harbor Navigation Study, cumulative impacts are evaluated in a comprehensive framework that includes impacts attributable to the proposed action (i.e., with-project), impacts likely to occur as a result of previously authorized projects that have not yet been constructed, and reasonably foreseeable future actions taken by other agencies as a result of Harbor deepening projects and expected increases in commerce that can be accommodated by the with-project condition.

1.73 The proposed action is described in Section 4; its impacts are detailed in Section 6. Previously authorized projects, including deepening of selected channels, and concurrent projects, such as the DMMP, were identified above (Section 1.1). These actions have been the subject of separate environmental assessments and statements. Impacts associated with the without-project or no-action alternative, including those attributable to accommodating projected increases in cargo, are detailed in Section 4. The combined effects of these actions are described in Section 6.

1.74 Although it is reasonable to expect that the non-Federal partners will act to accommodate more cargo through the port than can be accommodated if the proposed action is taken alone, their plans are not sufficiently developed to be assessed at this time. It is in recognition of this situation that the MOU for the CPIP has been developed, thus ensuring that any likely future actions that are insufficiently developed for assessment today will be the subject of thorough environmental assessment.

INDEX

B

Best Management Practices (BMPs) 16
BMPs 16

C

Comprehensive Port Improvement Plan (CPIP), defined 5
Containerships 7
CPIP 5, 20

D

DMMP 4

E

Economic benefits of project 7
Essential Fish Habitat (EFH) 19
estuaries 12

H

Historic importance of the ports 5

I

Interagency coordination of Navigation Study 19

P

Public involvement in Navigation Study 17
Purpose of study 1

R

Related projects 2
- Anchorages Study 4
- Arthur Kill south of Gulfport 3
- channel-deepening 2
- Comprehensive Port Improvement Plan 5
- Dredged Material Management Plan (DMMP) 4
- Freight Movement Major Investment Study (MIS) 5
- Port Strategic Investment Options Analysis, PANYNJ 4
- Strategic Plan for Redevelopment of Port 5

S

Statutes and regulations, applicable Federal and state 8–17
- Federal 8–13
- state 13–17
  - New Jersey 15–17
  - New York 13–15

T

TEU 7
TEU, defined 7

W

Wetlands 10, 12, 13, 14, 15, 16
Wetlands, tidal, Federal and New York categories explained 13–14

Table 1.2-1 (Page 1 of 2) Regulatory Compliance		
Federal Environmental Laws and Executive Orders	**Status**	**Notes**
Abandoned Shipwreck Act of 1987	Compliance[1]	See Section 5.6 and MOA Appendix B-1.3
Anadromous Fish Conservation Act	Compliance[1]	
Archaeological and Historic Preservation Act of 1974, as amended	Compliance[1]	See Section 5.6 and MOA Appendix B-1.3
Clean Air Act, as amended	Compliance[1]	Conformity statement Appendix B-1.10
Coastal Barrier Resources Act	Not Applicable[4]	
Coastal Zone Management Act of 1972, as amended	Compliance[1]	See Appendix B-1.7
Comprehensive Environmental Response, Compensation and Liability Act of 1980	Compliance[1]	
Endangered Species Act of 1973, as amended	Compliance[1]	See Appendix B-1.4
Estuary Protection Act (PL90-454)	Compliance[1]	See Section 5.4
Federal Migratory Bird Treaty Act	Compliance[1]	
Federal Water Pollution Control Act (Clean Water Act, 1977)	Compliance[1]	See Section 5.4
Federal Water Project Recreation Act, as amended	Not Applicable[4]	
Fish and Wildlife Coordination Act of 1934, as amended	Compliance[1]	See Appendix B-1.4
Land and Water Conservation Fund Act of 1965, as amended	Compliance[1]	
Marine Mammals Protection Act of 1972	Compliance[1]	
Marine Protection, Research, and Sanctuaries Act of 1972, as amended	Compliance[1]	
Magnuson-Stevens Fishery Conservation and Management Act of 1996	Compliance[1]	See Sections 5.4 and 6.4
National Environmental Policy Act of 1969, as amended	Compliance[1]	This document
National Historic Preservation Act of 1966, as amended	Compliance[1]	See Section 5.6 and MOA Appendix B-1.3
Outer Continental Shelf Lands Act	Not Applicable[4]	
Resource Conservation and Recovery Act	Compliance[1]	
Rivers and Harbors Appropriation Act of 1899, as amended: Section 10	Compliance[1]	
Rivers and Harbors Act of 1970, Section 122	Compliance[1]	
Watershed Protection and Flood Protection Act, as amended	Compliance[1]	
Wild and Scenic Rivers Act	Compliance[1]	Not Applicable
Executive Order 11988, Floodplain Management	Compliance[1]	
Executive Order 11990, Protection of Wetlands	Compliance[1]	
Executive Order 12114, Environmental Effects of Major Federal Actions	Compliance[1]	This document
Executive Order 12898, Environmental Justice	Compliance[1]	See section 6.8

Table 1.2-1 (Page 2 of 2) Regulatory Compliance		
State Laws of New York	**Status**	**Notes**
Agricultural District Law (1971)	Not Applicable[4]	
Coastal Zone Management Act	Compliance[1]	See Sections 5.4, 9.1 and Appendix B-1.7
Environmental Conservation Law, as amended	Compliance[1]	
Environmental Quality Review Law (1976)	Compliance[1]	This document
Fish and Wildlife Code (Title Three)	Compliance[1]	
Floodplain Protection Law (1974)	Compliance[1]	
Freshwater Wetland Protection Act (Article 24) (1975)	Compliance[1]	
Local Zone Enable	Not Applicable[4]	
New York State Environmental Laws (Local Admin)	Compliance[1]	
Open Space (ATRT13, Stat 247)	Not Applicable[4]	
Port District Enabling Law	Compliance[1]	
Soil Conservation District Law	Compliance[1]	
Protection of Waters Program	Compliance[1]	
Tidal Wetlands Act	Compliance[1]	See Section 5.4 , 7 and 9.1
Waterfront Revitalization and Coastal Resources Act	Not Applicable[4]	See Section 9.1 and Appendix B-1.7
Wildland Protection Law	Compliance[1]	
Wild, Scenic and Recreational Rivers System	Compliance[1]	Not Applicable
State Laws of New Jersey	**Status**	**Notes**
Coastal Area Facility Review Act (NJSA 13:19-1 et seq)	Compliance[1]	
New Jersey Green Acres Land Acquisition Act of 1961 (NJSA 13:8 A-47)	Not Applicable[4]	
Waterfront Development Law (NJSA 12:5-3)	Compliance[1]	See Appendix B-1.7
Wetlands Act of 1970 (NJSA 13:9 A-1 et seq)	Compliance[1]	
Waterfront Harbors Facility Development Law of 1914	Compliance[1]	
Coastal Zone Management Act (State Administered)	Compliance[1]	See Section 9.2 and Appendix B-1.7
New Jersey Water Pollution Control Act (NJSA 58:10A-1 et seq)	Compliance[1]	See Section 5.4
Riparian Interests (NJSA 12:3-1 et seq. and 18:56-1 et seq)	Compliance[1]	
Flood Hazard Area Control Act (NJS A58:16A-50 et seq)	Compliance[1]	
Freshwater Wetlands Protection Act	Compliance[1]	

[1]Compliance Having met all requirements of the statute, E.O. or other environmental requirements for the current stage of planning.
[2]Partial compliance Not having met some of the requirements that normally are met in the current stage of planning.
[3]Non-compliance Violation of a requirements of the stature, E.O. or other environmental requirements
[4]Not Applicable No requirements for the stature, E.O. or other environmental requirements for the current stage of planning.

Table 1.2-2a Newspapers and Journals Sent the Notice of Public Scoping Meetings New York and New Jersey Harbor Navigation Study	
Asbury Park Press Middletown, NJ	Home News & Tribune Woodbridge, NJ
Newark Star-Ledger Newark, NJ	New York Times White Plains, NY
The Wall Street Journal New York, NY	Staten Island Register Staten Island, NY
New Jersey Business Magazine Fairfield, NJ	Brooklyn Eagle Brooklyn, NY
Jersey Journal Bayonne, NJ	Brooklyn Bridge Brooklyn, NY
Staten Island Advance Staten Island, NY	Brooklyn Papers Brooklyn, NY
Maritime Reporter & Engineering News New York, NY	The Waterways Journal St. Louis, MO
World Dredging, Mining & Construction Irvine, CA	WWS/Worldwide Shipping Odessa, FL
American Shipper Jacksonville, FL	Civil Engineering Reston, VA
ENR Hightstown, NJ	Fairplay: International Shipping Weekly Germantown, NY
Intermodal Shipping Atlanta, GA	International Dredging Review Fort Collins, CO
Journal of Commerce New York, NY	NMU Pilot Jersey City, NJ
Port News Charleston, SC	Shipping Digest New York, NY
Courier Life Publications Brooklyn, NY	Interesting Gazette Brooklyn, NY

Table 1.2-2b Newspapers Sent the Notice of Public Information Meetings New York and New Jersey Harbor Navigation Study	
Staten Island Register Staten Island, NY	Newark Star Ledger Newark, NJ
Staten Island Advance Staten Island, NY	Jersey Journal Bayonne, NJ
Brooklyn Papers Brooklyn, NY	New York Post New York, NY
Home News & Tribune Neptune, NJ	

Table 1.2-3 Dates and Focus of Environmental Work Group Meetings New York and New Jersey Harbor Navigation Study	
Date	**Focus**
23 February 1998	Opening Meeting, Project Authorization, and General Project Description
06 March 1998	Modeling Focus Session
31 March 1998	Public Scoping and Agency Coordination Focus Session
23 June 1998	Progress of Study
25 August 1998	Data Gaps and Species Profiles
23 September 1998	Progress of Study
03 December 1998	Without Project Conditions and Permitting Requirements
26 January 1999	Biological Reconnaissance Survey
13 April 1999	Progress of Study
06 May 1999	Environmental Screening Tables
21 May 1999	Pre-Alternative Formulation Briefing
09 August 1999	Post-Alternative Formulation Briefing
09 November 1999	Preliminary Mitigation Plan

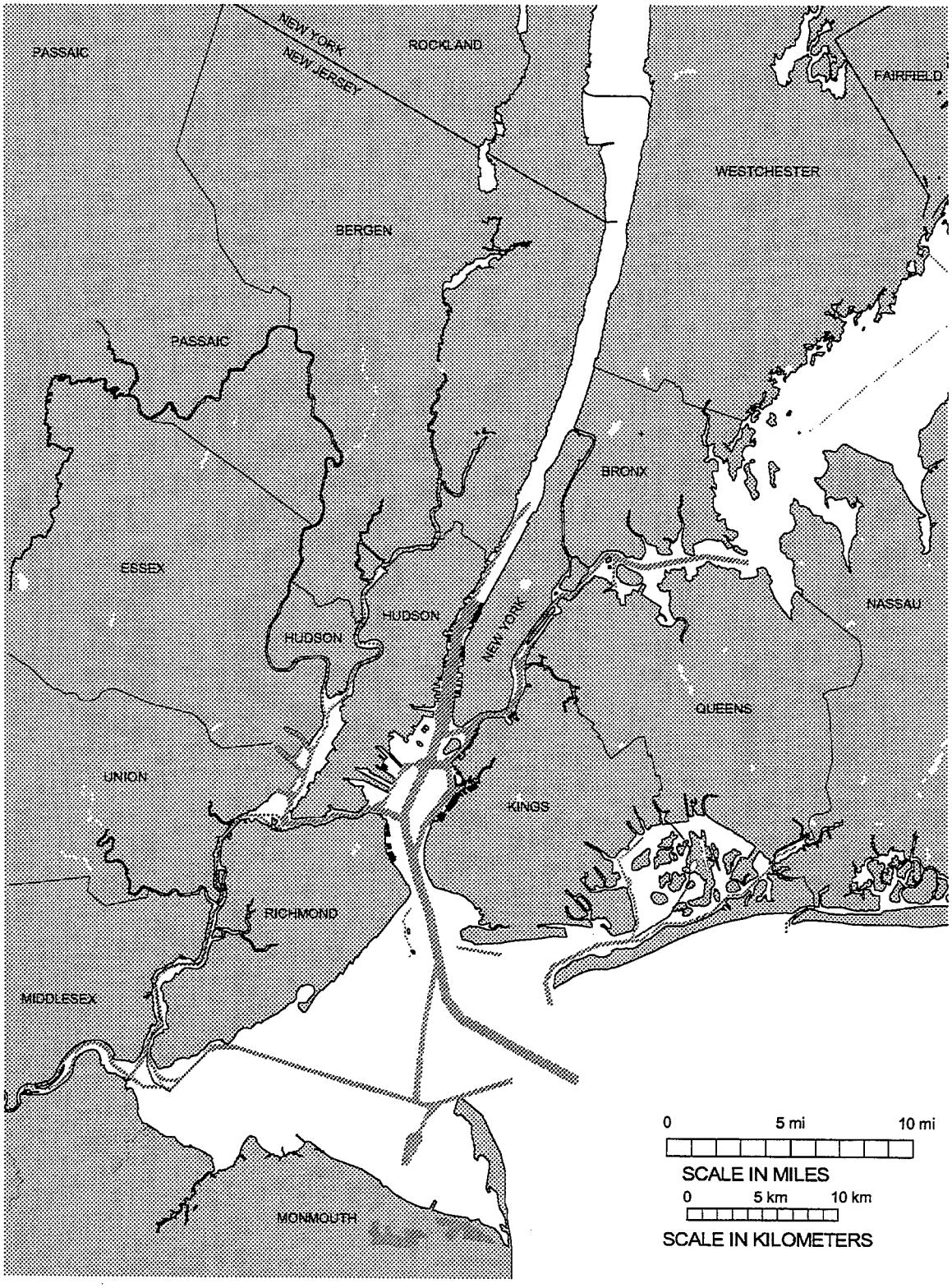


Figure 1.1-1 Study Area for the New York and New Jersey Harbor Navigation Study

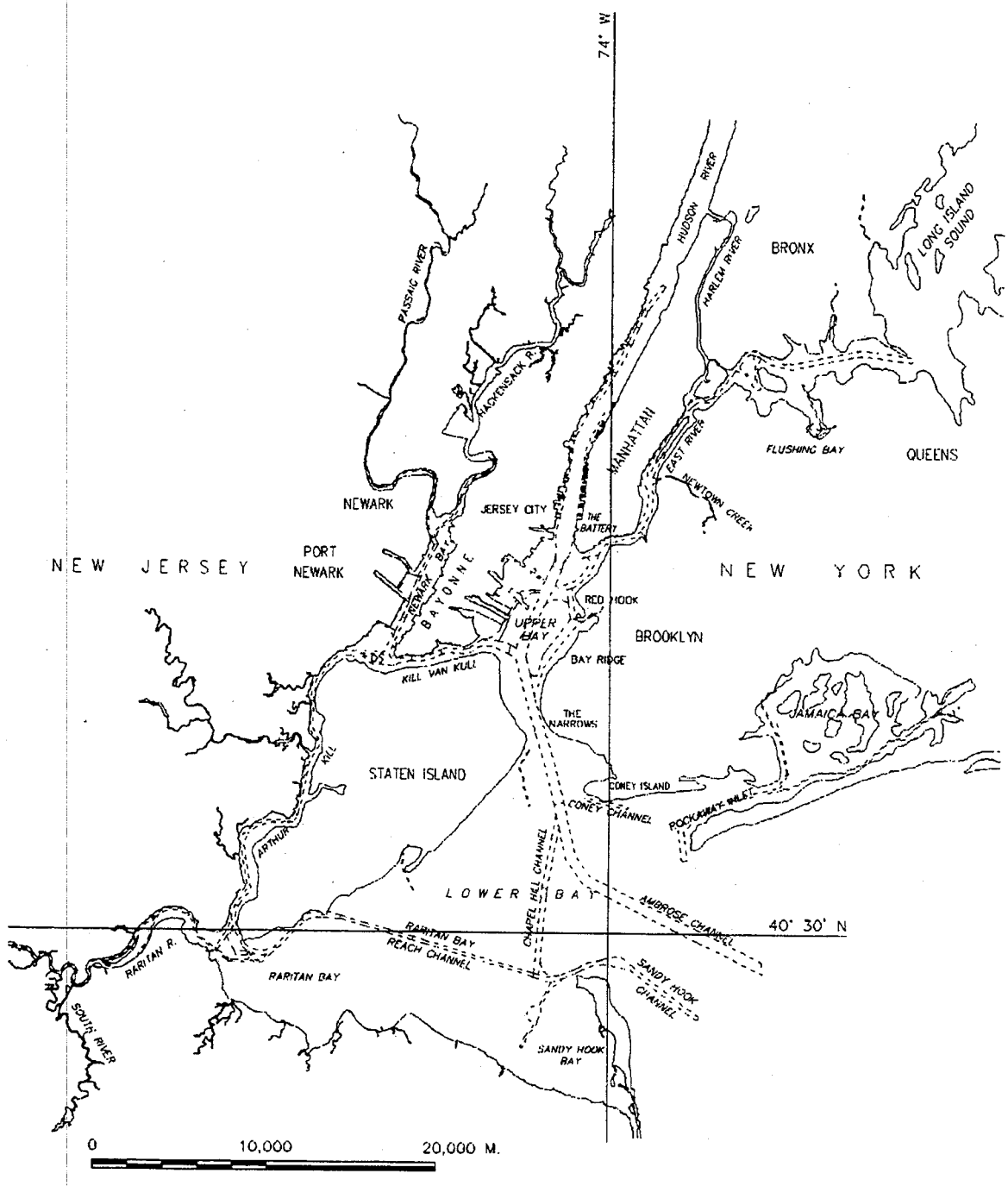


Figure 1.1-2 Project Area for the New York and New Jersey Harbor Navigation Study

2. ALTERNATIVES

2.1 Criteria for Evaluating Alternatives and Alternative Selection

2.1 In the early stages of the study, a variety of alternatives were evaluated to determine the extent to which they met project objectives. Those that met objectives and that were feasible were simultaneously evaluated for environmental impacts and National Economic Development (NED) Plan benefits. Some alternatives were eliminated because unavoidable environmental impacts were judged to be too severe and non-mitigatible; others were eliminated because they did not provide sufficient NED benefits. Upon elimination of an alternative, no further engineering or environmental studies were conducted with respect to that alternative.

2.2 The NED procedure to evaluate project alternatives is described in the Main Report. The environmental assessment of project alternatives employed a screening process, summarized in the following section.

Environmental Screening Criteria

2.3 Preliminary environmental screening served to document existing conditions and potential areas of concern. To assist in the selection of the recommended navigation channel deepening project, the preliminary environmental screening was incorporated into the Alternative Formulation Briefing (AFB) Technical Memorandum (USACE-NYD 1999a). Following the acceptance of the AFB, the proposed project alternatives were moved forward for more detailed environmental consideration in this document. The technical factors considered in the screening process are presented and discussed in detail in the New York and New Jersey Harbor Navigation Study Environmental Scoping Document (USACE-NYD 1999b), the AFB (USACE-NYD 1999a), and the Main Report for the New York and New Jersey Harbor Navigation Study. The following environmental criteria were considered in the preliminary environmental screening process:

- Aquatic Populations Affected
- Threatened or Endangered Species or Species of Special Concern in the Project Area
- Habitat Areas Affected
- Habitat Acres Disturbed
- Significant Harbor Habitats, Habitats of Concern, and Essential Fish Habitat
- Wildlife Habitat
- Hydrology and Water Quality
- Air Quality
- Dredged Material Quantity, Placement, and Sediment Characteristics
- Rock Blasting Requirements
- Aesthetics
- Noise

- Public Access, Recreation, and Shore Zone Use
- Archaeological, Historical, and Cultural Resources
- Environmental Justice Issues

2.2 No Action

2.4 The planning horizon for this project extends over many years, during which the Harbor will undergo many changes, with or without the proposed navigation channel improvements. Impacts associated with the proposed project should therefore be viewed in the context of changes likely to occur without the project. This is called the without-project condition or the no action alternative.

2.5 An annual 2 to 3% increase in port commerce is projected for the reasonably foreseeable future, resulting in an increase in TEUs from the current level of 2.4 million to 9.6 million by the year 2026. The projected increase in commerce will occur regardless of any channel improvements; the only projected influence of deeper navigation channels is the likelihood of commerce to arrive on more efficient vessels. Operators of the port's marine terminals indicate that they can accommodate this projected increase in commerce with increases in facility efficiencies and changes in facility operational parameters. No increase in the size of any facility is projected for the with- or without-project scenario.

2.6 The projected increase in port commerce, as well as an increase in consumer demand, is likely to result in an increase in truck and rail traffic into and out of the port facilities. Air quality and noise impacts will be associated with the projected increase in truck and rail traffic.

2.7 In the event that no proposed alternative met the Federal criterion of having a benefit-cost ratio (BCR) greater than 1.0 (i.e., positive net excess benefits) or that all alternatives had unacceptable environmental impacts, the no-action plan would become the Recommended Plan. Future conditions under such a plan are detailed in Section 4.3 of this document.

2.3 Non-structural Alternatives

2.8 Non-structural measures were examined as a means of achieving the planning objectives or portions thereof. Non-structural measures generally do not improve the available navigation channel areas, but rather fall into two other effect categories:

- Measures that allow for greater vessel loading economies without deepening of navigation channels;
- Alternate sites for, or means of, commerce delivery that include alternate ports (especially those with naturally deep harbors) and delivery to the New York and New Jersey area by rail or truck.

2.9 Several measures that allow for greater vessel loading economies are currently in use in the port. The measures currently in use include:



- Light-loaded vessels,
- High-tide transits (tidal advantage),
- Lightering.

2.10 Because the largest vessels currently in the fleet have maximum sailing drafts in excess of the channel depths in the Harbor, continued conduct of port operations using non-structural measures will not resolve the navigation problems facing carriers.

2.11 Another common navigation projection-structural plan involves the transport of cargo to an "alternative delivery site." This measure generally refers to an alternate site either within or outside the port.. Sites outside the port would require transportation back to the region by other means. A preliminary analysis of goods being shipped by water to Baltimore and then transported by land back to the New York/New Jersey area revealed that this alternative was not cost-effective. In addition, air quality analyses showed this solution would have significantly greater impacts than deepening the Harbor. Thus this alternative was dropped from further consideration. The non-Federal partners have not identified any alternative sites within the Port. Existing sites within the Port are usually being used for other types of transportation. Furthermore, construction of new terminals requires previously undeveloped land or redevelopment and conversion of sites presently serving other purposes. Channels to allow access to new terminals would also be required. The land and waterside impact associated with construction of new terminals may exceed the impacts associated with deepening existing channels to existing terminals. Eliminating this alternative would avoid such impacts to presently unchanged habitat. Therefore, no new terminal sites have been identified or proposed.

2.4 Structural Alternatives

2.12 Structural alternatives include physical modifications to channels and waterways. Structural plans for providing access to the port's container terminals were developed based on the full-load sailing draft of 48 ft for the Maersk K Class container vessel as the design vessel. For channels providing access to the port's petrochemical facilities along the Arthur Kill, the 55-ft draft Suezmax oil tanker was the design vessel.

2.13 The structural alternatives evaluated are listed below:

- Bayonne-Newark Bay Canal
- Offshore Island Port
- Deepening of Navigation Channels, Anchorages and Berthing Areas

Bayonne-Newark Bay Canal

2.14 A plan to construct a canal across Bayonne, New Jersey, was considered. The Bayonne-Newark Bay (BNB) Canal was to extend the Port Jersey Channel to Newark Bay across the Bayonne Peninsula near the Bayonne-Jersey City limits. This plan would have allowed for the deepening of the Port Jersey Channel as well as Newark Bay (northern portion), including the Port Newark and Elizabeth Channels, without having to deepen the Kill Van Kull.

2.15 This plan reduced the distance and amount of material to be dredged to reach the Port Newark/Elizabeth Port Authority Marine Terminal. It required 5.4 miles of channel construction, as opposed to more than 8 miles through the Kill Van Kull), and provided access to Newark Bay without significant turns, an important navigation improvement. However, the project faced myriad additional construction and environmental obstacles. Advantages and disadvantages of this plan are listed below:

Advantages:

- Eliminate the need to dredge 8+ miles of the Kill Van Kull, including significant amounts of rock and contaminated material;
- Provide access to Newark Bay without significant turns;
- Eliminate blasting impacts on adjacent structures.

Disadvantages:

- Significant socioeconomic, cultural, and environmental impacts associated with buying out or relocating approximately 300 structures in the channel footprint;
- Large amounts of rock excavation with associated blasting impacts on adjacent structures;
- Relocation of rail lines and roadways and the construction of several road/rail tunnels under the canal;
- Increased sedimentation rates, due to changed hydraulics, resulting in increased operation and maintenance (O&M) dredging.

2.16 Garnering the public support that would be critical to constructing this plan represents a further difficulty. Such support would be unlikely due to the significant quality-of-life changes resulting from construction. These changes include displacement of residents and increased traffic congestion due to limited channel crossings. The plan was dropped from consideration at the direction of the non-Federal partners.

Offshore Island Port

2.17 Construction of an offshore island port or terminal was evaluated. This terminal would serve as only an interim solution to addressing the port's depth constraints because the size of an

island terminal would be insufficient to handle the large number of containers forecast to be carried on the deep-draft vessels predicted to call on the port.

2.18 The terminal was to be located on top of a portion of an offshore Confined Disposal Facility (i.e., an "island" of dredged material), with pierside depths in excess of 60 ft MLW, thus providing access for the largest container vessels. The terminal would be used to offload a portion of a vessel's cargo such that the vessel's draft would be reduced to a level where the vessel could then safely transit to an existing port container terminal. Advantages and disadvantages of this plan are listed below.

Advantages:

- Little or no Harbor dredging required;
- Unrestricted access of vessels with sailing drafts of 60 ft or more;
- Potentially reduced depth requirements of the Harbor as a whole.

Disadvantages:

- Location of the island terminal/port would be relatively unprotected, hampering vessel dockings/sailings and barge operations;
- Carriers would transship cargo from the island terminal/port to in-Harbor terminals for distribution;
- Environmental issues associated with the loss of marine habitat are significant;
- Environmental issues associated with construction of a Confined Disposal Facility (CDF) are significant;
- Post-dismantling use/benefits may not offset environmental impacts.

2.19 As conceived, the Offshore Island Port was not intended to fully meet the planning objective, but rather to serve as an interim solution by providing a terminal for the deepest-draft vessels while other channel improvement plans were developed or implemented. This study has identified channel improvements that can meet the planning objectives in a reasonable time frame, thereby eliminating the need for further consideration of this plan.

Channel-deepening Plans

2.20 The channel-deepening alternatives are based on the need to provide access for deeper-draft, fully loaded vessels to the port's existing container and petrochemical terminals. Additionally, it has been thought, widening or realignment of channel sections, including adding larger turning basins, would improve large-vessel traffic flow and reduce the potential for maritime accidents. The study considered deepening all or some of the designated channels or pathways, at various navigational depths, to realize the maximum net benefits while minimizing environmental impacts.

2.21 The channel sections were developed with three horizontal to one vertical (3H:1V) sideslopes in non-rock material and 1H:1V in rock. Navigation channel improvements in the New York and New Jersey Harbor using the 3H:1V sideslope characteristic have demonstrated sideslope stability and minimal sediment sloughing. Channel widths and alignments were designed to provide safe navigation for all vessels throughout the channel.

2.22 Four bridges span the alternative pathways: the Verrazano Narrows Bridge, the Bayonne Bridge, the Goethals Bridge, and the Staten Island Railroad Bridge. With the exception of the Verrazano Narrows Bridge, which spans a naturally deep section of the Harbor (approximately 90-ft deep under the bridge), horizontal channel clearance under these bridges is limited by the position of the bridge piers and the fender and dolphin protective structures. Since the stability of these structures must not be threatened, expansion of the channel widths at these bridge crossings may be limited.

Navigation Channel-deepening Alternatives

2.23 Navigation channel-deepening alternatives providing unconstrained access to the container terminal facilities in the study area were evaluated. Each alternative included deepening Ambrose Channel and a portion of the Anchorage Channel. Alternatives, assessed individually, included:

- Kill Van Kull Channel, Newark Bay Channel, South Elizabeth Channel, and Elizabeth Channel to the Port Newark/Elizabeth Port Authority Marine Terminal;
- Kill Van Kull Channel and Arthur Kill Channel to the Howland Hook Marine Terminal;
- Port Jersey Channel to existing and proposed facilities on both sides of the Channel. The Claremont Channel and Pierhead Channel were also evaluated. Based on construction and economic considerations, they were eliminated from further consideration following preliminary evaluation.
- Bay Ridge Channel to the South Brooklyn Marine Terminal. The Buttermilk and Red Hook channels were also evaluated, and were dropped from further consideration following the preliminary review.

Tanker Channel-deepening Alternatives

2.24 A channel-deepening alternative providing unconstrained access to the two petrochemical facilities identified in the study was evaluated and is described in the Main Report. This alternative included deepening the Ambrose Channel, the Anchorage Channel, the Kill Van Kull, and the Arthur Kill to Gulfport to depths sufficient for safe passage of the Suezmax design vessel. As described in the Main Report, this plan was not found to be economically favorable and was not included in the NED plan.

Anchorage-deepening Alternative

2.25 Deepening alternatives for the Harbor's major anchorages were also evaluated. Due to the fact that the anchorage study will not be completed until after publication of this report, further evaluation of anchorage-deepening alternatives will be deferred until completion of that study.

Projected Environmental Effects to Navigation Channels

2.26 All tanker-channel deepening and anchorage-deepening alternatives were subjected to the preliminary environmental screening process. Results are summarized by alternative. Influences upon Harbor hydraulic conditions and water quality parameters were evaluated using three-dimensional hydrodynamic models. Estimates of habitat disturbance were determined through the planimetric evaluation of preliminary construction drawings. Environmental assessments related to channel improvements were obtained by viewing habitat disturbances in the light of: (1) Harbor maps (wetland inventory maps, navigation charts); (2) the results of a comprehensive Harbor reconnaissance survey and biological monitoring program; (3) an evaluation of projected changes in hydraulic conditions and water quality parameters based on three-dimensional hydrodynamic model output; and (4) projected construction impacts, including sub-surface rock blasting.

Ambrose Channel

2.27 No influence or disturbance is projected in upland areas; in tidal marshes, shoals, or flats classified as the intertidal zone (mean high water [MHW] to mean low water [MLW]); in littoral zones (MLW to 6 ft below MLW, expressed as "6 ft MLW"); or in sublittoral zones (>6 to 15 ft MLW) as a result of dredging of the Ambrose Channel, which is the main entrance channel to the Harbor and is located in Lower New York Bay. Short-term disruption of benthic habitat is expected in the channel. No influence is expected upon USFWS-designated significant land habitat (manmade islands, such as Swinburne and Hoffman Islands) located in the general vicinity of the Ambrose Channel, nor is any influence projected on Breezy Point.

2.28 Channel deepening will result in minimal to non-detectable changes in salinity, water temperature, dissolved oxygen, and hydraulic conditions. No influence on channel use or distribution patterns by aquatic populations is projected based on changes in hydraulic conditions or water quality. Dredging in this area is not expected to have a significant influence on pelagic or migratory fish populations. Benthic fish populations, including red hake (*Urophycis chuss*), winter flounder (*Pleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), butterfish (*Peprilus triacanthus*), Atlantic mackerel (*Scomber scombrus*), summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), and black sea bass (*Centropristis striata*), all of which are designated Essential Fish Habitat (EFH) species, could temporarily be influenced. However, no long-term influence is projected. Marine mammals and turtles listed as species of concern by state and Federal agencies may be present in the vicinity, although they are not expected to be influenced by dredging activities or channel usage. Best management practices (BMPs), designated in state dredging permits, including onboard observers, should

minimize or eliminate the potential for adverse impact to EFH or threatened and endangered species.

Anchorage Channel

2.29 No influence or disturbance is projected in upland areas, wetlands, marshes, shoals, flats, intertidal, littoral, or sublittoral zones by dredging of the Anchorage Channel, which is located in Upper New York Bay. Although short-term disruption of benthic habitat is expected in the channel, no long-term influence is projected.

2.30 Channel deepening will result in minimal to non-detectable changes in salinity, water temperature, dissolved oxygen, and hydraulic conditions capable of causing changes in aquatic population use or distribution patterns in the channel. An evaluation of dredging in this area does not project a significant influence on pelagic or migratory fish populations. Benthic fish populations, including red hake, winter flounder, windowpane flounder, butterfish, summer flounder, scup, and black sea bass, are designated EFH species that could temporarily be influenced by dredging activities; however, no long-term influence to growth, development or migratory patterns is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the vicinity, although they are not expected to be influenced by dredging activities or channel usage. BMPs, including no-barge-overflow when dredging contaminated sediments, are expected to minimize or eliminate the potential for adverse impact to EFH or threatened and endangered species.

Kill Van Kull

2.31 No influence or disturbance is projected in upland areas or intertidal zones by dredging of the Kill Van Kull. Dredging the Kill Van Kull Channel will result in the disturbance of 0.06 acres of littoral zone habitat (Table 2.4-1). Some or all of this area may be converted to sublittoral (> 6 to 15 ft MLW) habitat as a result of the channel deepening. The disturbed areas are located at the point where the Kill Van Kull meets the Arthur Kill, and along the north shore of Staten Island at the western end of the Constable Hook Reach. Although short-term disruption of benthic habitat is expected in the channel region, no long-term influence is expected. Disturbance to the benthic community is expected to be minor and temporary as a result of channel improvements and sideslope modifications.

2.32 Channel deepening will not result in changes in salinity, water temperature, dissolved oxygen, or hydraulic conditions that would alter use or distribution patterns by aquatic populations. Dredging in this area is not expected to have a significant influence on pelagic or migratory fish, shellfish, or macroinvertebrate populations, although it could have a temporary influence on benthic fish populations such as red hake, winter flounder, windowpane flounder, summer flounder, scup, and black sea bass (all EFH species). No long-term influence is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the vicinity of the channels, and nesting peregrine falcons (*Falco peregrinus*) on the Bayonne Bridge could temporarily be disturbed during dredging operations in the area. BMPs designated in state dredging permits, including seasonal dredging windows in the immediate vicinity of

Shooters Island, are expected to minimize the potential for adverse impacts to EFH or threatened and endangered species.

Newark Bay

2.33 No influence or disturbance is projected in upland areas or intertidal zones by dredging of the Newark Bay, Elizabeth, or South Elizabeth Channels. Dredging operations in the Newark Bay Channel (including the Elizabeth Port Authority Marine Terminal and South Elizabeth Channel) would disturb approximately three acres of littoral zone habitat and 25 acres of sublittoral zone habitat, with the subtidal flats located along the western side of the South Reach of the Newark Bay Channel being the primary area affected (Table 2.4-1). Although short-term disruption of benthic habitat is expected in the channel region, no long-term influence is projected.

2.34 Channel deepening will result in minimal changes in salinity, water temperature, dissolved oxygen, and hydraulic conditions, which will not result in any adverse impact to intertidal wetlands. No alteration in use or distribution patterns by aquatic populations is projected on the basis of water quality or hydraulic changes. Dredging in this area is not expected to have a significant influence on pelagic or migratory fish, shellfish, or macroinvertebrate populations, although benthic fish populations such as red hake, winter flounder, windowpane flounder, summer flounder, scup, and black sea bass (all EFH species) could temporarily be influenced. No long-term adverse effect is projected. Marine mammals and turtles listed by state and Federal agencies may be seasonally present in the channels. BMPs designated in state dredging permits, including no barge overflow when dredging contaminated sediments, are expected to minimize or eliminate the potential for adverse impact to EFH or threatened and endangered species.

Arthur Kill Channel to Howland Hook

2.35 No influence or disturbance is projected in upland areas by dredging of the Arthur Kill Channel to Howland Hook. Shooters Island, a harbor heron rookery, and Staten Island land area adjacent to the Island is designated by USFWS and NYSDOS as significant coastal fish and wildlife habitat. These wetland and shoreline areas provide foraging habitat for newly fledged wading birds. Dredging operations are not expected to result in any alteration to area tributary stream drainage patterns and their associated wetlands. Dredging along the north shore of Staten Island west of the Shooters Island and Port Ivory area, including the tidal flats in the vicinity of the US Dike, would disturb 3.23 acres of littoral zone and 3.22 acres of sublittoral zone habitat. Old Place Creek marsh and the wetlands along Staten Island south of Howland Hook are part of the Harbor Wetlands Restoration Program. Short-term disruption of benthic habitat is expected in the channel and impacted shore zone areas; no long-term influence is projected. Recolonization is expected within a short time following dredging.

2.36 Hydrodynamic model projections related to channel deepening indicate the likelihood of minimal changes in salinity, water temperature, dissolved oxygen, and hydraulic conditions in the northern reaches of the Arthur Kill. The projected changes will not alter use or distribution

patterns of aquatic populations. Dredging in this area is not projected to have a significant influence on pelagic or migratory fish populations, although it could have a temporary influence on benthic fish populations, including red hake, winter flounder, windowpane flounder, summer flounder, and scup (all EFH species). No long-term influence is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the vicinity. Harbor herons nesting on Shooters Island and peregrine falcons nesting on the Goethals Bridge could be disturbed during dredging operations. Designated BMPs, including the use of silt curtains at the mouth of tributary streams, should minimize any potential for adverse impact to EFH or threatened and endangered species.

Port Jersey

2.37 No influence or disturbance is projected in upland, intertidal, or littoral zone areas by the deepening and straightening of the Port Jersey Channel, although the Jersey Flats area is expected to be impacted by this action. Dredging this channel would disturb approximately 12.35 acres of the sublittoral zone along the flats located east of the PANYNJ North East Auto Marine Terminal (NEAT) (Table 2.4-1). Short-term disruption of benthic habitat is expected in the channel region; no long-term influence is projected. The direct result of channel modification will be the loss of several acres of the north end of the Jersey Flats. Some of the sublittoral zone will be permanently altered to channel sideslope or channel bottom habitat. Most of the sublittoral zone habitat will become slightly deeper, but will remain within the depth range (7-15 ft MLW) for the habitat type. The greatest impact to the Jersey Flats is associated with the currently authorized straightening and deepening of the Port Jersey Channel from 35 ft MLW to 41 ft MLW. Mitigation of this impact is to be included in that authorized project. Details of the mitigation plan are not available at this time.

2.38 Channel deepening will result in no changes in salinity, water temperature, dissolved oxygen, or hydraulic conditions that could alter use or distribution patterns by aquatic populations. Dredging in this area will not have a significant influence on pelagic or migratory fish, shellfish, or macroinvertebrate populations. Benthic fish populations could temporarily be influenced, including winter flounder (an EFH species), although no long-term effect is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the channels. Designated BMPs, such as use of an environmental bucket and slow lift rates, are expected to minimize or eliminate potential adverse impacts to EFH or threatened and endangered species.

Claremont Channel

2.39 No influence or disturbance is projected in upland areas, intertidal, or sublittoral zones by dredging of the Claremont Channel (not included in the NED plan). Dredging operations related to channel deepening would disturb approximately 2.9 acres of littoral zone habitat located on the north end of the Jersey Flats. Short-term disruption of benthic habitat would be expected in the channel region; no long-term influence is projected.

2.40 Channel deepening will result in no changes in salinity, water temperature, dissolved oxygen, or hydraulic conditions that could alter use or distribution patterns by aquatic populations. The influence of dredging in this area is, however, not projected to have an adverse influence on pelagic or migratory fish populations, although benthic fish populations may be temporarily impacted. No long-term influence is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the vicinity of the channels. BMPs, including dredging windows, are expected to minimize or eliminate the potential for adverse impact to EFH or threatened and endangered species.

Bay Ridge Channel

2.41 No influence or disturbance is projected in upland areas, intertidal, littoral, or sublittoral zones by deepening the Bay Ridge Channel to the South Brooklyn Marine Terminal. The proposed channel deepening and turning basin will not influence the Bay Ridge Flats. Short-term disruption of benthic habitat is expected in the channel; no long-term influence is projected.

2.42 Channel deepening will result in no changes in salinity, water temperature, dissolved oxygen, or hydraulic conditions that could alter use or distribution patterns by aquatic populations. Dredging in this area is not expected to have a significant influence on pelagic or migratory fish, shellfish, or macroinvertebrate populations. A temporary influence on benthic fish populations, including red hake, winter flounder, windowpane flounder, summer flounder, scup, and black sea bass (all EFH species), is possible. This influence, however, would be limited to the immediate vicinity of the dredging activity. No long-term influence is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the vicinity. BMPs, such as no-barge-overflow when dredging contaminated sediments, are expected to minimize or eliminate the potential for adverse impact to EFH or threatened and endangered species.

Red Hook Channel

2.43 Influence or disturbance is projected in upland areas, intertidal, littoral, or sublittoral zones by dredging of the Red Hook Channel (not included in the NED plan). Short-term disruption of benthic habitat is expected in the channel; no long-term influence is projected.

2.44 Channel deepening will not result in detectable changes in salinity, water temperature, dissolved oxygen, or hydraulic conditions that could alter use or distribution patterns by aquatic populations. Dredging in this area is not expected to have a significant influence on pelagic or migratory fish, shellfish, or macroinvertebrate populations, although it could have a temporary influence on benthic fish populations, including winter flounder, an EFH species. No long-term influence is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the vicinity. BMPs are expected to minimize or eliminate the potential for adverse impact to EFH or threatened and endangered species.

Buttermilk Channel

2.45 No influence or disturbance is projected in upland areas, wetlands, marshes, shoals, flats, or intertidal, littoral, or sublittoral zones by dredging the Buttermilk Channel (not included in the NED plan). Short-term disruption of benthic habitat is expected; no long-term influence is projected.

2.46 Channel deepening will not result in changes in salinity, water temperature, dissolved oxygen, or hydraulic conditions that could alter use or distribution patterns by aquatic populations. Dredging in this area is not expected to have a significant influence on pelagic or migratory fish, shellfish, or macroinvertebrate populations, although it could have a temporary influence on benthic fish populations, including winter flounder, an EFH species. No long-term influence is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the vicinity, although they are not expected to influence dredging activities or channel usage. Dredging permit BMPs ought to minimize or eliminate the potential for adverse impacts to EFH or threatened and endangered species.

Stapleton, Gravesend Bay and Bay Ridge-Red Hook Anchorages

2.47 No influence or disturbance is projected in upland areas, wetlands, marshes, shoals, flats, or intertidal, littoral, or sublittoral zones by deepening of the New York and New Jersey Harbor anchorages (not included in the NED plan). Short-term disruption of benthic habitat is expected; no long-term influence is projected.

2.48 Anchorage deepening will not result in changes in salinity, water temperature, dissolved oxygen, or hydraulic conditions that could alter use or distribution patterns by aquatic populations. Dredging in this area is not expected to have a significant influence on pelagic or migratory fish, shellfish, or macroinvertebrate populations, although it could have a temporary influence on benthic fish populations, including winter flounder, an EFH species. No long-term influence is projected. Marine mammals and turtles listed by state and Federal agencies may be present in the vicinity, although they are not expected to influence dredging activities or channel usage. Dredging windows and other BMPs should serve to minimize or eliminate the potential for adverse impact to EFH or threatened and endangered species.

2.5 Summary and Plan Formulation

2.49 Similar impacts are associated with each deepening alternative, although the extent and significance of the impacts vary among alternatives. Dredging any of the channels will have a direct, short-term impact on benthic populations. None of the alternatives for this project will directly impact tidal marshes or intertidal wetlands, nor significantly alter Harbor hydrology or water quality. Disturbance to littoral areas and sublittoral habitats differs among alternatives. Areas impacted are compared in Table 2.4-1.

2.50 The fundamental study objective is to develop an optimal plan that can accommodate existing and future vessel traffic, that will be acceptable, on the one hand, from the NED

perspective, as directed by the *Guidance for Conducting Civil Works Planning Studies (Planning Guidance Notebook, USACE 1997)*, and on the other from the Environmental Quality (EQ) and Regional Economic Development (RED) perspectves, and that can also account for Other Social Effects (OSE). Plans were formulated to be complete, effective, efficient, and acceptable, and to reasonably maximize net benefits.

2.51 Recommended Plan, described in Section 3, includes several, but not all, of the individual alternatives evaluated in the preliminary environmental screening.

INDEX

B

BMPs 7, 9, 10, 11, 12

C

Criteria for screening alternatives 1–2

E

EFH.....7, 8, 9, 10, 11, 12
Environmental effects, projected 7–12

N

No-action alternative 2
Non-structural alternatives..... 2–3

S

Structural alternatives 3–7
  Bayonne-Newark Bay Canal..... 4
  channel deepening..... 5
  offshore island port 4

TABLE 2.4-1 Estimated Acreage of Disturbed Areas by Channel and Depth				
	Disturbed Areas (Acres)			
Channel	Intertidal (MHW to MLW)	Littoral Zone (MLW to -6ft MLW)	Sublittoral Zone (-6ft to -15ft MLW)	Total Intertidal And Littoral
Ambrose	0.0	0.0	0.0	0.0
Anchorage	0.0	0.0	0.0	0.0
Bay Ridge/Red Hook	0.0	0.0	0.0	0.0
Port Jersey	0.0	0.0	12.35	0.0
Claremont	0.0	2.88	0.0	2.88
Kill Van Kull	0.0	0.06	1.41	0.06
Arthur Kill to Howland Hook	0.0	3.23	3.22	3.23
Newark Bay	0.0	2.72	7.79	2.72
South Elizabeth	0.0	0.0	15.84	0.0
Elizabeth	0.0	0.25	1.42	0.25
Totals	0.0	6.26	42.03	6.26

3 RECOMMENDED NEW YORK AND NEW JERSEY HARBOR NAVIGATION CHANNEL IMPROVEMENT PLAN

3.1 Description of the Plan

3.1 The National Economic Development (NED) Plan, which provides for navigation improvements to nine channels in the New York and New Jersey Harbor, is the Recommended Plan. The proposed navigation channel improvements, which consist of channel deepening, channel realignment, turning-basin construction, and berth deepening, will permit larger, deeper-draft vessels to gain access to four main container terminals while loaded in an economically efficient manner.

3.2 The basis for the selection of the NED Plan is its contribution to national economic development through transportation cost savings. The Recommended Plan must be consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal requirements. This plan provides complete, effective, efficient, and acceptable navigation channel improvements that maximize net excess benefits. The NED Plan includes the baseline construction features that are used to establish the financial limits of Federal participation. On the basis of plan formulation, environmental assessment, and local coordination, the NED Plan components described below have been made part of the New York and New Jersey Harbor Navigation Study.

3.3 The authorization for the New York and New Jersey Harbor Navigation Study directs USACE-NYD to evaluate navigation channel depths to 50 ft MLW or greater. Recommended channel depths for the proposed project are presented in Table 3.1-1.

3.4 In Table 3.1-1, the column entitled "Maintained Depth" refers to the Recommended Plan depths that USACE is seeking as the authorized depth for the improved channels. The column entitled "Excavated Depth" refers to the depth to which the channel must be constructed to satisfy safety criteria (due to the presence of rock or hard sediments at the channel bottom). In addition to the extra depth required for underkeel safety, an additional allowance of 2 ft has been made. This additional depth is commonly referred to as "overdredge," which may or may not reach a full 2-ft in practice. [NOTE: The overdredge depth was taken into consideration in estimating the potentially disturbed areas of the littoral and sublittoral zones.] The column entitled "Habitat Assessment Depth" indicates the depths used for estimating areas of potential project disturbance in each of the project reaches and includes the allowable 2-ft overdredge. The areas of disturbance estimated for channel side slopes fully account for the potential 2 ft of overdredge, and the project habitat mitigation plan uses these conservative area estimates as part of the basis for overall habitat impact assessment.

3.2 Waterside Elements

Pathway and Channel Design

Channel Depth

3.5 The selection of the project depth is determined by economic analysis of the expected project benefits compared with the project cost at various alternative depths as described in the Main Report. The depths providing the greatest net excess benefits (total benefits minus total costs) form the NED Plan. The determination of the class of vessel that can pass through the selected depth efficiently loaded is based upon the loaded static summer saltwater draft of the vessel, plus allowances for various underkeel clearances such as squat, water density, ship response to waves, and safety clearance. Refer to the Main Report for further details on depth allowances.

3.6 The total underkeel clearances required by vessels with loaded static drafts of 46 and 55 ft for the various Harbor navigation channels are provided in the Main Report and its Engineering Appendix.

Channel Width

3.7 The channel width for the Ambrose Channel, the Harbor's main entrance channel, was based on guidance in *Approach Channels: A Guide for Design* (Permanent International Association of Navigation Congresses, 1997) for outer channels exposed to open water. The guidance takes into account factors such as ship speed, prevailing crosswinds, both cross-currents and longitudinal currents, significant wave height, aids to navigation, bottom surface, depth-to-draft ratio, cargo hazard level, bank conditions, and traffic density. The results of the analysis indicate that, for severe wind, wave, and current conditions that might be encountered off shore, the channel width should be approximately 2,100 ft for two-way traffic. Based, however, upon the consistency of ship track plots from a New York and New Jersey Harbor ship motion study and on meetings with harbor pilots, the existing width of 2,000 ft is judged to be adequate.

3.8 The width of the proposed interior channels was designed in accordance with *Hydraulic Design Guidance for Deep-Draft Navigation Projects* (USACE 1995). This guidance is based upon factors such as traffic patterns (one-way or two-way), design vessel dimensions, shape of channel cross-section, current speed and direction, quality of aids to navigation, and variability of channels and currents. For one-way channels, widths might vary from 2.5 times the vessel beam (for a well-defined channel with minimal currents) to 5.5 times the vessel beam (for a variable channel with stronger currents). Two-way channels might vary from 4 to 8 times the vessel beam. The recommended widths for the Harbor's interior navigation channels in the NED Plan are described in the Channel Design Appendix (Appendix E) to the Main Report.

Bend Widening Details

3.9 Channel width is increased in bends because the swept path of a ship making the turn is wider than the path of the ship in a straight channel. The width of the swept path is dependent upon the ratio of the turn radius to the ship length and the deflection angle. Other factors taken into account are ship yaw angle, ship dimensions, ship rudder angle, bank effects, navigational aids, currents, and other physical conditions. The guidance document recommends turn-width increase factors (a multiple of the vessel beam) of 0.0 to 2.0, with a recommended turn-radius ratio of not less than 3, based upon the maneuverability of the vessels. Many of the interior channel bends in the port, however, have turn-radius ratios less than 3; however, vessels making use of tug support or bow and stern thrusters safely transit these channel bends. Based on the final navigation channel improvement designs, turn-width factors for these channel bends may increase to 3 or more.

Dredging

Initial Dredging

3.10 Initial dredging consists of dredging virgin soil or rock to attain the design channel depths. This is referred to as "new work" dredging. Material to be dredged for this project includes sand, relatively stiff clays, and bedrock, with some silty material overlying the virgin soil layer. Dredging depths are based on the "underkeel" or "safety" clearance for the design vessels, on whether channel bottoms are "soft" or "hard" (e.g., rock), and on whether channels are exposed to waves.

3.11 Initial dredging depths, based on final project authorizations, for the NED Plan are 50 ft MLW for soft bottoms, 52 ft MLW for hard bottoms, and 53 ft MLW for the Ambrose Channel.

Maintenance Dredging

3.12 Maintenance dredging consists of dredging fine-grained silts and clays that have been deposited within the channels since the last dredging operation. These deposits are the result of upland soil erosion and sediment runoff, runoff from relatively impervious upland areas such as paved areas and buildings, littoral and wave-induced relocation of sediment from adjacent and oceanic sources, and atmospheric deposition.

3.13 Maintenance dredging will be to depths stated above for soft bottoms (i.e., 50 ft MLW for container vessels, except for 53 ft MLW in the Ambrose Channel). Hard-bottomed channels that were initially dredged 2 ft deeper will be allowed to silt in over time to create a soft bottom with a maintained safety clearance of 2 ft.

Dredging Techniques

3.14 A hopper dredge will be used to excavate the clean sand in the Ambrose Channel. Surficial silt, clay, and sands found in the upper layers of the other channels will be dredged by clamshell bucket. For soft material unsuitable for placement at the Historic Area Remediation Site (HARS), an environmental dredge (sealed clamshell bucket) will be used. [The HARS is an area in the New York Bight Apex designated by USEPA as a placement area for non-contaminated materials that can be expected to mitigate the impacts resulting from past ocean disposal practices.] All dredge types are described below. The barges that carry dredges likely to perform this work have dimensions ranging from 45 by 120 ft to 75 by 225-ft and draw from 7 to 20 ft of water. Stiffer virgin soils and blasted bedrock would be dredged using marine excavators (backhoe dredges) or specially designed "rock" buckets. Due to the length of time required for the navigation channel improvements to be completed, it is possible that other dredging techniques may become available for use during the course of the project. These techniques, following evaluation on economic and environmental grounds, may be suggested for use on the project.

3.15 Both conventional and environmental clamshell dredges have been used successfully for remedial dredging applications at New York and New Jersey Harbor locations. The hopper dredge is proposed for use in the Ambrose Channel because the sediments are primarily sand and are not considered contaminated. Various kinds of dredges, including marine excavators, are described below.

Hopper Dredge

3.16 The hopper dredge is a self-propelled vessel that features suction pipelines (known as drag arms) that are lowered from the side of the vessel to engage the bottom. Material is excavated through the suction pipes into a hopper contained within the hull of the vessel. A hopper dredge transports material by slurry through the drag arms into the hopper. Once the material has been loaded into the hopper, excess water is decanted either over the sides of the vessel or through discharge pipes extending through the vessel's bottom.

3.17 Typically, a hopper dredge, which is usually employed when depth of cut is shallow, can effectively excavate only soft mud/silt and loose sands. With modifications to the drag heads, firm to dense sands can also be excavated. Since the material is transported to the hopper as a slurry, large amounts of water must be handled in the hopper. This can pose problems when grain size is small or when water quality is a concern. A hopper dredge is the preferred dredge for deepening of the Ambrose Channel.

Conventional Clamshell Dredge

3.18 A conventional clamshell or bucket dredge is operated from a barge-mounted crane. Once the open bucket is positioned over the target area, it is lowered by cable to the subsurface bed. After contact with the bottom, the crane operator closes the bucket to excavate the

sediment. The speed at which the bucket is lowered and brought back to the surface can be varied to minimize sediment resuspension and dispersion. The level of vertical accuracy of conventional clamshell equipment is 1 to 4 ft, depending upon sediment characteristics, operator skill level, tides, and sea-state. The capacities of conventional clamshell dredges that could complete the work range from approximately 5 to 50 CY. The conventional clamshell dredge is most effective in excavating unconsolidated silts and sands. A smaller, heavier bucket is required for excavation of dense material such as consolidated (i.e., stiff) clay.

Environmental Clamshell Dredge

3.19 The environmental clamshell dredge was developed to excavate contaminated sediment on projects requiring tight vertical tolerance and minimal sediment re-suspension/dispersion. The environmental clamshell dredge operates from the same barge platform as the conventional clamshell dredge, and moves in the same manner. More precise vertical and horizontal control is, however, achieved by using pressure, or depth, sensors, Differential Global Positioning Systems (DGPS), and modern computer software. Modifications to the bucket permit excavation of sediment in level cuts, as opposed to pockets. Additionally, the environmental clamshell bucket provides cover-and-seal closure to minimize water column sediment dispersion as the excavated material is brought to the surface. The environmental clamshell dredge is most effective in excavating unconsolidated silts and sands; it is not suitable for the excavation of stiffer materials.

Marine Excavator (Backhoe Dredge)

3.20 A marine excavator, using a turret-mounted backhoe as the primary excavator, is capable of performing both surficial dredging of unconsolidated contaminated sediment and excavation of stiffer, consolidated materials. The U.S. dredging industry in recent years has constructed a number of new hydraulic-powered marine excavator (backhoe) dredges. Ranging in capacity from 6 to 40 CY, these dredges are capable of tight-tolerance excavation of marine sediment with minimal water entrainment. Vertical dredge accuracy to 2 ft is possible, as is horizontal positioning to within 3 ft. Achievable tolerances are dependent upon sediment characteristics, operator skill level, tides, and sea-state.

Production Capacity

3.21 The production capacities of the dredges capable of performing the work related to this project are highly variable and dependent upon sediment characteristics, depth of excavation, size of excavator bucket, dredge cycle time, and crew skill level. To reduce resuspension of sediment as a result of washing from the bucket, it may be necessary to decrease the rate of descent and rate of haul of the excavator. This will, of course, lengthen the cycle time of the dredge.

Dredging Scheme

3.22 For a given channel reach, the dredge will advance in "sets" ranging from 5 to 15 ft. Once the dredge advances, it will lower and set its spuds into the bottom sediment, providing a stable and fixed platform from which the excavator can operate. Dredge mobility will be supplied either by tugboats or an onboard spud carriage. If a dredge with a spud carriage is used, the dredge will be capable of a certain amount of self-propulsion, setting itself ahead up to 30 ft per set of the carriage before the tug assist would be required for resetting. If the dredge is not equipped with a spud carriage, the dredge will be moved into position for its next cut sequence by one or more tugboats. Material dredged from the entrance channel, and unconsolidated surface layers, will be placed in hopper or dump scows for transport to the placement site. One scow will be moored alongside the dredge for filling when excavation is in progress while one or more scows are in transit to or from the placement or off-loading location. To optimize production, dredging will proceed along a pre-determined cut-path, preferably in long, straight lines. It is assumed that dredging operations will be permitted 24 hours per day.

Dredged Material Management

3.23 USACE-NYD is currently in the process of finalizing the Dredged Material Management Plan (DMMP) for the Port of New York and New Jersey. USACE policy (EC-1165-2-200) requires each district to prepare a DMMP for maintaining the Federal navigation channels in its jurisdiction for at least 20 years. The plan identifies how much material will be dredged to maintain the channels and how the dredged material will be managed in an economically sound and environmentally acceptable manner. In addition to the placement needs for Federal dredged materials, the DMMP also considers private and local/state needs. In this manner, the DMMP strives to develop a regionally supported, comprehensive plan to meet all the dredged material management needs for the port.

3.24 As part of the DMMP study, placement alternatives were developed to manage dredged material from construction of the recommended navigation channel improvement plan. Once the channels are deepened, maintenance-dredging quantities are expected to increase. The DMMP has included these increased maintenance quantities in developing alternatives for long-term dredging and disposal needs.

Strategies

3.25 The twin goals of dredging the naturally shallow port while restoring and preserving the estuary were identified in the Interim Report for the DMMP (USACE-NYD 1996). The dredged material management options identified in the DMMP represent alternatives to the practice of dredged material placement at a designated ocean site. Avoiding ocean placement of dredged material (as opposed to remediation with suitable material of a site previously used for ocean disposal) is consistent with regulations promulgated under the Marine Protection, Research and Sanctuaries Act (MPRSA). The MPRSA authorizes the use of ocean disposal sites only if there is a demonstrated need to dredge and no practicable alternative for disposal is available (40 C.F.R. §227). The examination and inclusion of non-ocean options (including other aquatic options) that stress beneficial use and environmental protection/ restoration is also consistent

with the Comprehensive Conservation and Management Plan (CCMP) of the New York/New Jersey Harbor Estuary Program (HEP).

3.26 In identifying options to include in the DMMP, those that best utilize dredged material as a resource take preference as follows:

- Reduce the level of contaminants in the Harbor (contaminant reduction) and the volume of material to be dredged in the future (sediment reduction).
- Reduce the level or bioavailability of contaminants in dredged material (decontamination).
- Use dredged material in a beneficial manner (environmental restoration/remediation and construction/transportation projects).
- Dispose only of material that cannot feasibly be used beneficially.

3.27 The DMMP considers many factors in evaluating dredged material placement options to meet the listed priorities. These factors include economic benefits and costs, availability, capacity, environmental impacts (positive and negative), and support by the non-Federal partners. Several technical reports describing investigations of various options provide data on many of these factors. Results are summarized and referenced in the Technical Appendix to the DMMP (USACE-NYD 1999). A Programmatic Draft Environmental Impact Statement (PDEIS) for the DMMP has also been prepared to evaluate environmental concerns and benefits of each of the options under consideration (USACE-NYD 1999). In accordance with the National Environmental Policy Act (NEPA), the DMMP PDEIS is incorporated by reference in this FEIS as a means of providing widespread public review of the potential impacts of the recommended and alternate plans.

3.28 Some dredged materials from New York and New Jersey Harbor contain contaminants. These contaminants, whose concentrations vary, enter the waterways from a variety of different sources, many of which are outside the Harbor (including many upland sources). Some of the contaminants may occur at toxicity levels that pose a high risk to aquatic organisms or that tend to accumulate within the tissues of these organisms (bioaccumulation). Biological testing is performed to ascertain which dredged material presents such a risk. These tests are the basis for determining which sediments are suitable for ocean placement.

3.29 The approach used to characterize the potential short- and long-term biological impacts of the sediments proposed for dredging is a tiered approach. Tiered testing (bioassay and bioaccumulation) determines if any applicable water column toxicity criteria would be exceeded (liquid-phase testing), if uptake of contaminants by test organisms takes0 place (solid-phase testing), or if sediment exposure causes mortality of the test organisms (also solid-phase testing). Solid-phase testing involves a ten-day acute toxicity test and a 28-day bioaccumulation test. The tests provide a measure of the potential mobility (accumulation and movement through the food chain) of contaminants. Typical test organisms for marine habitats are mysid shrimp, amphipods, seaworms, or killifish. All tests feature control organisms as well as test organisms.

Typically the results of the bioassay and bioaccumulation are subjected to statistical analysis and are reviewed to determine the management requirements for sediment.

3.30 Since the closure of the ocean disposal site (Mud Dump) in October 1997, such testing has become the basis for determining whether material may be used at the HARS. Material under consideration for use at the HARS must meet the placement criteria established for the site in accordance with 40 C.F.R. §227. If the material is unsuitable for placement at the HARS, then it must be evaluated to determine its suitability for other management options.

3.31 Several management options to handle HARS-unsuitable material have been implemented as part of state or local ventures, private initiatives, or as public-private partnerships. Many of these options are in accordance with the PANYNJ plan and a New York and New Jersey dredging plan developed under the auspices of the two governors to maintain the bi-state port. These options provide sufficient capacity for HARS-unsuitable material to meet most maintenance needs through 2000. Additional efforts are underway to increase placement capacity by some 25 MCY over the next five years, with more to follow. These existing and future sites (described in the DMMP), when implemented, will provide sufficient capacity to meet dredging needs through the 2010 timeframe for the recommended navigation channel improvement plan, as well as through projected maintenance needs. Variations of those options that prove most successful will be pursued in accordance with a long-term strategy outlined in the DMMP to manage dredged material placement needs for the port through 2040 and beyond.

Management Options

3.32 As discussed above, the DMMP examined a wide range of options for the management and placement of dredged materials. As part of the DMMP, a placement options plan was developed to meet the needs of the recommended navigation channel improvement plan.

3.33 Details of the placement options considered for the dredged material resulting from the proposed navigation channel improvements and maintenance material are presented in Appendix B-1.5 to the DEIS.

Rock Blasting

3.34 The following rock-blasting information is based on data from dredging operations conducted for USACE-NYD from July 1991 to March 1993 in the Kill Van Kull as part of channel deepening to 42 ft MLW, and from other information provided by USACE-NYD (URS Greiner Woodward Clyde Federal Services [URSGWCFS] 1999; WCFS 1997).

3.35 On the basis of new and existing subsurface data collected by USACE-NYD, the elevation of the top of bedrock was measured in borings where it was encountered. A structure map showing the elevation of the top of bedrock was then prepared to show the location and horizontal extent of bedrock that will be encountered as the channels are deepened. This map was used to determine the location and volumes of rock that will require removal.

3.36 Metamorphic rock (serpentinite, gneiss, and schist) was found in the eastern portion of the Kill Van Kull and in the vicinity of Port Jersey. Diabase, an igneous rock, was identified in the western portion of the Kill Van Kull and Newark Bay. Sedimentary rock (shale and sandstone) was found in the Arthur Kill, Newark Bay, and South Elizabeth Channels. Rock was not encountered in any borings or vibracore samples taken in the Ambrose Channel or Gravesend Anchorage, nor was it encountered in Upper New York Bay Channels (Anchorage, Bay Ridge, Port Jersey, and Claremont) or anchorages (Red Hook Flats and Stapleton) above their projected dredge depths. However, in Port Jersey, rock overlain with hard consolidated sediments is found just below the projected maintenance dredge, requiring the additional two feet of underkeel safety clearance, and in several parts of the Kill Van Kull, Newark Bay, and Arthur Kill, it lies above the proposed navigation depths.

3.37 The channels where bedrock is to be blasted may be divided into five areas (Figure 3.2-1), as follows:

- Arthur Kill
- Serpentine rock area of the Kill Van Kull
- Diabase rock area of the Kill Van Kull
- Newark Bay and the South Elizabeth Channel
- Port Jersey Channel

3.38 Removal of rock will be accomplished by blasting and dredging. The selected blasting contractor will prepare location-specific blasting plans, including blast safety plans. Two different types of blasting plans are anticipated for deepening the channels in rock: Type I (Production) and Type II (Precautionary). Within each type of blasting plan different charge patterns are used, depending on the location. Each of these blasting plans and their associated patterns is described below:

- Type I (Production) blasting is proposed where vibratory effects of blasting are unlikely to exceed regulatory limits. Two blasting patterns, "Confined" and "Production," will be used, as shown in Figure 3.2-2. Type I blasting areas are shown in Figures 3.2-3 to 3.2-13.

- Type II (Precautionary) blasting is proposed where vibratory effects of blasting are likely to exceed regulatory limits at critical structures. Three blasting patterns, "Relief Trench," "Cautious Production," and "Production" will be used, as shown in Figure 3.2-14. Type II blasting areas are shown in Figures 3.2-3 through 3.2-13.

3.39 Because commercial use of the Kill Van Kull, Newark Bay, and Arthur Kill navigation channels must continue throughout the dredging program, these channels cannot be closed entirely during blasting and dredging operations. Typically, one side of a channel will be closed to navigation while blasting and dredging are carried out on the other side. Following completion of blasting and dredging on one side of a channel, navigation on that side will have to

be authorized by the Coast Guard before blasting and dredging can begin on the other side of the channel. Blasting will proceed either from the centerline of the channel outward to the edge of the proposed channel (Type I), or from the edge of the proposed channel to the centerline (Type II).

Estimates of Peak Particle Velocity (PPV)

3.40 The criterion for avoiding damage to structures subjected to transient or blasting vibrations is provided by the U.S. Bureau of Mines (1980). The Bureau has identified cracking of plaster walls in a one-story residential building as a threshold, determining that a peak particle velocity (PPV) of 2.0 in/sec was about half the PPV required to affect plaster walls. The measurement of PPV, defined as the maximum particle velocity in any direction, is used by both New York and New Jersey to monitor and regulate blasting programs. The typical regulatory PPV is 2.0 in/sec unless the question concerns a residential structure in New Jersey or a designated historic structure in New York, for which the maximum PPVs are 1.0 and 0.5 in/sec, respectively.

3.41 The threshold of human response to blasting vibrations is a PPV of about 0.02 in/sec. From this minimal value to the regulatory maximum PPV of 2.0 in/sec, humans feel vibrations. Because of their short duration, however, the vibrations—although a potential annoyance—pose no threat to human health. During previous blasting activities in the Kill Van Kull, a PPV of 0.3 in/sec proved to be the threshold of citizen complaints.

3.42 PPVs measured at a critical structure depend on the rock/soil type through which the vibrations are transmitted, the distance from the blast, and the size of the charge that is detonated. As seismic waves are transmitted from the source (point-detonation) outward to a receptor (critical structure), the seismic waves are attenuated, frequencies are reduced, and PPVs are also reduced.

3.43 Data recorded at seismographs from the blasting in the Kill Van Kull were used to estimate PPVs in two of the three rock types present in the project area. Data are thus available for the serpentinite and the diabase, but not for the shale/sandstone found in parts of the Kill Van Kull and throughout the Arthur Kill. For planning purposes, seismic data for serpentine rock were used to estimate the PPVs in the parts of the project area underlain by shale/sandstone.

3.44 Data from the Kill Van Kull seismograph records were divided into two groups, one each for serpentine and diabase rock types. These data were used as input to a standard PPV estimating program (Precision Blasting). The program generated a best-fit regression curve that related the charge weight in pounds to the distance in feet and the measured particle velocity for each of the two rock types in the Kill Van Kull.

3.45 The resulting regression equations were used to estimate distances from a point-detonation to specified PPVs for different charge weights per detonation for diabase and serpentinite (sandstone/shale) in the Kill Van Kull, Newark Bay, South Elizabeth, and Port

Jersey Channels. At various depths, the distances from the blast point to a critical structure were estimated for differing PPVs (2.0, 1.0, 0.5, and 0.3 in/sec) and blast-hole diameters. These estimates are provided for various blasting patterns for diabase in Table 3.2-1 and for serpentinite (sandstone/shale) in Table 3.2-2.

Monitoring

3.46 The contours shown in Figures 3.2-3 through 3.2-13 are estimates of PPVs during production blasting at the margins of the Kill Van Kull and Arthur Kill Channels. Sensitive structures such as bridges, churches, and historic properties within approximately 50 ft of the predicted regulatory PPV contours will be monitored to ensure that regulatory limits are not exceeded. All monitoring will be accomplished by means of seismographs placed near potentially critical structures. Pre-blast and post-blast surveys of these structures will also be conducted as part of the monitoring program. In addition, Public Information Meetings will be held in the blasting areas to describe the plan and to set up baseline structure parameters to use in determining subsurface rock blasting impacts.

No-blasting Areas

3.47 Damage to structures from vibrations depends upon several factors, including:

- The frequency of ground vibrations
- The dynamic response of the structure (its natural frequency and rigidity)
- The age of the structure
- The duration of the vibrations
- The initial condition of the structure
- The ground settlement beneath the structure produced by vibrations

3.48 Certain areas are designated as no-blasting areas at this time. These are areas where special planning and site-specific reviews by structural or geotechnical engineers or both are required before blasting may be permitted. Coordination with regulatory agencies and owners of the potentially affected properties may be required. In some cases, blasting may not be possible unless exceptions to regulatory limits are granted.

3.49 A general diagram showing the no-blasting areas is presented in Figure 3.2-15. These include the areas in proximity to the Goethals Bridge and the railroad bridge piers of the Arthur Kill, as well as the pipeline crossings in the Arthur Kill. Additional no-blasting zones have been designated near the northern pier of the Bayonne Bridge and pipeline crossings in Newark Bay.

3.3 Landside Elements

3.50 The EIS is generally limited to consideration of impacts directly associated with Harbor navigation channel improvements. As discussed in the Main Report, the future volume of commerce is expected to increase beyond the present capacity of the port, even if the channels are not improved. The expected increase in commerce will be addressed in a Comprehensive Port Improvement Plan (CPIP). In general, the landside impacts associated with the proposed project are related to noise, air quality and infrastructure issues. There will be an increase in truck and rail traffic as a result in the projected increase in port commerce. The increased truck

and rail traffic will result in greater road congestion, increases in engine emissions, and elevated noise levels. Landside impacts are discussed in greater detail in Section 6; however, it should be noted that the increases in air emissions will be partially offset by the reduced emissions from fewer ships.

3.51 Because the CPIP may recommend any of several major Federal or state actions (e.g., permits for fill to expand port facilities, modification/expansion of existing transportation networks, channel improvements, or habitat enhancement/restoration projects) that could have significant environmental effects, USEPA, USACE-NYD, and the non-Federal partners have developed and signed a Memorandum of Understanding (MOU) to clarify a cooperative approach for achieving landside improvement decisions (see Appendix B-1.8). The version of the MOU presented in Appendix B-1.8 contains the signatures of the parties as of the printing of this report. The decision making process associated with the potentially recommended actions in the CPIP requires the preparation of an EIS pursuant to NEPA. In light of this, and in an effort to consolidate and effectively use limited resources, the parties to this MOU will agree that the most effective approach is to prepare a comprehensive EIS on all contemplated landside improvement activities in the CPIP requiring Federal regulatory consideration.

3.52 Regardless of any agreements between the above-mentioned parties, the EIS for the Recommended Plan addresses projected impacts that will occur during the project implementation period at port facilities. It does not, however, address any proposed landside expansions or reconfigurations presented in the CPIP. The proposed CPIP-EIS will evaluate terminal-improvement impacts that are exclusive of the Recommended Plan's impacts.

INDEX

C

Comprehensive Conservation and Management Plan (CCMP) 6
Comprehensive Port Improvement Plan (CPIP) 11
CPIP 11, 12

D

Description of plan 1–12
  landside elements 11–12
  waterside elements 1–11
    blasting 8–11
    channel design 2–3
    dredging 3–8
DMMP 6, 7, 8
Dredged Material Management Plan (DMMP) 6

E

estuary 6

H

Harbor Estuary Program (HEP) 6
HARS 4, 7
Historic Area Remediation site (HARS) 4

N

National Economic Development (NED) Plan 1
NED Plan 1, 2, 3

P

Peak Particle Velocity (PPV) 9
PPV 9, 10, 11

TABLE 3.1-1
Recommended Channel Depths

Channel Name	Maintained Depth	Excavated Depth	Habitat Assessment Depth
Ambrose[1]	53 ft	53 ft	55 ft
Anchorage[2]	50 ft	50 ft	52 ft
Bay Ridge[3]	50 ft	50 ft	52 ft
Port Jersey	50 ft	52 ft	54 ft
Kill Van Kull	50 ft	52 ft	54 ft
Newark Bay	50 ft	52 ft	54 ft
Elizabeth[4]	50 ft	52 ft	54 ft
South Elizabeth[5]	50 ft	52 ft	54 ft
Arthur Kill[6] (to HH)	50 ft	52 ft	54 ft

HH – Howland Hook Marine Terminal

[1] Ambrose Channel extended 2400 ft toward the sea.

[2] Excavation from channel's southern end just north of the Verrazano Narrows to 1000 ft north of Port Jersey Channel entrance.

[3] Excavation of 600-ft-wide channel to South Brooklyn Marine Terminal and construction of 1600-ft diameter turning basin west of Terminal.

[4] Deepening of two adjacent berths to 50 ft MLW.

[5] Deepening of three adjacent berths to 50 ft MLW and widening of channel to 500 ft.

[6] Excavation to southern end of Howland Hook Marine Terminal.

TABLE 3.2-1
Estimated Minimum Distances from Detonation Point to Various Peak Particle Velocities in Diabase

		BLASTING PATTERN							
		Confined		Production		Cautious		Relief Trench	
Rock above Grade	Explosives Required	Charge 4 1/2" Diameter	Distance	Charge 4 1/2" Diameter	Distance	Charge 3 1/2" Diameter	Distance	Charge 3" Diameter	Distance
ft	ft	lbs	ft	lbs	ft	lbs	ft	lbs	ft
2.0 in/sec ppv - Regulatory Limit									
5	11	94	175	94	175	61	141	45	121
10	16	130	206	130	206	89	171	65	146
15	21	166	233	166	233	116	195	85	167
1.0 in/sec ppv - New Jersey Regulatory Limit for Residential Structures									
5	11	94	270	94	270	61	218	45	187
10	16	130	318	130	318	89	263	65	225
15	21	166	359	166	359	116	300	85	257
0.5 in/sec ppv- Historic Structures Limit (NYC)									
5	11	94	417	94	417	61	336	45	289
10	16	130	491	130	491	89	406	65	347
15	21	166	554	166	554	116	463	85	397
0.3 in/sec ppv- Threshold of Human Complaints during former blasting at the KVK									
5	11	94	574	94	574	61	462	45	397
10	16	130	675	130	675	89	559	65	477
15	21	166	763	166	763	116	638	85	546

TABLE 3.2-2
Estimated Minimum Distances from Detonation Points to Various Peak Particle Velocities in Serpentinite and Sandstone/Shale

		BLASTING PATTERN							
		Confined		Production		Cautious		Relief Trench	
Rock above Grade	Explosives Required	Charge 4 1/2" Diameter	Distance	Charge 4 1/2" Diameter	Distance	Charge 3 1/2" Diameter	Distance	Charge 3" Diameter	Distance
ft	ft	lbs	ft	lbs	ft	lbs	ft	lbs	ft
2.0 in/sec ppv - Regulatory Limit									
5	11	94	138	94	138	61	111	45	95
10	16	130	162	130	162	89	134	65	115
15	21	166	183	166	183	116	153	85	131
20	26	203	202	203	202	144	171	106	146
1.0 in/sec ppv - New Jersey Regulatory Limit for Residential Structures									
5	11	94	228	94	228	61	184	45	158
10	16	130	268	130	268	89	222	65	190
15	21	166	303	166	303	116	253	85	217
20	26	203	335	203	335	144	282	106	242
0.5 in/sec ppv- Historic Structures Limit (NYC)									
5	11	94	377	94	377	61	304	45	261
10	16	130	444	130	444	89	367	65	314
15	21	166	501	166	501	116	419	85	359
20	26	203	555	203	555	144	467	106	401
0.3 in/sec ppv - Threshold of Human Complaints during former blasting at the KVK									
5	11	94	547	94	547	61	441	45	378
10	16	130	643	130	643	89	532	65	455
15	21	166	727	166	727	116	608	85	520
20	26	203	804	203	804	144	677	106	581

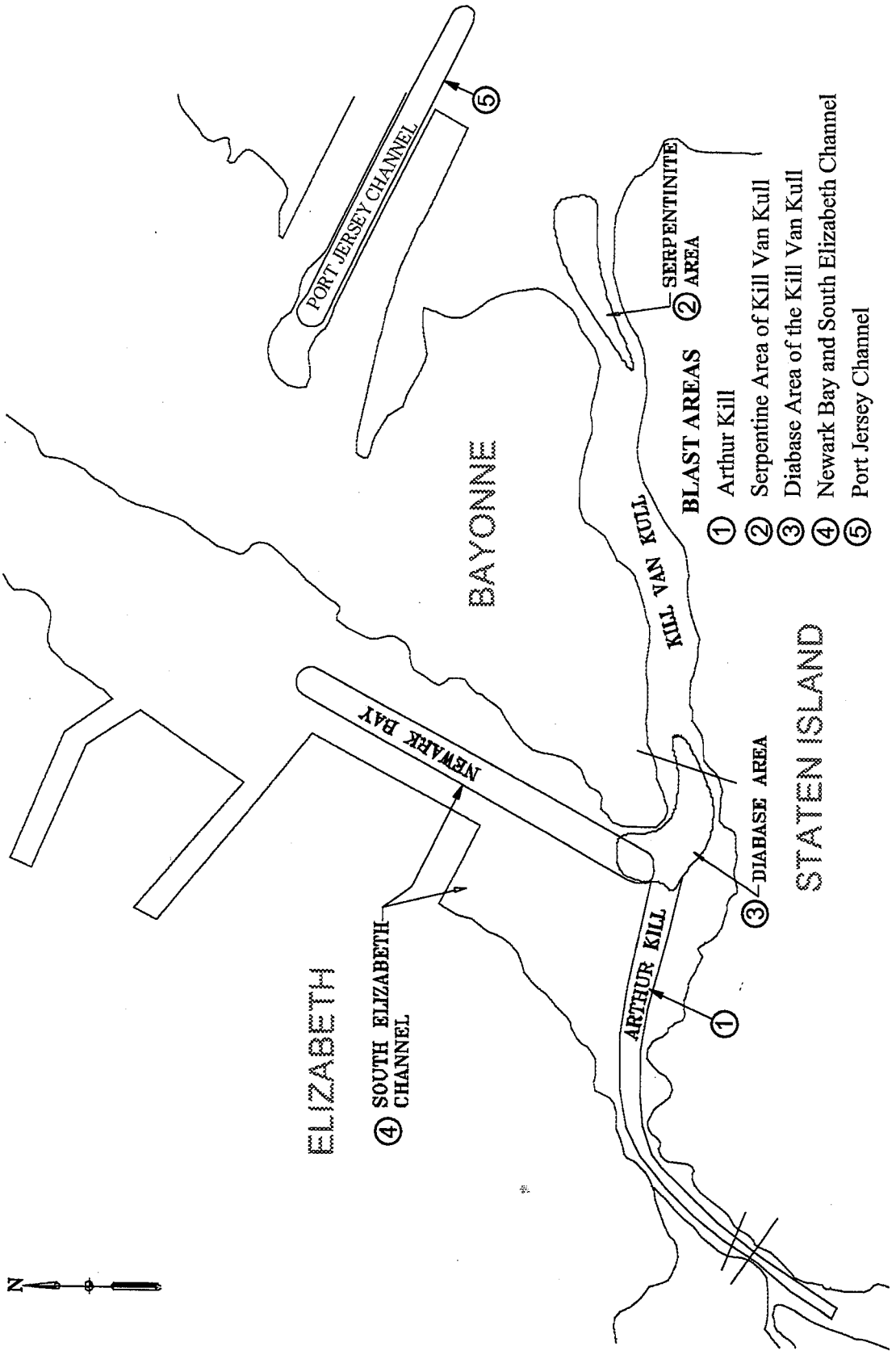


Figure 3.2-1 Locations of Areas to be Blasted

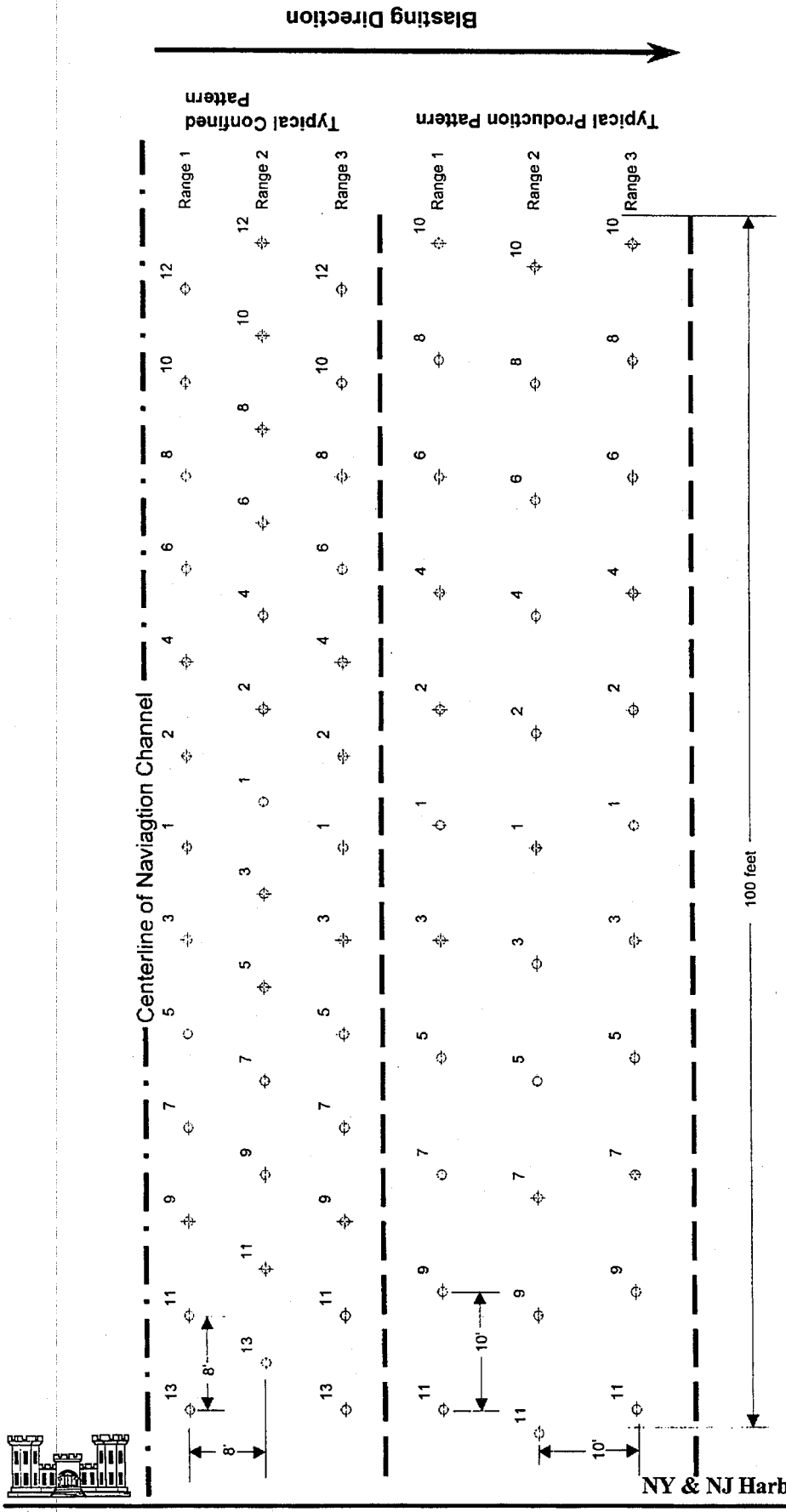


Figure 3.2-2 Typical Production (Type I) Blasting Plan

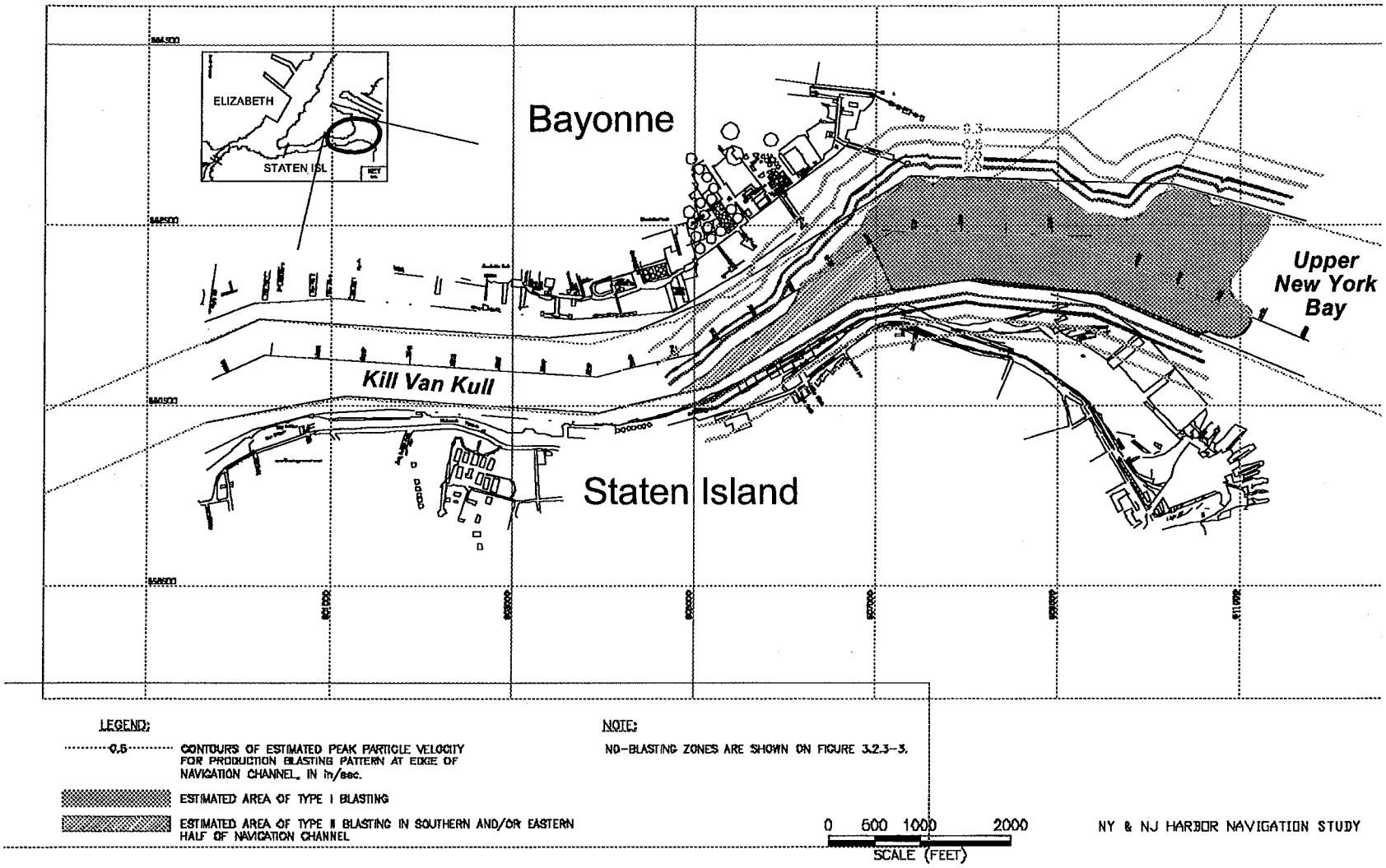


Figure 3.2-3 Summary of Blasting Plan - Increase in Depth 47-52 Feet, Kill Van Kull Serpentine Rock Area

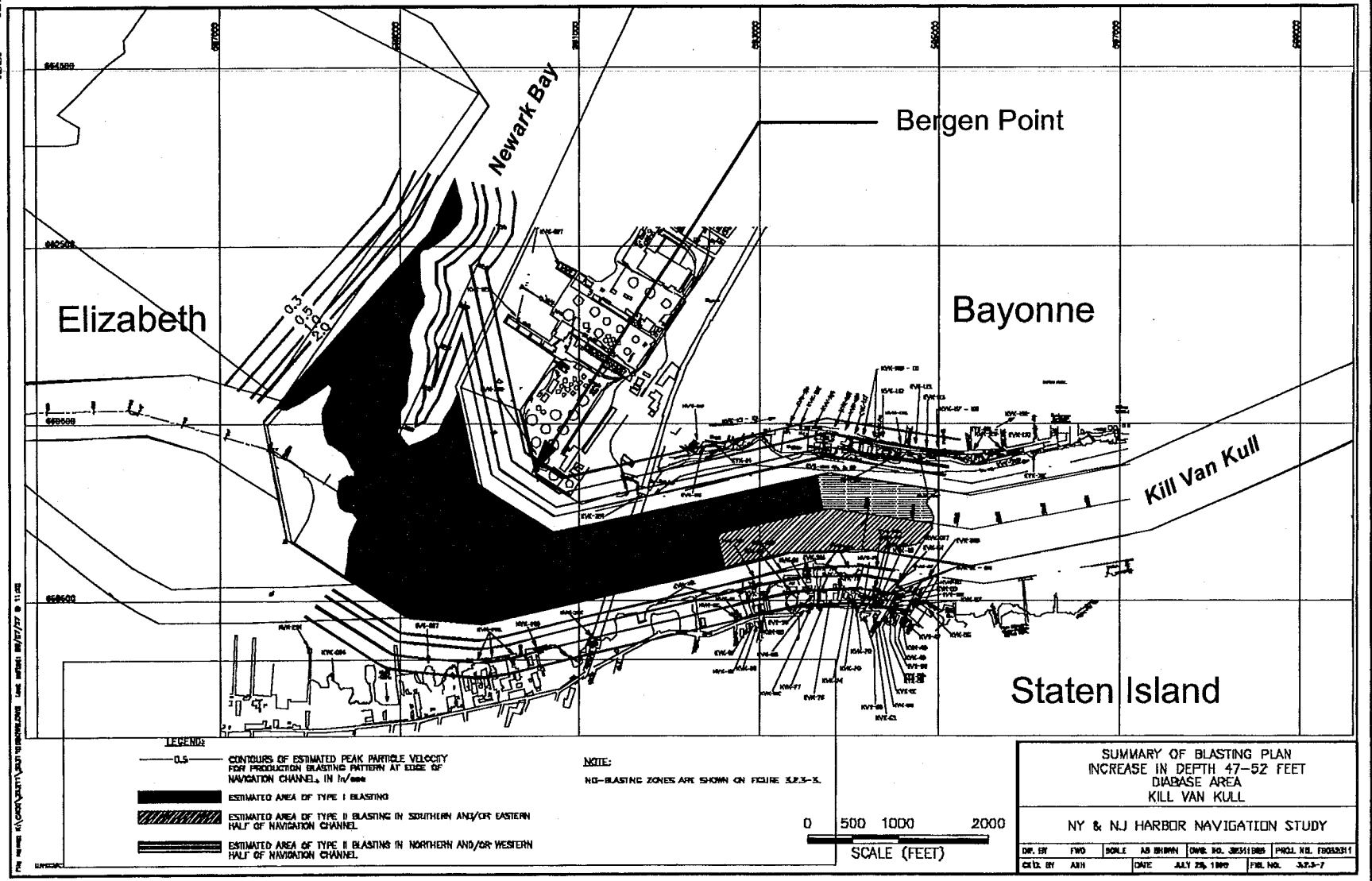


Figure 3.2-4 Summary of Blasting Plan - Increase in 47-52 feet Diabase Rock Area, Kill Van Kull

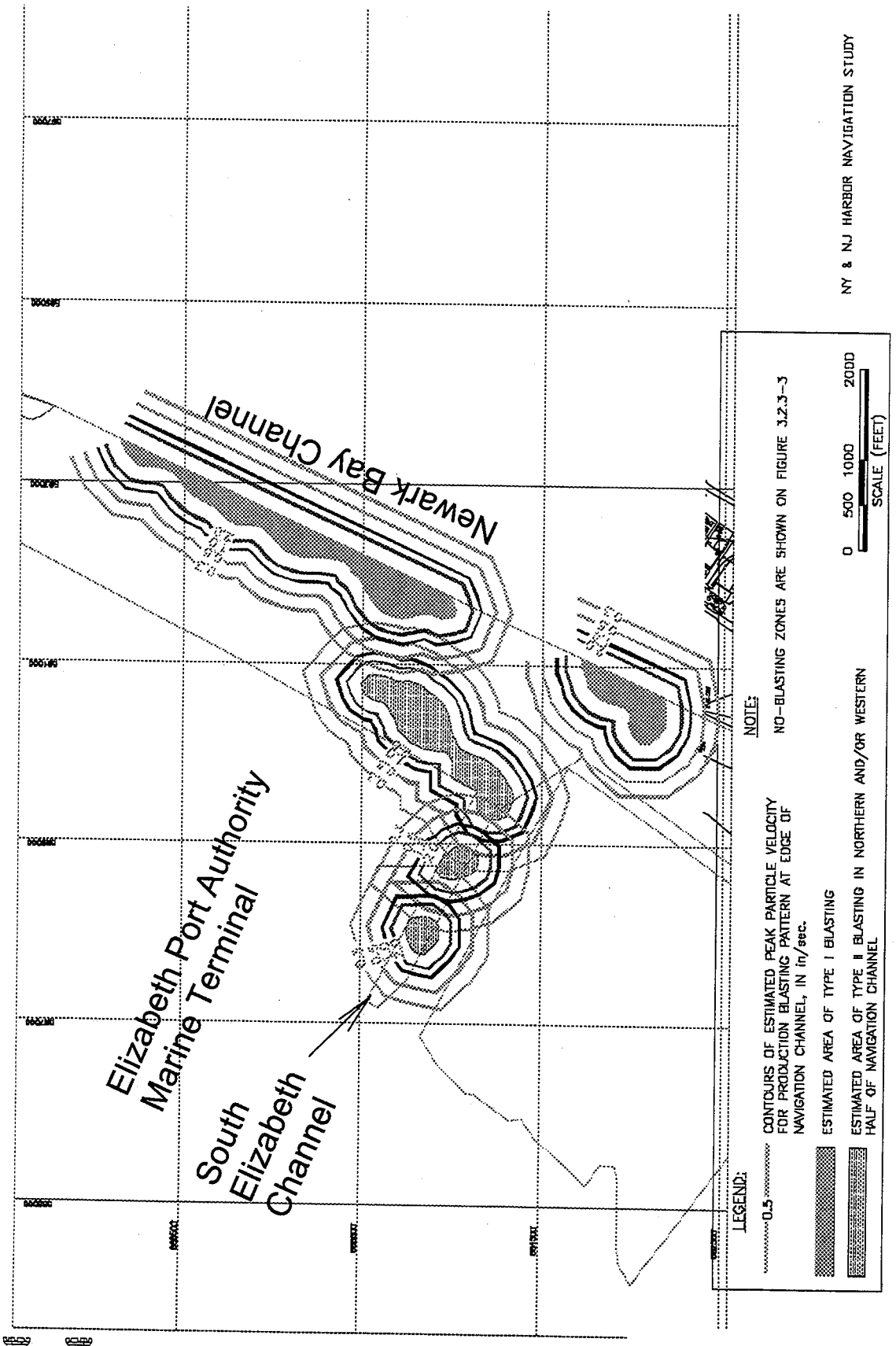


Figure 3.2-5 Summary of Blasting Plan - Increase in Depth 47-52 Feet, Newark Bay and South Elizabeth Channel

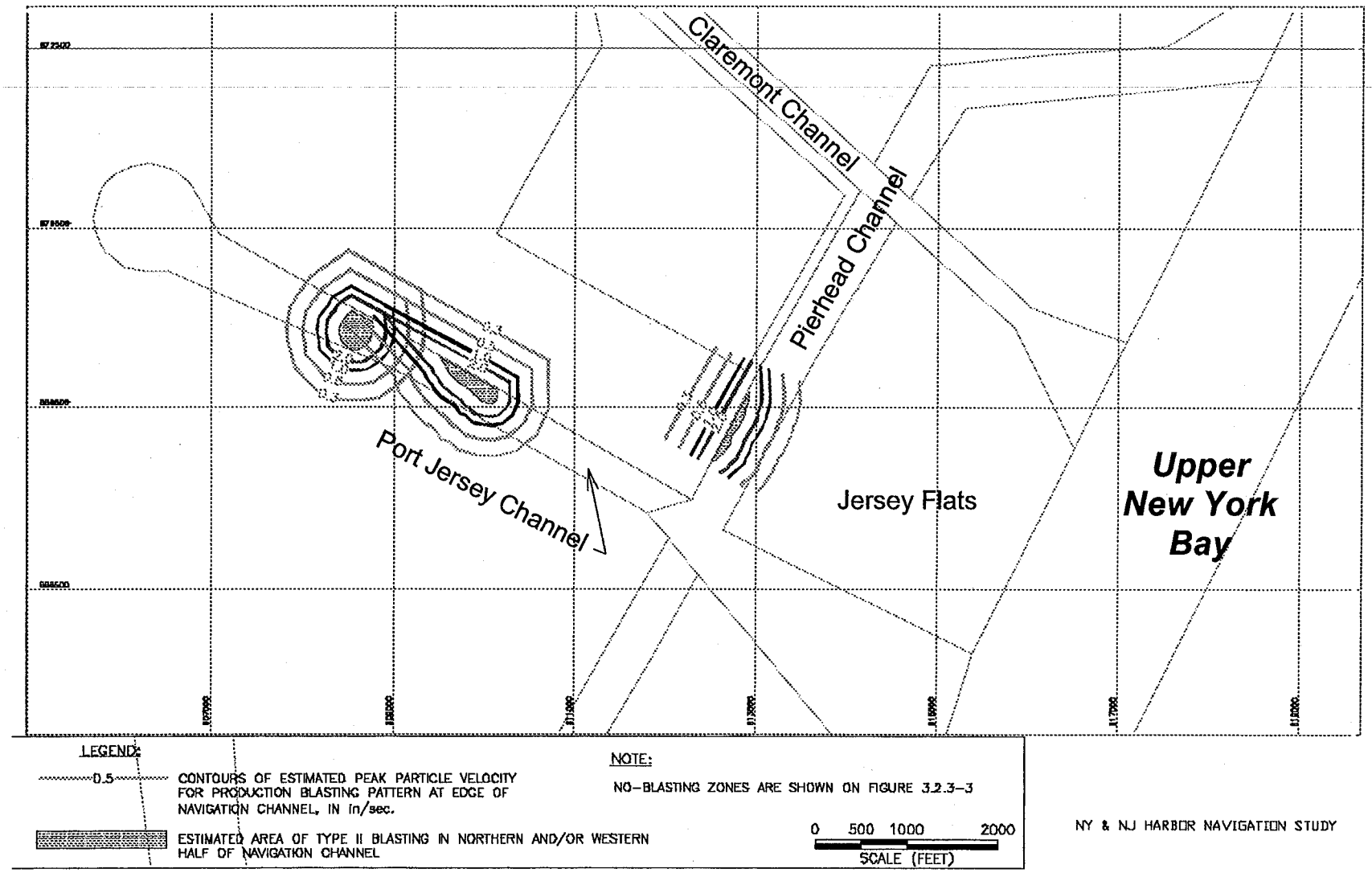


Figure 3.2-6 Summary of Blasting Plan - Increase in Depth 47-52 Feet, Port Jersey Channel

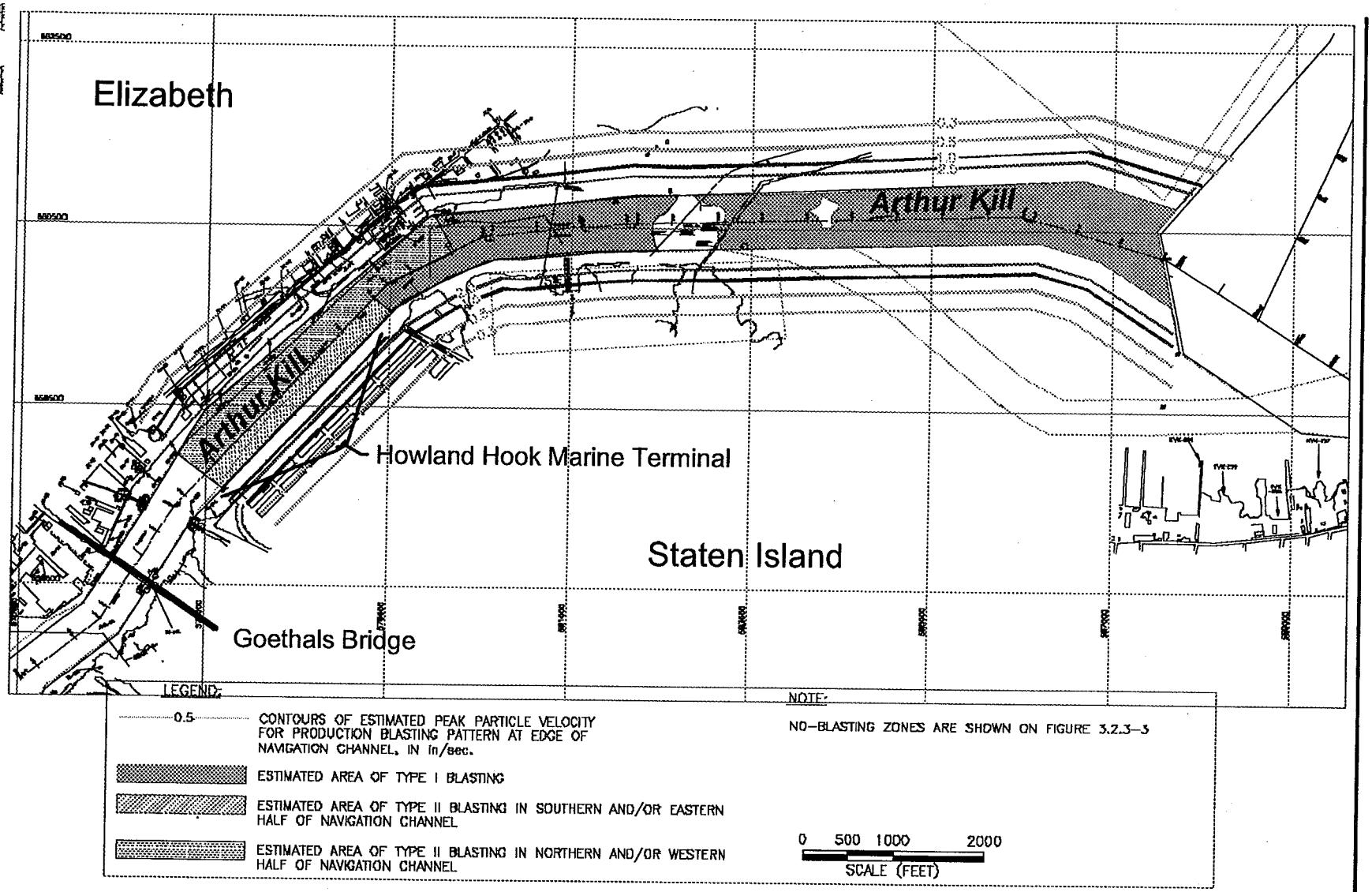


Figure 3.2-7 Summary of Blasting Plan - Increase in Depth 47-52 Feet, Arthur Kill

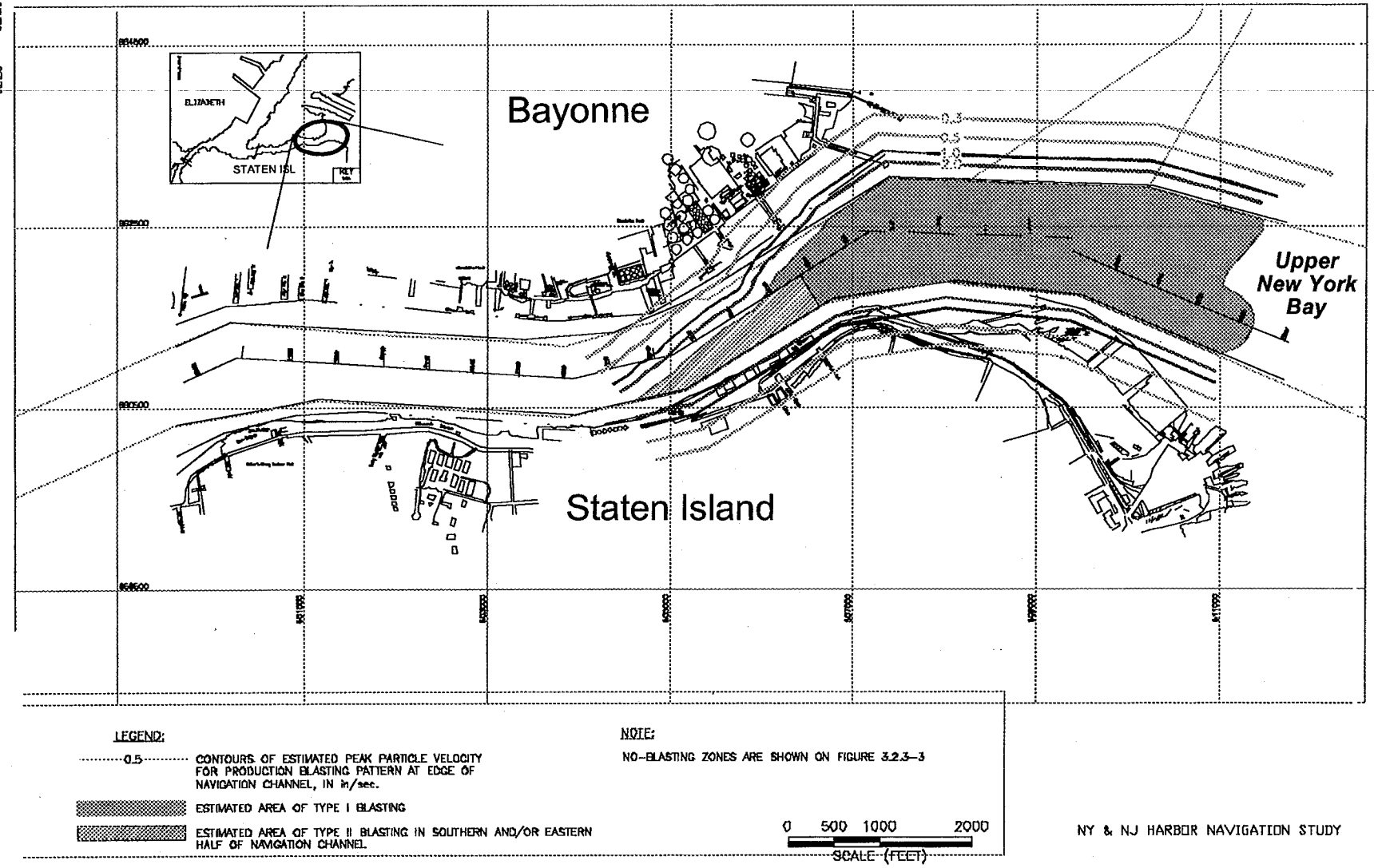


Figure 3.2-8 Summary of Blasting Plan - Increase in Depth 52-62 Feet, Kill Van Kull Serpentine Rock Area

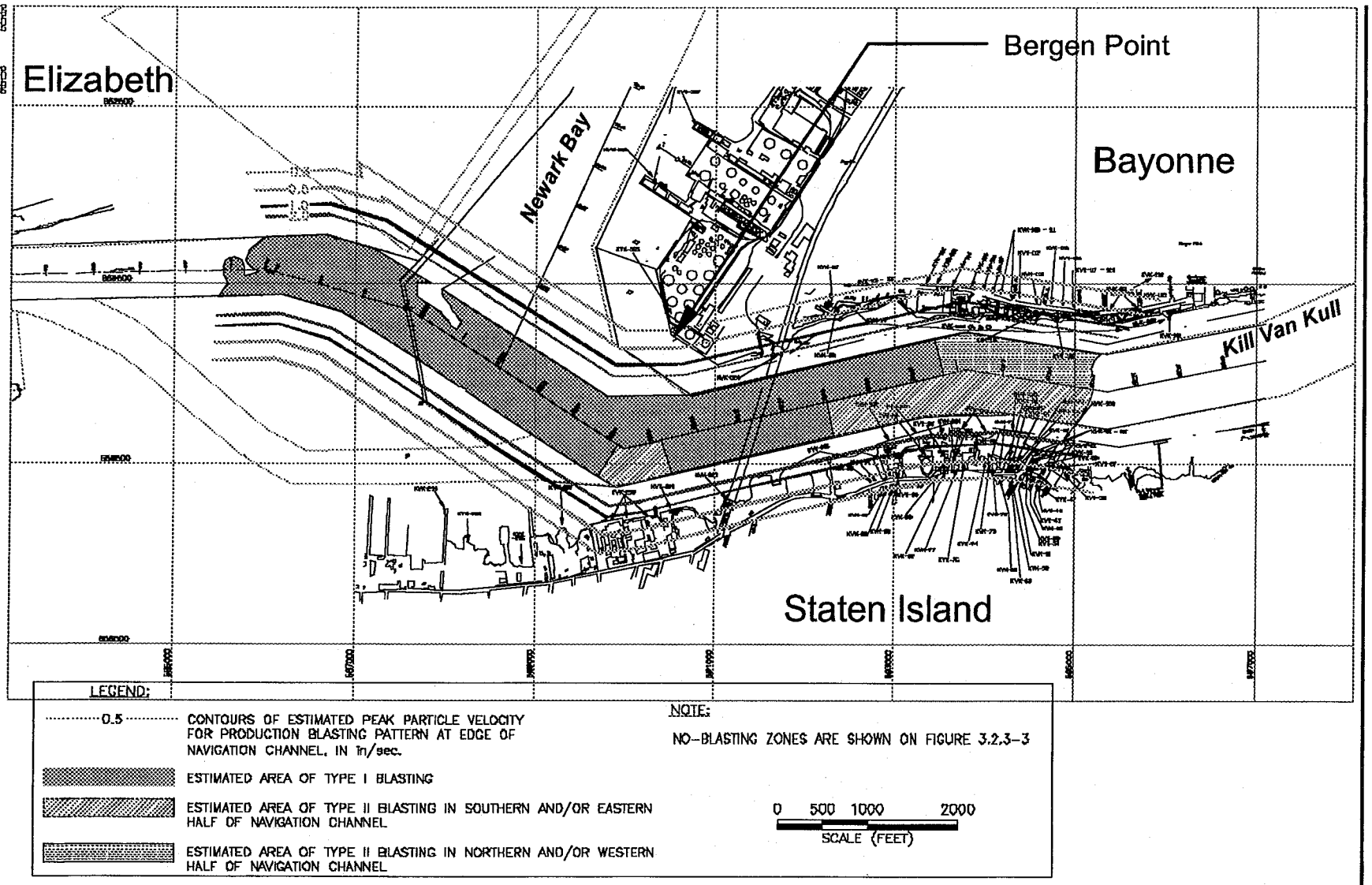


Figure 3.2-9 Summary of Blasting Plan - Increase in Depth 52-62 feet - Kill Van Kull Diabase Rock Area

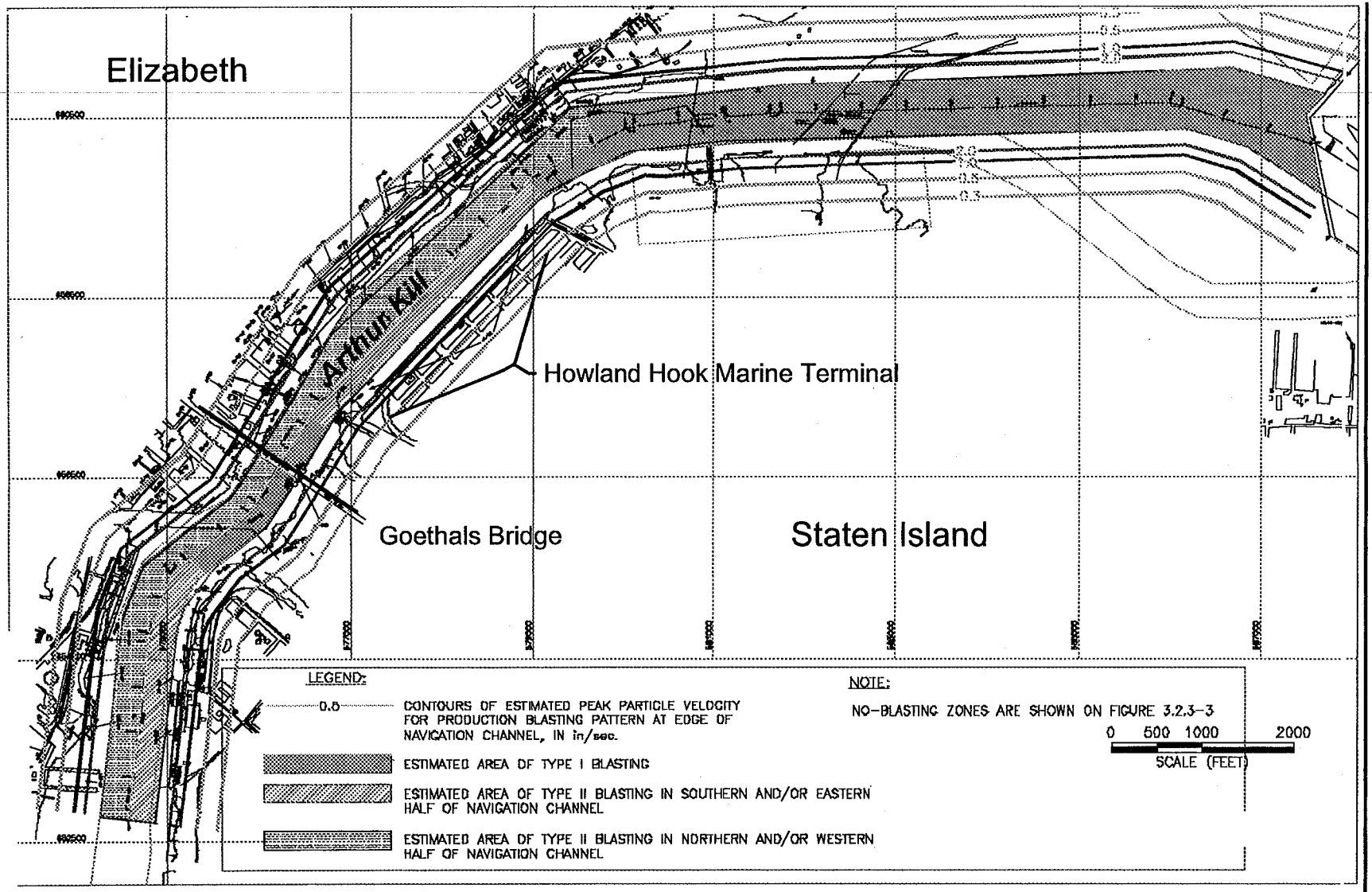


Figure 3.2-10 Summary of Blasting Plan - Increase in Depth 52-62 feet - Arthur Kill

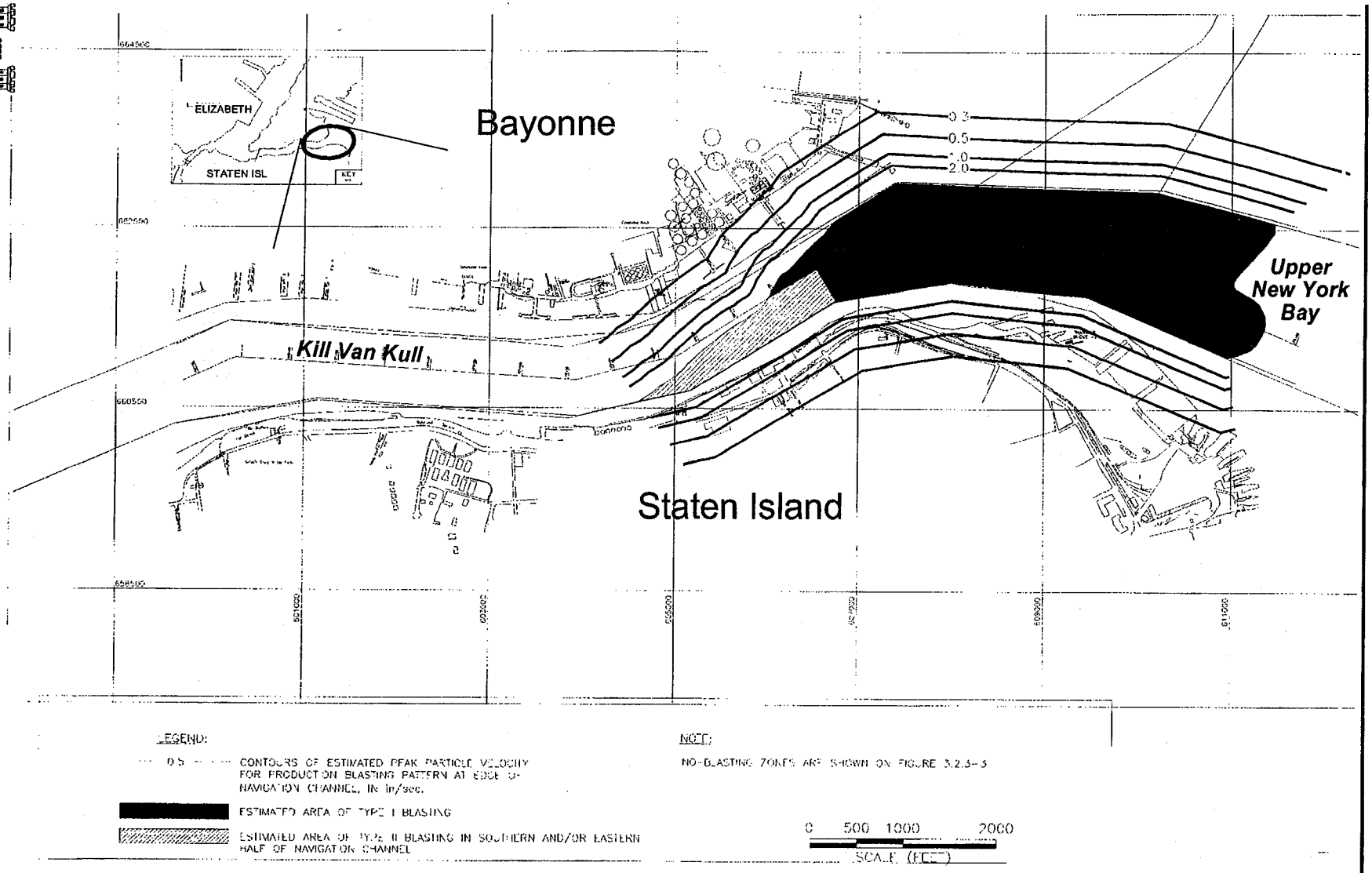


Figure 3.2-11 Summary of Blasting Plan - Increase in Depth 47-62 ft - Kill Van Kull Serpentine Rock Area

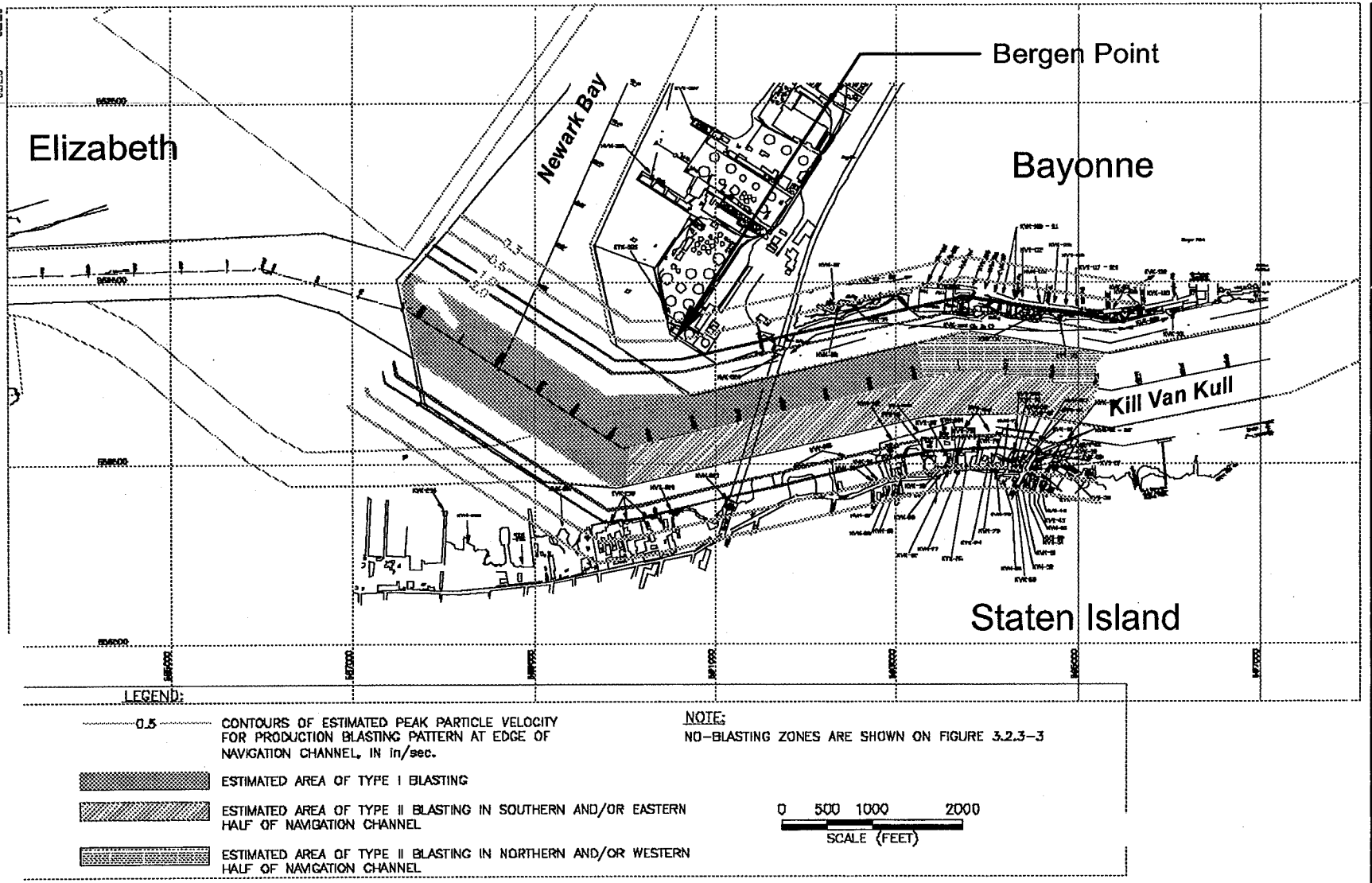


Figure 3.2-12 Summary of Blasting Plan - Increase in Depth 47-62 feet - Kill Van Kull Diabase Rock Area

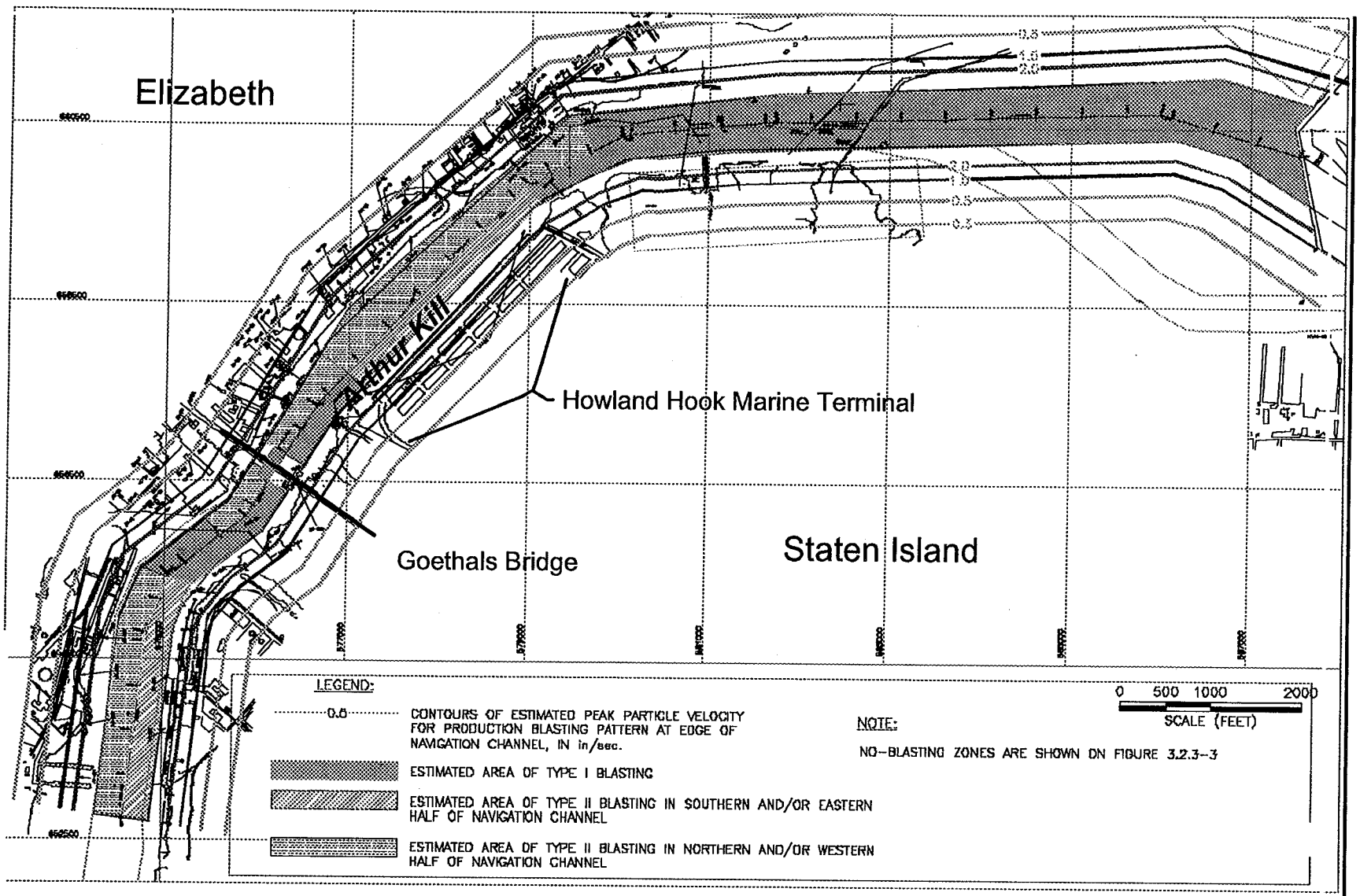


Figure 3.2-13 Summary of Blasting Plan - Increase in Depth 47-62 feet - Arthur Kill

Figure 3.2-14 Typical Precautionary (Type II) Blasting Plan

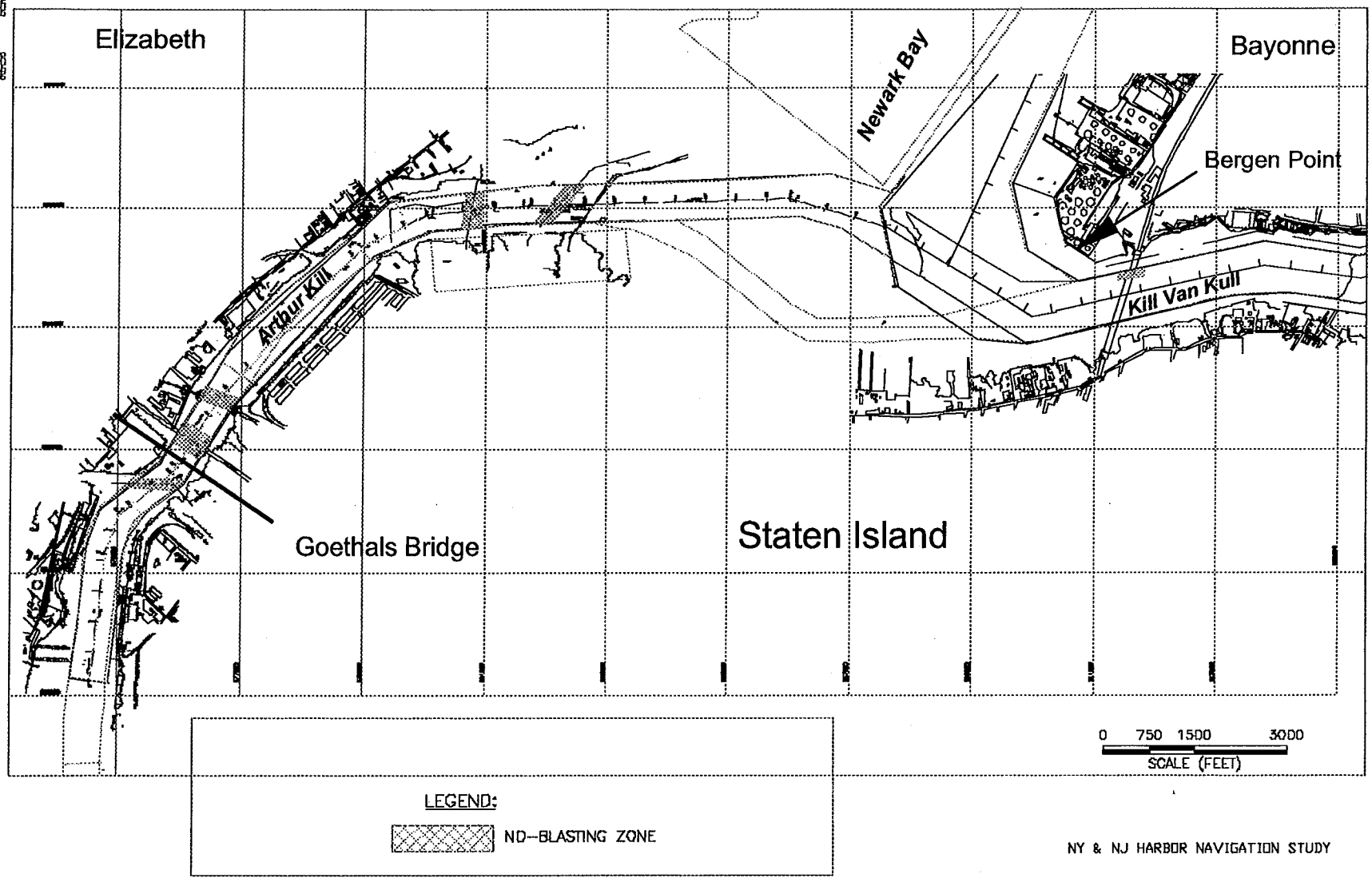


Figure 3.2-15 Summary of Blasting Plan - No Blasting Zones

4 WITHOUT-PROJECT CONDITION

4.1 General

4.1 The without-project condition is defined by the USACE Engineering Regulation (ER) 1105-2-100, *Guidance for Conducting Civil Works Planning Studies* (*Planning Guidance Notebook*) (USACE 1990, 1997) to be the future condition expected to occur within the study area in the absence of project implementation. The vast majority of goods entering the port is destined for the port's primary hinterland, which encompasses a landside area within a 260-mile radius of the Harbor. Forecasts indicate that, as a result of population growth, of development of worldwide markets, and of shifts in world trading routes, the quantity of goods passing through the Harbor may be expected to increase from 2.4 million TEUs/year today to over 19.1 million TEUs/year by the year 2060, independent of future channel deepening.

4.2 Non-Federal Partners' Comprehensive Port Improvement Plan

4.2 The non-Federal partners have developed a Comprehensive Port Improvement Plan (CPIP) that reflects their proposed terminal improvements (see Main Report for a detailed description). This plan, however, is reflective only of the non-Federal partners' level of commitment without Federal improvement. No inference of endorsement or other expression of approval of these plans on the part of USACE-NYD or any of the appropriate permitting agencies, including the USACE-NYD Operations Division, is intended or should be drawn. The plans put forward by the non-Federal partners to increase capacity in part through the expansion of container terminal area through fills, have not been included in the without-project condition.

4.3 The non-Federal partners' CPIP for the port's terminals is predicated upon maximizing market share by providing capacity to meet all demands for container-handling services predicted in their economic analysis. The plan, however, calls for development and expansion through land reclamation, a feature likely to meet with regulatory resistance. The plan has a strong level of commitment from the non-Federal partners, but the regulatory agencies responsible for permitting these developments have indicated that alternatives to fills must be evaluated, and a separate environmental analysis must be completed prior to construction. Following discussions among USEPA, USACE-NYD, and the non-Federal partners, it was determined that a CPIP-EIS would be required to determine how to prioritize and screen potential terminal expansions put forth in the non-Federal partners' CPIP.

4.3 Without-Project Condition

Shortage of Throughput Capacity

4.4 Unconstrained projections of the volume of commerce passing through the port

over the planning period (2010-2060) exceed the port's projected theoretical throughput capacity. At the present theoretical productivity of 1,500 lifts per acre per year, the port's terminals taken together are capable of handling 3.25 million TEUs (1.9 million containers, given the current mix of container sizes) annually. Assuming that by 2040 theoretical productivity rises to 3,500 lifts per acre per year, as discussed in the Main Report and the following sections, the port would then be capable of handling 7.1 million TEUs (4.5 million containers) annually. Commerce volume, however, is projected to grow to 19.1 million TEUs (11.2 million containers) annually by 2060 (even if the channels are not improved), leaving an annual throughput-capacity shortfall of 12 million TEUs (7.1 million containers). If this excess demand is to be fully or even partly accommodated, throughput capacity must be increased further.

4.5 This might be accomplished in any of several ways: productivity might be further increased, non-water-dependent facilities might be relocated upland to provide additional yard space, the terminals might be expanded, or new facilities might be developed. On the assumption that they will find it in their interest to increase capacity sufficiently to satisfy all demand for container-handling services implied by their economic forecast, the non-Federal partners have proposed expansion of terminal land area as the means of accommodating some portion of the forecast increase in trade through the port. Since waterfront land is scarce, the expansion and development of new facilities would require new waterfront fills. The non-Federal partners have indicated in this vision of the port that about 600 acres of new land for container terminals will be needed and that the required area will come mostly from new waterfront fills.

4.6 A review of the full build out plan, as envisioned by the non-Federal partners to capture all commerce predicted to come to the port, raised concern about the regulatory viability of expansions that required fill in open waters (a concern also expressed in the USEPA letter of 7 April 1999). As a result, it was determined that the most probable future condition, the required basis of the without-project future condition, consisted of enhanced productivity and reconfiguration of existing terminal areas to provide more container terminal area, as described below. This configuration does not require fills.

Productivity Increases

4.7 Due to advances in technology and to changes in cargo-handling procedures, theoretical land productivity (i.e., throughput per acre of port terminal space) is anticipated to increase gradually at 1-3% annually, but the cumulative impact should be quite dramatic. The non-Federal partners have predicted that theoretical land productivity will more than double over the next 40 years, increasing from 1,500 container lifts/acre/year now to about 3,500 lifts/acre/year in 2040. At approximately 1.7 TEUs per container lift, this means that throughput capacity is expected to increase from about 2,550 TEUs/acre/year to about 5,950 TEUs/acre/year.

Terminal Reconfigurations

4.8 Due to the uncertainty surrounding the viability of the fills, the Recommended

Plan was formulated on the basis of a without-project future condition that does not include fills and that does not capture all projected growth. The non-Federal partners have indicated that, in order to accommodate a portion of the projected growth in cargo, they expect to increase productivity and expand terminal yard area with or without channel deepening. These proposed terminal configurations/expansions, which do not involve waterfront fill, are presented as the without–project future condition. The Recommended Plan was formulated upon the same productivity increases and area expansions as described in the without-project future condition. Productivity, terminal area, and throughput are therefore the same in both the with- and without-project condition. The changes to terminal areas are not an indirect impact of the project because they will occur even if the project is not constructed.

4.9 The terminal reconfiguration at Port Newark, which consists of demolishing existing warehouses to provide 100 acres of additional productive container-terminal yard area, is included in the without-project condition. Similarly, a 100-acre terminal created at South Brooklyn was included in the formulation process as part of the without-project condition. The configuration of the proposed terminal does not involve the need for waterfront fills. The without-project condition for Port Jersey consists of the existing 100-acre Global Marine Terminal, a 130-acre portion of the former Military Ocean Terminal at Bayonne (MOTBY) property, and the reconfiguration of the 80 acres that currently comprise the Northeast Auto Terminal (NEAT). The following table summarizes the without-project condition for the terminals as used in the plan formulation, none of which require the placement of fill for land reclamation.

Terminal Descriptions – Without-Project Condition	
Terminal	**Description**
Port Newark/Elizabeth Port Authority Marine Terminal	1,050-acre container terminal, including all facilities (950 acres + 100 acres reconfiguration) – no fill
Howland Hook	147-acre container terminal – no fill
Port Jersey/MOTBY	310-acre container terminal, including MOTBY (100 acres + 80 acres NEAT + 130 acres MOTBY) – no fill
South Brooklyn	100-acre container terminal – no fill
Red Hook	No container terminal (converted to general cargo by 2010)
TOSCO/GATX	Oil facilities

4.10 The Main Report includes descriptions of the proposed new and expanded terminal developments, which will be detailed in the non-Federal partners' CPIP. Combined, these anticipated terminal reconfigurations result in an additional 410 acres of terminal area. This will result in an increase in throughput capacity from 7.1 million TEUs/year to 9.6 million TEUs/year in 2060 at the predicted theoretical productivity of 3,500 lifts per acre per year. The without-project condition is therefore based on a throughput capacity of 9.6 million TEUs/year entering the Port in the year 2060.

Channel/Anchorage Maintained Depths

4.11 Table 4.2-1 presents both the present and authorized dimensions of the Harbor's navigation channels and anchorages. This EIS uses these depths in the without-project condition.

4.4 Impacts of the Without-project Condition

4.12 Under the future without-project condition, navigation channel improvements would be limited to those presently authorized (see Table 4.2-1). Impacts to habitat, hydrology, water quality, biological resources, etc. due to the currently authorized channel improvements are described in the EIS for each respective project. The reader should refer to these documents for a discussion of the impacts associated with these projects (USACE 1997, USACE 1998).

Aquatic Impacts

4.13 Additional hydrodynamic and water quality modeling was performed for the without-project condition for this study in order to provide a baseline upon which to compare potential with-project impacts to these parameters. Water surface elevations for future without-project conditions are virtually unchanged throughout the system from existing conditions. The maximum difference in tidal range is less than 1.42 cm. Similarly, the changes in system temperature, salinity, and DO are small. The maximum increase in average salinity occurs in the Passaic River where the average salinity increase is estimated to be 0.3 ppt. There were no measurable changes in average salinity for the Hudson, East, or Harlem Rivers. Differences in DO levels between existing and baseline conditions were negligible at all locations. The largest reduction in DO was 0.2 mg/L. It should be noted that the commonly accepted accuracy limit for DO field measurements is 0.1 mg/L.

4.14 In addition to water quality issues related to the currently authorized channel improvements, water quality issues relative to the upland terminal improvements under the without-project condition were also considered. Since facility improvements at upland terminal sites will involve expansion onto existing developed land, no significant increases in impervious surfaces or runoff are expected. In any case, new projects will be required to comply with current stormwater management regulations. Environmental reviews and permitting actions associated with these projects will not allow significant water quality impacts to result. While it is true that temporary impacts to water quality may occur during construction, it is also true that mitigating measures to minimize such impacts will be required through the environmental review process.

4.15 In addition to the hydrodynamic and water quality modeling, an analytical model was developed for Upper New York Bay to evaluate potential wave impacts from ship wakes. The results suggest that the impact of ship wakes will increase under without-project conditions. The increase is not the result of construction of the authorized

channels under the without-project condition, but rather the result of an increase in the number of ship calls over time.

4.16 On a harborwide basis, the projected increase in throughput from about 3.25 million TEUs (year 2000) to 9.6 million TEUs (year 2060) will be accompanied by an approximately threefold increase in the number of ships entering the Harbor. This increase in ship traffic will result in an increase in air emissions. The projected air emissions increase will result not just from an increased number of vessels, but from vessel size: smaller ships entering the Harbor under the without-project condition will be (as they are today) relatively inefficient at maneuvering, mooring, loading, and unloading, especially when entering in large numbers. This will keep them in port longer, increasing air emissions still further under the without-project condition. Finally, in addition to potential air quality impacts related to the projected increase in ship traffic under the without-project condition, an increase in Harbor congestion and consequent navigation-related accidents is also possible.

4.17 An increased risk of petroleum-product spills during lightering may also be associated with the without-project condition. Of the vessels that currently enter the Harbor, the larger petroleum-product carriers require offshore lightering to decrease their draft and allow them to enter the Harbor's shallower channels. Under the without-project condition, it is expected that the number of petroleum carriers lightering will increase, thereby increasing the risk of product spills. Although this risk is not quantifiable, an increased risk of exposure of ecological receptors in the Harbor by petroleum contaminants is possible under the without-project condition.

Upland Impacts

4.18 No significant impacts to biological resources are anticipated from the improvements expected to take place at Harbor terminals, since these terminals are already paved, industrialized sites, and no expansions requiring fills are projected under the without-project condition. Potential minor and temporary impacts upon water quality may result, as mentioned above. Most of the upland impacts associated with the without-project condition will be related to the inland transportation infrastructure needed to transport the additional goods coming through the Harbor.

4.19 Associated with this are potential upland impacts related to traffic, air quality and noise. When the impact analyses for traffic, air quality, and noise were performed, these parameters were first evaluated with regard to the increase in traffic expected to occur regardless of the number of TEUs entering the Harbor. Each parameter was then evaluated with regard to the additional impacts related to the increase to 9.6 TEUs/year entering the Harbor under the without-project scenario. The following sections, therefore, discuss impacts that are not directly related to the amount of cargo entering the Harbor, as well as impacts related to the increase to 9.6 million TEUs/year entering the Harbor. Detailed analyses of traffic, air quality, and noise impacts are provided in Appendices B-1.9, B-1.10, and B-1.11, respectively. A summary of these analyses is provided below.

Traffic

4.20 As discussed previously, an increase in cargo throughput from a present level of approximately 3.25 million TEUs/year to 9.6 million TEUs/year is expected to occur under the without-project condition. A traffic analysis has been conducted (see Appendix B-1.9) to assess the impact of additional container traffic and employee traffic at the critical intersections near each of the four terminal sites. The traffic analysis at all four sites took into consideration projected regional growth in traffic volumes. It also took into consideration projects scheduled to be implemented nearby over the next ten years. The results of the analysis at each of the four terminal sites are discussed below.

4.21 Two-thirds of the additional throughput entering the Harbor will pass through the Port Newark/Elizabeth Port Authority Marine Terminal site. The specific projects considered near this site in the analysis are:

- Elizabeth Center at 13A (in the Port Authority Industrial Park)
- Jersey Gardens Mall Retail Development (OENJ)
- Kapkowski Road Upgrade/Extension Project
- Seaport International Retail Center Project
- Expressport Warehouse Project
- Warehouse Distribution Center Project
- Allied Chemical Warehouse Project
- Kapkowski Road Light Industrial/Warehouse Project.

4.22 The results of traffic analysis for the Port Newark/Elizabeth Port Authority Marine Terminal site indicate that traffic is projected to increase by 184% along North Avenue (the most highly impacted link) regardless of any increases in TEUs entering the Harbor. An increase to 9.6 million TEUs/year entering the Harbor will result in a further traffic increase of 19%, for a maximum cumulative increase in traffic of 203%. These increases will result in capacity deficits, for which Traffic Improvement Measures (TIMs) have been recommended. A list of TIMs for the Port Newark/Elizabeth Port Authority Marine Terminal, with a preliminary evaluation of their potential impacts, is shown in Table 4.4-1.

4.23 At Port Jersey/MOTBY, ambient traffic growth (regardless of any increases in TEUs entering the Harbor) is expected to result in a 27% increase in traffic volume at the most highly impacted intersection (Port Jersey Boulevard and West Pulaski Street). An increase to 9.6 million TEUs/year entering the Harbor is projected to increase traffic another 21%, for a maximum cumulative increase in traffic volume of 46%. This cumulative increase in traffic volume is expected to result in capacity deficits. To address these deficits, relatively minor TIMs have been recommended. They are shown in Table 4.4-1, along with a preliminary evaluation of their potential impacts.

4.24 At Howland Hook, the cumulative traffic impact, taking into account ambient growth and the expected increase to 9.6 million TEUs/year, is expected to result in an increase in traffic volumes ranging from 15 to 32%. The local intersections appear to have sufficient reserve capacity to handle this increase. However, capacity deficits at the Goethals Bridge will exist under either scenario (ambient growth only and ambient growth plus an increase to 9.6 million TEUs/year). Table 4.4-1 includes recommended TIMs (including the twinning of the Goethals Bridge), as well as a preliminary evaluation of the potential impacts associated with these TIMs.

4.25 At South Brooklyn, a 13% increase in traffic is projected based on ambient traffic growth only. A further increase in traffic volume of 5% at critical intersections is projected as a result of an increase to 9.6 million TEUs/year entering the Harbor, for a cumulative impact at these intersections of 18%. At this location, capacity issues on the Gowanus Expressway will exist whether or not TEUs entering the Harbor increase to 9.6 million per year, although capacity deficits will be greater with the projected increase in TEUs. Proposed TIMs (including local intersection improvements, as well as improvements to the Gowanus Expressway) are listed in Table 4.4-1, along with a preliminary evaluation of the their potential impacts.

Air Quality

4.26 Air quality for the without-project condition was evaluated on a local, or microscale level, projecting carbon monoxide impacts at local critical intersections. These impacts are a result of increased traffic carrying cargo and employees to and from the sites. This analysis considered the cumulative impact of the increase in TEUs to 9.6 million/year, together with other traffic growth over the project period. The impacts of the microscale analysis are summarized below and are provided in detail in Appendix B-1.10.

4.27 At Port Newark, the microscale analysis made use of a computer model to predict carbon monoxide concentrations at critical intersections. The worst-case cumulative impact (based on ambient traffic growth and traffic growth associated with an increase to 9.6 million TEUs/year) resulted in a 1-hour CO concentration of 9.5 ppm and an 8-hour concentration of 6.7 ppm (in 2060). The corresponding Federal and state standards are 35.0 ppm and 9.0 ppm, respectively.

4.28 At Port Jersey/MOTBY, the estimated cumulative impact, based on the microscale analysis, was a 1-hour CO concentration of 8.2 ppm and an 8-hour concentration of 5.7 ppm.

4.29 At Howland Hook, the estimated cumulative impact, based on the microscale analysis, was a 1-hour CO concentration of 6.4 ppm and an 8-hour concentration of 3.0 ppm.

4.30 At South Brooklyn, the estimated cumulative impact, based on the microscale analysis, was a 1-hour CO concentration of 8.6 ppm and an 8-hour concentration of 4.5 ppm.

4.31 These results are all within the applicable Federal and state standards for CO, and are based on the projected traffic data, with capacity deficits. In other words, the air quality results for the without-project condition described in this section are not dependent on the recommended transportation improvement measures.

Noise

4.32 A detailed analysis of noise impacts associated with an increase to 9.6 million TEUs/year entering the Harbor is provided in Appendix B-1.11. Noise impacts associated with the without-project condition will result primarily from increased truck and employee traffic. Regional (ambient) growth in traffic will add to this impact, resulting in a cumulative impact that has been quantitatively estimated. At present, terminals operate internally (ship unloading and loading) on a 24-hour/day basis without significant noise complaints. It is expected that gate operating hours (hence truck traffic) will be extended in the future as part of planned productivity improvements. However, it is not expected that gates will operate on a 24-hour/day basis. Currently, gate operations are 10 to 12 hours/day, 5 days/week. The extension of hours will affect traffic peaking, which has been accounted for in the traffic projections.

4.33 At the Port Newark/Elizabeth Port Authority Marine Terminal, the normal growth in ambient traffic (not accounting for any increases in TEUs entering the Harbor) is expected to increase noise levels 3 to 4 dbA on critical local streets (North Avenue). The cumulative impact (including the projected increase in TEUs) will add less than 1 dbA to this noise level. It is expected that some Category C (commercial) receptors may approach or exceed the FHWA Noise Abatement Criteria level of 72 dbA, based on ambient growth, potentially requiring some form of noise mitigation. The increase in cargo entering the Harbor to 9.6 million TEUs/year will not add significantly to this impact.

4.34 At Port Jersey/MOTBY, ambient traffic growth is expected to increase noise levels at critical intersections by less than 1 dbA. The increase to 9.6 million TEUs/year entering the Harbor will cause noise levels to increase by an additional 1 dbA, an imperceptible increase. Impacts above the FHWA Noise Abatement Criteria for Category B or C receptors are not expected.

4.35 At Howland Hook, ambient traffic growth is expected to increase noise levels by less than 1 dbA at local critical intersections. The increase to 9.6 million TEUs/year will increase this noise level by less than 0.5 dbA. According to local noise regulations, noise levels near the project site under either scenario will fall into the marginally acceptable to marginally unacceptable categories.

4.36 At South Brooklyn, ambient traffic growth is expected to increase noise levels by 1 to 2 dbA. The increase to 9.6 million TEUs/year entering the Harbor will result in less than a 0.5 dbA additional increase in noise levels. According to local noise regulations, noise levels near the project site under either scenario will fall into the marginally acceptable to marginally unacceptable categories.

INDEX

C

CPIP 1, 3

I

Impacts of without-project condition 4–10
- Air quality impacts 7–8
- Noise impacts 8–9
- Traffic impacts 6–7

P

Productivity increases 2

T

Throughput capacity, shortage of 1–2

W

Without-project condition, description of 2–4

TABLE 4.2-1
Federally Authorized and Maintained Channels and Anchorages in New York and New Jersey Harbor

Waterway	Authorized Depth	Authorized Width	Presently Maintained Dimensions
Ambrose Channel	45 ft MLW	2,000 ft	Authorized width is maintained. Due to sand mining by commercial interests, depths are greater in many areas than authorized 45 ft MLW.
Anchorage Channel	45 ft MLW	2,000 ft	Same as authorized. Little maintenance is required.
Kill Van Kull and Newark Bay	45 ft MLW (47 ft MLW in rock)	500 ft to 2,200 ft	Authorized width is maintained. Interim depth of 40 ft MLW is maintained pending construction of the deeper 45-ft MLW channel.
Arthur Kill to Gulfport	40 ft MLW	500 ft to 800 ft	Authorized widths are maintained. The previously authorized depth of 35 ft MLW is maintained at the present time, pending reauthorization of a 40-ft MLW interim depth. A GRR is underway for the 45-ft channel.
Port Jersey Channel	41 ft MLW	370 ft to 600 ft	Authorized width is maintained. A 35 ft/38 ft depth is maintained. Construction of a deeper Federal channel will federalize maintenance requirements.
Bay Ridge-Red Hook Channels	40 ft MLW	1,200 to 1,750 ft	Same as authorized.
Buttermilk Channel	35 ft MLW in the western half, 40 ft MLW in the eastern (or Brooklyn) half	1,000 ft	Same as authorized.
Claremont Channel (Including New Jersey Pierhead Channel)	42 ft MLW, subject to a favorable report by the Chief of Engineers (the favorable report of the Chief recommended an interim depth of 34 ft).	300-ft width authorized, subject to a favorable report by the Chief of Engineers.	A natural channel, 27 ft deep, roughly at the authorized width, exists and is being used, pending construction of the authorized channel.
Stapleton Anchorage	None, naturally 45 ft to 75 ft deep		None
Gravesend Bay Anchorage	47 ft MLW		Same as authorized.
Red Hook Flats Anchorage	45, 40 and 35 ft MLW south to north in federally maintained portions; 10 to 20 ft MLW in the northeast, unmaintained barge anchorage.		Same as authorized.

TABLE 4.4-1 (page 1 of 7)

Proposed Traffic Improvements/Harbor Improvement Projects and Potential Adverse Impacts

Proposed Traffic Improvement	Potential Adverse Impacts	Comments/Reference Document(s)
Port Newark/Elizabeth		
Widen North Avenue Bridge over I-95	The 1995 document identifies the presence of wetlands in the vicinity of the North Avenue/I-95 Bridge. Impacts identified include the following: land acquisition, utility relocation/disruption (construction), wetlands (both construction and permanent), water quality (construction related impacts to the Peripheral Ditch located northwest of the existing North Avenue Bridge), wildlife (construction) and hazardous materials (construction).	Environmental Document Report for the North Avenue East Improvements Project prepared by Killam Associates and dated April 1995 identifies impacts associated with roadway widening of North Avenue
Construct Express Rail Flyover on Corbin Street	The Corbin Street area is characterized by existing roadway. Conrail railway is situated west and existing port facilities are situated east of Corbin Street. Small isolated wetlands areas and/or open water are present at certain locations along Corbin Street. Impacts may include land acquisition, wetlands (both construction and permanent), utility relocation/disruption (construction), water quality (construction related impacts to the Peripheral Ditch located generally west of Corbin Street), wildlife (construction) and hazardous materials (construction).	
Redesign Doremus Avenue with a new bridge and connection to Central Avenue in Kearny	The proposed bridge would span the Passaic River. Impacts associated with the project may include the following: land acquisition (commercial, residential, vacant), utility relocation/disruption (construction), historic and archeological resources, visual resources, water resources, biotic communities including aquatic resources, wetlands (generally during construction), wildlife (construction in seasonal/critical periods), hazardous materials (during construction), and navigation (during construction).	

TABLE 4.4-1 (page 2 of 7)

Proposed Traffic Improvements/Harbor Improvement Projects and Potential Adverse Impacts

Proposed Traffic Improvement	Potential Adverse Impacts	Comments/Reference Document(s)
Construct a new Turnpike Exit to the Seaport from I-78, east of the I-95/I-78 interchange	The area adjacent to Turnpike/Route 78, east of the I-95/I-78 interchange is generally developed. Mapping identifies a surface water body and wetland area north of the NJ Turnpike extension east of the I-95/I-78 interchange. Impacts may include: land acquisition, wetlands (construction and permanent), utility relocation/disruption (construction), water quality (construction), wildlife (construction) and hazardous materials (construction).	
Construct a new "Truck Only" Turnpike Exit to the Seaport on I-95 between exits 13A and 14, in addition to or as an alternative to the new exit described above	Newark International Airport is located west and the Conrail railway and existing port facility are located east of the Turnpike corridor. The Peripheral Ditch runs along the eastern portion of the airport. Small isolated wetlands areas and/or open water areas are present at certain locations along the Turnpike Corridor. Impacts may include: land acquisition, utility relocation/disruption (construction), wetlands (construction and permanent), water quality (construction), wildlife (construction) and hazardous materials (construction).	
Port Jersey/MOTBY		
Street widening and signal timing adjustment at the Route 169/Pulaski Street intersection	The intersection is situated at a developed area at the entrance to the Port Jersey peninsula. Wetlands are unlikely to be of concern with regard to this area. Impacts may include: land acquisition, utility relocation/disruption (construction), and hazardous materials (construction).	Various environmental impact statements associated with the New Jersey Transit Light Rail Project include the Draft EIS dated November 1992, the Jersey City Supplement dated November 1995, the Bayonne Supplement dated November 1995 and the Final EIS dated 1996.

TABLE 4.4-1 (page 3 of 7)

Proposed Traffic Improvements/Harbor Improvement Projects and Potential Adverse Impacts

Proposed Traffic Improvement	Potential Adverse Impacts	Comments/Reference Document(s)
Construct grade-separated interchange at the Route 169/Prospect Avenue intersection	The intersection is situated at a developed area along Route 169. Wetlands are unlikely to be of concern with regard to this area. A church and associated school are located west of the existing interchange. Impacts may include: land acquisition, utility relocation/disruption (construction), historic resources, and hazardous materials (construction).	Various environmental impact statements associated with the New Jersey Transit Light Rail Project include the Draft EIS dated November 1992, the Jersey City Supplement dated November 1995, the Bayonne Supplement dated November 1995, and the Final EIS dated 1996.
Change signal timings and redesign the 32nd Street/Avenue E intersection	The intersection is situated at a developed area along Avenue E. Wetlands are unlikely to be of concern with regard to this area. Impacts may include: land acquisition, utility relocation/disruption (construction), and hazardous materials (construction).	Various environmental impact statements associated with the New Jersey Transit Light Rail Project include the Draft EIS dated November 1992, the Jersey City Supplement dated November 1995, the Bayonne Supplement dated November 1995, and the Final EIS dated 1996.
Restripe and/or widen the Port Jersey Boulevard NB approach ramp at the 53rd Street/Port Jersey Boulevard/Avenue E intersection	The intersection is situated at a developed area at the entrance to the Port Jersey peninsula. Wetlands are unlikely to be of concern with regard to this area. However, isolated, marginal wetland areas may be in the vicinity of the intersection. Impacts may include: land acquisition, utility relocation/disruption (construction), and hazardous materials (construction).	Various environmental impact statements associated with the New Jersey Transit Light Rail Project include the Draft EIS dated November 1992, the Jersey City Supplement dated November 1995, the Bayonne Supplement dated November 1995, and the Final EIS dated 1996.
Widen the streets and install a traffic signal at the Port Jersey Boulevard/West Pulaski Lane intersection	The intersection is situated at a developed area within the Port Jersey peninsula. Wetlands are unlikely to be of concern with regard to this area. Impacts may include: land acquisition, utility relocation/disruption (construction), and hazardous materials (construction).	Various environmental impact statements associated with the New Jersey Transit Light Rail Project including the Draft EIS dated November 1992, the Jersey City Supplement dated November 1995, the Bayonne Supplement dated November 1995, and the Final EIS dated 1996.

TABLE 4.4-1 (page 4 of 7)
Proposed Traffic Improvements/Harbor Improvement Projects and Potential Adverse Impacts

Proposed Traffic Improvement	Potential Adverse Impacts	Comments/Reference Document(s)
Redesign and/or signalize the 40th Street/Avenue E intersection (2020)	The intersection is situated at an existing entrance to MOTBY. Wetlands are unlikely to be of concern with regard to this area. Impacts may include: land acquisition, utility relocation/disruption (construction), and hazardous materials (construction).	Various environmental impact statements associated with the New Jersey Transit Light Rail Project include the Draft EIS dated November 1992, the Jersey City Supplement dated November 1995, the Bayonne Supplement dated November 1995, and the Final EIS dated 1996.
Howland Hook		
Expansion or twinning of the Goethals Bridge	Impacts are described in the May 1995 USCG Draft EIS document. Specific impacts vary with alternatives. The following impacts have been identified with regard to one or more of the proposed alternatives: land acquisition (commercial, residential, vacant), utility relocation/disruption (construction), historic and archeological resources, visual resources, water resources, biotic communities including aquatic resources, wetlands (generally during construction), wildlife (potential impacts to endangered species during construction in seasonal/critical periods), hazardous materials (during construction), and navigation (during construction).	U.S. Coast Guard Staten Island Bridges Program, Draft Environmental Impact Statement/Draft Section 4(f) Statement, May 1995
Installation of traffic signals and/or redesign of the intersections at Goethals Road North/Western Avenue, Goethals Bridge North/Forest Avenue, and/or Gulf Avenue/Forest Avenue, if necessary	Wetlands are present in the vicinity of the intersections. Impacts will be based on specifics of each project. In general, impacts may include the following: land acquisition, utility relocation/disruption (construction), wetlands (construction and permanent), water quality (construction) , wildlife (construction) and hazardous materials (construction).	U.S. Coast Guard Staten Island Bridges Program, Draft Environmental Impact Statement/Draft Section 4(f) Statement, May 1995

TABLE 4.4-1 (page 5 of 7) Proposed Traffic Improvements/Harbor Improvement Projects and Potential Adverse Impacts		
Proposed Traffic Improvement	**Potential Adverse Impacts**	**Comments/Reference Document(s)**
Widen Western Avenue north of Goethals Road North to two lanes in each direction—this could be required if project-related trucks/autos are routed to a potential new facility entrance located north of the existing entrance on Western Avenue, if necessary	Wetlands areas, open water and subsurface utilities are situated along the Western Avenue Roadway corridor. In general, impacts may include the following: land acquisition, utility relocation/disruption (construction), wetlands (construction and permanent), water quality (construction) , wildlife (construction) and hazardous materials (construction).	U.S. Coast Guard Staten Island Bridges Program, Draft Environmental Impact Statement/Draft Section 4(f) Statement, May 1995
South Brooklyn		
Redesign intersection and retime traffic signal at the Second Avenue/39th Street/Gowanus Expressway Off-Ramp intersection	The proposed project involves an existing intersection in a developed area. Wetlands are not anticipated to be a concern. Impacts may include: land acquisition, utility relocation/disruption (construction), and hazardous materials (construction).	The Gowanus Expressway Project I-278 from 92nd Street to BBT/Hamilton Avenue Interchange prepared by US Department of Transportation, Federal Highway Administration and NYSDOT and dated August 1995
Redesign intersection and retime traffic signal at the Third Avenue/39th Street intersection	The proposed project involves an existing intersection in a developed area. Wetlands are not anticipated to be a concern. Impacts may include: land acquisition, utility relocation/disruption (construction), and hazardous materials (construction).	The Gowanus Expressway Project I-278 from 92nd Street to BBT/Hamilton Avenue Interchange prepared by US Department of Transportation, Federal Highway Administration and NYSDOT and dated August 1995
Redesign intersection and retime traffic signal at the Fourth Avenue/39th Street intersection	The proposed project involves an existing intersection in a developed area. Wetlands are not anticipated to be a concern. Impacts may include: land acquisition, utility relocation/disruption (construction),and hazardous materials (construction).	The Gowanus Expressway Project I-278 from 92nd Street to BBT/Hamilton Avenue Interchange prepared by US Department of Transportation, Federal Highway Administration and NYSDOT and dated August 1995

TABLE 4.4-1 (page 6 of 7)

Proposed Traffic Improvements/Harbor Improvement Projects and Potential Adverse Impacts

Proposed Traffic Improvement	Potential Adverse Impacts	Comments/Reference Document(s)
Reconstruct and improve the Gowanus Expressway	Impacts are described in the August 1995 document. The following impacts have been identified with regard to one or more of the options outlined in the rehabilitation project: land acquisition (commercial, portions of a playground and parkland), archeological resources and hazardous materials (construction). Short term impacts associated with construction activities include impacts to the structure and the ground (new lateral drains) as well as dust and noise at certain locations.	The Gowanus Expressway Project I-278 from 92nd Street to BBT/Hamilton Avenue Interchange prepared by US Department of Transportation, Federal Highway Administration and NYSDOT and dated August 1995
Harbor-Wide Projects		
Portway	This project involves upgrading highway facilities and building a cohesive connected freight-handling and distribution system along a 20-mile route in northeastern New Jersey. The project includes rehabilitation of existing roadways and expanding bridge and railway capacity to relieve congestion on existing roadways. Impacts would be based upon proposed improvements at specific locations within the project area. In general, impacts may include the following: land acquisition, utility relocation/disruption (construction), historic and archeological resources, visual resources, water resources, biotic communities including aquatic resources, wetlands, wildlife, hazardous materials (during construction), and navigation (bridge capacity expansion during construction).	

TABLE 4.4-1 (page 7 of 7)
Proposed Traffic Improvements/Harbor Improvement Projects and Potential Adverse Impacts

Proposed Traffic Improvement	Potential Adverse Impacts	Comments/Reference Document(s)
Cross-Harbor Tunnel	New York Economic Development Corporation (EDC) has performed a Cross Harbor Freight Movement Major Investment Study (MIS) to evaluate the region's freight movement. Alternatives to connect facilities east of the Hudson with transportation facilities on the west include expanded car float service and two cross-harbor tunnel alternatives (a cross-harbor rail tunnel between either Staten Island or Greenville Yards). Impacts associated with the selected alternative may include the following: land acquisition, utility relocation/disruption (construction), historic and archeological resources, visual resources, water resources, biotic communities including aquatic resources, wetlands, wildlife, hazardous materials (during construction), and navigation (during construction).	
Staten Island Railroad	Reactivation of the Staten Island Railroad and Arlington Yards to provide access to Howland Hook Terminal via New Jersey. Wetland areas have been identified in the vicinity of the existing railway. Impacts associated with the reactivation of the railroad may include the following: land acquisition, utility relocation/disruption (construction), historic and archeological resources, visual resources, water resources, biotic communities including aquatic resources, wetlands, wildlife, hazardous materials (during construction) and navigation (reactivation of the Arthur Kill Lift Bridge).	

5 AFFECTED ENVIRONMENT

5.1 Study Area

Location

5.1 The purpose of this section is to provide a comprehensive description of the study area that may be affected by the proposed channel deepening. Information contained in this section was obtained from various literature sources, the New York and New Jersey Harbor Baseline Biological Reconnaissance Survey (USACE 1999a), and ongoing sampling programs.

5.2 The New York and New Jersey Harbor is located at the apex of the New York Bight. It serves as the port for the greater metropolitan New York area, providing maritime access to shipping terminals via a network of dredged and maintained channels and anchorages throughout the Harbor. The Harbor's channels, as shallow as 18 ft without dredging, are maintained at 35 to 45 ft by dredging. The shoal and channel areas provide diverse habitats that are used by different species on a seasonal basis. The rivers and tidal straits that form part of the Harbor offer habitat with higher tidal currents. Taken together, the different habitat types provide a complex estuarine system, but one that has been greatly influenced by man's activities (USACE-NYD 1998).

5.3 The Harbor comprises four large embayments: Upper and Lower New York Bay, Newark Bay, and Raritan Bay. The Verrazano Narrows connects Upper New York Bay and Lower New York Bay. Newark Bay, the smallest of the four, is linked to the other embayments by narrow, natural waterways: to Upper New York Bay by the Kill Van Kull, and to Raritan Bay/Lower New York Bay by the Arthur Kill. The Harbor also contains a network of public and private channels and berths (Wakeman et al. 1996, USACE 1999b).

5.4 The New York and New Jersey Harbor exists within the confines of the Hudson-Raritan estuary. An estuary is a semi-enclosed coastal body of water having a free connection with the open sea. It is strongly affected by tidal action and by seawater, mixing (measurably diluted) with freshwater from land drainage (Odum 1971). Estuaries are transition zones between freshwater and marine habitats. The Hudson-Raritan estuary extends from the Troy Dam on the upper Hudson River in New York State to the Sandy Hook-Rockaway Point Transect of the Harbor's entrance. The Harbor portion of the estuary includes the bi-state waters of Raritan Bay, Lower New York Bay, Upper New York Bay, Hudson River, Kill Van Kull, Arthur Kill, and smaller New Jersey tributaries. These include: the Passaic and Hackensack Rivers, which empties into Newark Bay; the Raritan River, which empties into Raritan Bay; and New York's East River, which enters Upper New York Bay at the southern end of Manhattan (Martin et al. 1996) (Figure 5.1-1). The Harbor portion of the estuary includes approximately 298 square miles of surface water and has an average depth of 21-ft (USACE 1999b).

5.5 Habitat types found in the Harbor include tidal rivers, salt and freshwater tidal marshes, woodlands, shallow bays, barrier beaches, and sand dunes. Water is the predominant habitat

type. Salt and freshwater tidal marshes cover 180,000 acres in New Jersey and 25,000 acres in New York. The greatest extent of Harbor marshes is found outside the proposed study area (USACE 1999b). The New York and New Jersey Harbor supports diverse and productive finfish, crustacean, and shellfish populations, with over 100 species of fish. Many of the species are of commercial and recreational importance. The list includes striped bass (*Morone saxatilis*), winter flounder (*Pleuronectes americanus*), lobster (*Homarus americanus*), blue crab (*Callinectes sapidus*), and the northern quahog or hard clam (*Mercenaria mercenaria*). Over the last 100 years aquatic populations have declined due to overfishing, deteriorating water quality, and loss of habitat.

5.6 The upland and intertidal habitats in the study area have been heavily manipulated for over three centuries. Nearshore areas have been filled to create uplands, existing uplands have been cleared and developed, wetlands have been isolated by shoreline development, and watercourses have been dredged and deepened to establish or expand commerce. Besides the direct losses associated with filling, area wetlands have been damaged by ditching (in an effort to control mosquitos), and by siltation and sedimentation. Tidal exchange patterns, moreover, have been altered by urban and industrial runoff and by the installation of tide gates. Invasion by common reed (*Phragmites australis*) has negatively affected the plant diversity and wildlife value of large expanses of high marsh and intertidal wetland. The creation of vast areas of impervious surface (streets, rooves, parking lots) in upland habitats has changed the hydrologic regime by increasing (and concentrating) surface runoff and reducing groundwater infiltration. Virtually no native upland plant communities exist, most of the plantings in parks consisting of a mixture of native and introduced species. Forested areas that have resulted from vegetative succession in urban areas typically consist of invasive, non-native species.

Newark Bay

5.7 Newark Bay is rectangular, approximately 5.5 miles long, varying in width from 0.6 to 1.2 miles, with the widest section of the Bay opposite Port Newark and the narrowest section opposite the Elizabeth Port Authority Marine Terminal. With the exception of the maintained shipping channels, turning basins, and docking facilities, Newark Bay is very shallow, with extensive shallow areas found throughout the eastern half. Newark Bay may be divided longitudinally into four reaches: (1) South Reach, the southern section of the Bay, corresponding to the area between the Arthur Kill/Kill Van Kull to the south and South Elizabeth Channel to the north (South Elizabeth Channel being the southern access channel to the Elizabeth Port Authority Marine Terminal); (2) Middle Reach, the Bay area in front of Port Newark and the Elizabeth Port Authority Marine Terminal (location of the Newark Bay Confined Disposal Facility [NBCDF]), extending from South Elizabeth Channel north to Port Newark Channel; (3) North Reach, extending from the Port Newark Channel to a point approximately 3,000 ft north of the CSX railroad bridge; and (4) the northern area, consisting of the Kearny Point Reach (corresponding to the area around the mouth of the Passaic River), and the Droyers Point Reach (corresponding to the area around the mouth of the Hackensack River) (USACE-NYD 1998).

5.8 The South Reach of Newark Bay is characterized by an extensive shallow area to the west of the navigation channel and north of the Arthur Kill. Because the navigation channel is

close to the Elizabeth/Newark shore, there are relatively limited shallows and a few piers along the eastern shore (Bayonne). Water depth in the east and west shallows areas ranges from 1 to 8 ft at mean low water (MLW). In the Middle Reach, the Elizabeth Port Authority Marine Terminal channel extends to the main navigation channel, with water depth maintained at approximately 40 ft (MLW) by dredging. A narrow ship channel is maintained to the Port Newark pierhead. The large shallow area between the Port Newark Pierhead Channel and Newark Bay Middle Reach navigation channel (where water depth ranges from 1 to 5 ft MLW) is an area of flats that includes the Newark Bay Confined Disposal Facility (NBCDF). The eastern side of Newark Bay, included in the Middle and North Reaches, is an extensive shallows area with water depths ranging from 1 to 11 ft MLW. The presence of the Federal navigation channel along the western side of the Bay in the North Reach results in limited shallows along the Newark shore in this area. The northwestern section of the Bay consists of the Meadowlands Natural Area. In the extreme northern end of Newark Bay, the navigation channel is approximately 300 ft wide, with an average depth of 6.5 ft recorded in the Passaic River and 18 ft in the Hackensack River. The area around the Kearny Point and Droyers Point Channels is very shallow, ranging in depth from 1 to 4 ft MLW (USACE-NYD 1998).

5.9 The bottom area of Newark Bay is approximately 4,082.5 acres, as calculated from National Oceanic Atmospheric Administration (NOAA) navigation charts 12333 and 12337 using surface planimetry (a two-dimensional method). Estimating bottom area using planimetry techniques fails to take into account bottom area associated with steep slopes, and therefore can result in an underestimate of actual exposed bottom area. This underestimate might be especially pronounced in the navigation channel area (USACE-NYD 1998).

5.10 The mean tidal range in the Bay as a whole is approximately 5.1 ft at the Port Newark Terminal. The mean tidal range at the northern end of the Bay (Kearny Point) is 5.2 ft, and at the southern end off the Elizabeth Port Authority Marine Terminal, it is 5.1 ft. Maximum flood and ebb tidal currents are 1.2 ft per second (fps). The Hackensack River, which enters Newark Bay at its northeast corner, has a drainage basin area of approximately 113 square miles and an annual mean discharge of 95.8 cubic feet per second (cfs) (Bauersfeld, et al. 1994). The Passaic River, which enters Newark Bay directly to the west of the Hackensack River on the Bay's northwest corner, has a drainage basin area of approximately 100 square miles and an annual mean discharge of 173 cfs (USGS 1995, USACE-NYD 1998).

5.11 Newark Bay and its shoreline have been modified extensively by dredging, filling, and commercial development since the mid-1800s (Crawford, et al. 1994). The Bayonne, or eastern, side of Newark Bay is characterized by industrial complexes near the Hackensack River and the Kill Van Kull. Residential areas, school campuses, parks, and light industry are found distributed over most of the remainder of the eastern shoreline. The Bay's western shore is dominated by the extensive containership facilities of the Elizabeth Port Authority Marine Terminal and Port Newark. Small, isolated vegetated or emergent wetland areas are found on the western shore of the Bay north and south of Port Newark and the Elizabeth Port Authority Marine Terminal. Most of the remainder of Newark Bay is designated as either "estuarine, subtidal, open water substrate unknown" or "estuarine, intertidal flat" (USACE-NYD 1998).

5.12 As is true for most of the New York and New Jersey Harbor Complex, the aquatic resources of Newark Bay are impacted by the discharge of a variety of inorganic and organic pollutants. These materials are released from numerous sources, including municipal and commercial point and nonpoint sources, combined sewer overflows (CSO), and accidental spills. Although some of these contaminants are considered relatively unreactive, most have a strong affinity to sediments, and to fine-grained particles in particular. The accumulation, movement, and transport pathways for these substances are governed largely by the processes that govern sediment suspension, transport, and deposition in Newark Bay. Discussion of these conditions is presented in the Final Environmental Impact Statement (FEIS) prepared for the NBCDF (USACE-NYD 1997a, USACE-NYD 1998).

Arthur Kill

5.13 The Arthur Kill is a tidal strait connecting Raritan Bay in the south with Newark Bay in the north and separating Staten Island from New Jersey. This strait, which is approximately 13 miles long, varies in width from about 800 to 2,800 ft. It has a total surface water area of approximately 4.4 square miles. A Federal navigation channel, maintained at a depth of 35 ft MLW and 500 ft wide, runs the entire length of the Kill. The New York and New Jersey shorelines of the Arthur Kill have a variety of shoreline features and characteristics. The shorelines of the Elizabeth and Gulfport Reaches have been extensively bulkheaded and riprapped, the result of vast amounts of commercial development, leaving little or no undisturbed natural shoreline in these reaches. Many of the wetland areas remaining along this water body have been invaded by monoculture stands of common reed, which is indicative of disturbance.

5.14 Greater commercial development (petroleum refineries and storage facilities, and power-generating facilities) along the New Jersey shoreline has resulted in a high percentage of shoreline being stabilized by bulkheads and riprap. Large acres of wetland and marsh areas (natural and restored) are found along the New York shoreline, mixed in with oil storage facilities, generating facilities, and the Fresh Kills landfill (USACE-NYD 1999a).

5.15 The hydrology of the Arthur Kill is dominated by a semidiel tide that enters the Kill from both ends. The flood from Raritan Bay northward to Newark Bay and the ebb in the reverse direction dominates. Mean tidal range in the Kill varies from 4.9 to 5.3 ft along the water body, with spring tide range varying from 6.0 to 6.4 ft (NOAA 1993). Tidal currents in the Arthur Kill are moderate, ranging from 1.3 to 2.3 fps (USACE-NYD 1998), 0.9 to 1.4-fps flood and 0.8 to 1.2 fps ebb (Ellison 1999).

5.16 Due to the fact that it connects two tidal water bodies, the hydrodynamics of the Arthur Kill are complex. Because tides in Newark Bay are not in phase with those of Raritan Bay, flushing time of the Kill is slow, suggesting that materials present in this strait may remain for a long time. Tidal action moves to and from the deepwater areas of the channel, whereas the shallow regions provide storage volume with little motion (Oey, et al. 1985). The interaction of tide-induced flows and freshwater inputs over the length of this tidal strait results in a net flow of water south toward Raritan Bay (USACE-NYD 1998).

5.17 Freshwater enters the Arthur Kill predominantly along its western (New Jersey) shore, with the largest tributaries being the Rahway and Elizabeth Rivers. Water quality in the Rahway River is described as fair, and in the Elizabeth, severely degraded (NJDEP 1990). The third largest tributary is Fresh Kills, located on the western shore of Staten Island, and draining an extensive wetland complex. In addition to these three major tributaries, a number of minor tributaries are located along the eastern and western shores of the Arthur Kill. These include: Old Place Creek, Saw Mill Creek, Neck Creek, and Mill Creek on the Staten Island side, and Morses Creek, Piles Creek, Smith Creek, and Woodbridge Creek on the New Jersey side. Additional freshwater flow is contributed to the Kill by municipal sewage treatment plants (STPs) and CSOs. Combined, these two sources contribute more than 200 cfs to the Kill, which is more than twice the combined contribution of the three largest tributaries (USACE-NYD 1998).

Kill Van Kull

5.18 The Kill Van Kull connects Newark Bay at its southern end with Upper New York Bay and forms the boundary between the southern shore of Bayonne, New Jersey, and the northern shore of Staten Island, New York. It is approximately 5 miles long and ranges in depth from 11 to 50 ft MLW. There are few shallow-water areas in this waterway because most of it lies within the Federal navigation channel or has been deepened for dock and pier space (USACE-NYD 1998). The Kill Van Kull currently has an 800-ft wide, 40-ft deep dredged channel flanked by shallow inshore areas (Frederic R. Harris, Inc. 1997).

5.19 The tidal range of the Kill Van Kull is approximately 5 ft. The tides in Newark Bay differ slightly from those of Upper and Lower New York Bays, causing slack water and strong currents at both ends of the Kill Van Kull. These tidal effects cause a slow easterly flushing pattern. Saline water enters the Kill Van Kull from Upper New York Bay along the channel bottom. At a point near the Bayonne Bridge salinity becomes homogeneous in the water column (Frederic R. Harris Inc. 1997).

5.20 Since most of the shoreline is bulkheaded and riprapped, not much natural vegetation or intertidal habitat is present (USACE-NYD 1998). Portions of the shoreline are in use as industrial facilities, marinas, and for non-waterfront-dependent purposes. The remaining shoreline is undeveloped or abandoned. Derelict vessels, as well as timber and debris, are found throughout the channel in both developed and undeveloped areas (Frederic R. Harris, Inc. 1997).

5.21 As with the rest of the New York and New Jersey Harbor, the Kill Van Kull is eutrophic, a condition caused by high nutrient loadings from STPs and other point and nonpoint sources. These loadings can ultimately lead to low dissolved oxygen (DO) levels. Although improvements in water quality have been observed in recent years, low DO, high turbidity, and high concentrations of contaminants in the sediments continue to restrict the biological communities in this water body (USACE-NYD 1998).

Lower New York Bay

5.22 Lower New York Bay is part of the larger Lower Complex, which includes Lower New York Bay, Raritan Bay, and Sandy Hook Bay. Raritan and Sandy Hook Bays are treated separately below. For purposes of this discussion, Lower New York Bay is bordered to the southeast by the Sandy Hook-Rockaway Point Transect; to the east by a line drawn from Rockaway Point to the New York Aquarium on Coney Island, thence following the Brooklyn shoreline north around Nortons Point to the east end of the Verrazano Narrows Bridge; to the north by a transect drawn directly under this bridge, thence following the southern shoreline of Staten Island west to Crookes Point on Great Kills Harbor; to the west by a transect drawn from Crookes Point south to Point Comfort in Monmouth County, New Jersey; and to the south by a transect drawn from Point Comfort to the tip of Sandy Hook (USACE-NYD 1998).

5.23 Lower New York Bay is composed of shoals and a network of shipping channels. The average depth of Lower New York Bay is 28 ft MLW, with the shipping channels being maintained at 35 to 45 ft MLW (USACE-NYD 1998).

5.24 Widths of channels range from 500 to 2,000 ft. Mean tidal range is from 4.6 to 4.9 ft and the spring tide range is from 5.6 to 5.9 ft (Duedall et al. 1979). Tidal currents vary from about 0.1 to 3.0 fps throughout Lower New York Bay, with the strongest currents occurring along the Sandy Hook-Rockaway Point Transect and the weakest occurring toward Staten Island. The net flow is directed from Upper New York Bay and Raritan Bays through the Sandy Hook-Rockaway Point Transect to the open ocean. Based on the delineation of Lower New York Bay presented above, there are few point sources contributing pollution directly to the Bay. However, waterborne pollution from all sources throughout the estuary passes through Lower New York Bay on its way to the New York Bight (USACE-NYD 1998).

Raritan Bay

5.25 Raritan Bay is the westernmost portion of the Lower New York Bay Complex, extending west from a line drawn between Crookes Point on Staten Island, New York, to Point Comfort, New Jersey. This bay is triangular in shape, with the apex of the triangle being the mouth of the Raritan River, the major source of freshwater input to Raritan Bay. A second, significant volume of water is contributed through the Arthur Kill, which carries water from Newark Bay and Upper New York Bay via the Kill Van Kull to Raritan Bay. The circulation pattern through Raritan Bay is counterclockwise, with water moving along the New Jersey shoreline toward the Bight. Flushing times are longer in this system than in other portions of the Hudson-Raritan estuary (USACE-NYD 1998).

5.26 Raritan Bay has extensive shoals and shallows cut by a network of navigation channels. The Bay is somewhat shallower than Lower New York Bay, having a mean depth of 22 ft, and shoal depths generally less than 20 ft. Navigation channels are 80 to 1,400 ft wide, and are maintained to depths ranging from 10 to 35 ft MLW. Mean tidal range is from 4.7 to 5.0 ft. The range of spring tides within the Bay is 5.7 to 6.0 ft. Tidal currents range from 0.0 fps at flood

tide to 2.4 fps near the mouth of the Arthur Kill. Tidal current velocities diminish in an easterly direction. The water coming into Raritan Bay carries a substantial amount of STP effluent, and, consequently, is nutrient-rich. This, coupled with the Bay's relatively long flushing times and shallowness, provides ideal conditions for phytoplankton production. Shoreline development ranges from heavily developed industrial complexes in the vicinity of Perth Amboy to areas of intertidal marshes, creeks, dunes, sand beaches, and remnant forests along the Bay's southern and western ends. The Staten Island shoreline includes beach, forest, pond, and wetland areas, as well as intertidal and subtidal mudflats that extend out to 0.25 miles (USACE-NYD 1998).

Sandy Hook Bay

5.27 Sandy Hook Bay is that portion of the Lower New York Bay Complex that lies southeast of a line drawn between the tip of Sandy Hook and Point Comfort, New Jersey. It is a relatively shallow bay, bordered on the east by the Sandy Hook peninsula and on the south and west by the New Jersey shoreline. The Sandy Hook peninsula shoreline is mostly within the Gateway National Recreation Area. It is mostly undeveloped, sandy, and possesses native vegetation. From the border of the recreation area west to Point Comfort, the shoreline is broken by a series of public and private marinas, interspersed with sandy beaches and riprapped areas. The remainder of the shoreline includes a strip of bayshore marshes, creeks, dunes, and remnant forests. Intertidal and shallow subtidal mudflats and sandflats extend out about 0.25 miles from the mean low water line. Together with Raritan Bay, Sandy Hook Bay drains about 1,400 square miles. Freshwater comes into Sandy Hook Bay primarily from the Navesink and Shrewsbury Rivers, which enter the bay at Atlantic Highlands. Unlike several of the rivers that enter the Arthur Kill and Raritan Bay from the more urban portions of New Jersey, these rivers are relatively clean and provide less stressed habitat for several important game fish species (USACE-NYD 1998).

5.28 Mean tidal range in Sandy Hook Bay is from 4.6 to 4.7 ft, and mean spring tides are in the range of 5.6 to 5.7 ft. Tidal currents in the Bay range from 0.2 to 1.0 fps, with the prevailing direction of these currents being northerly, from Atlantic Highlands toward Sandy Hook. East- and west-running tidal currents occur in the Bay only along its northern border, accelerating around Sandy Hook itself (USACE-NYD 1998).

Upper New York Bay

5.29 The northern border of Upper New York Bay is the confluence of the East and Hudson Rivers at the Battery. The western border is the New Jersey shoreline from a point directly west of the Battery in Jersey City, south to Staten Island at the mouth of the Kill Van Kull, and then south to the Verrazano Narrows Bridge. The bridge marks the southern border of Upper New York Bay. The eastern boundary is the Brooklyn waterfront from the Verrazano Narrows Bridge north to the confluence of the East River at the Battery. The shoreline is dominated by bulkheading, piers, pile fields, interpier areas, commercial and industrial development, and military installations. Virtually no undisturbed areas exist along the shorelines of Upper New York Bay (USACE-NYD 1998).

5.30 The two primary sources of water to Upper New York Bay are the Hudson River and the East River, the latter connecting the Bay with Long Island Sound. The Hudson River is the major source of freshwater for Upper New York Bay (USACE-NYD 1998).

5.31 Wetland areas are found on the west side of Liberty Island, in various interpier areas (between Global Marine Terminal and MOTBY, and between MOTBY and Constable Hook), and in a small area north of Caven Point. Mudflats were documented in many areas along the New Jersey shoreline of Upper New York Bay. A large mudflat area exists between MOTBY and Constable Hook. Shoreline degradation due to waves and vessel wakes is not evident in this area because manmade material or structures protect nearly every section of shoreline (USACE-NYD 1999a).

5.32 The northeast shoreline of Staten Island from the Verrazano Narrows to St. George consists predominantly of a commercial waterfront with varying types of use (USACE-NYD 1999a).

5.33 The Brooklyn shoreline is well defined. The shoreline from the Brooklyn Bridge to Gravesend Bay the waterfront is predominantly developed (riprap and bulkhead), with both usable and dilapidated piers. The shoreline from around Coney Island to Manhattan Beach is primarily sandy beach, with occasional rock riprap and seawalls. Shoreline erosion is occurring but not readily evident in this area (USACE-NYD 1999a).

Hudson River

5.34 The portion of the lower Hudson River that is included in this project extends from the Tappan Zee Bridge in the north to its confluence with Upper New York Bay at the Battery on the lower tip of Manhattan. This portion of the river is tidal, with saltwater intrusion proceeding upriver beyond the Tappan Zee Bridge during periods of low freshwater flow. A Federally maintained navigation channel extends through the reach. Dredging of this channel is not often needed, as the mean depth of the river through this reach is about 40 ft MLW. Most of the river's eastern shoreline between Manhattan and the Tappan Zee Bridge is extensively disturbed by industrial, commercial, and residential development that has caused bulkheading and filling of large areas. The shorelines on both sides of the river from the Battery upstream for 6 miles are extensively developed with piers, pile fields, and interpier areas. From the vicinity of the George Washington Bridge north, the New Jersey shoreline is dominated by a rocky talus slope at the base of the Palisades. The area is an unstable escarpment and debris field that permits little shoreline development. Because of the nature of this environment, wetlands or stands of aquatic macrophytes are uncommon. North of the Palisades, on the western shoreline at the confluence of Sparkill Creek with the Hudson River, is found the 405-acre Piermont Marsh. This is one of the four marshes along the Hudson that have been designated by NOAA and NYSDEC as part of the Hudson River National Estuarine Research Reserve (USACE-NYD 1998).

5.35 This reach of the river is about 5,000 ft wide, has a mean depth of approximately 40-ft MLW, and a mean tidal range of 4 to 5 ft. The area can be divided into a polyhaline reach with relatively high salinity from the Battery to Yonkers, New York, and a mesohaline (moderate

salinity) zone from Yonkers to the Tappan Zee Bridge. The Hudson River is the major source of freshwater to the Hudson-Raritan estuary (USACE-NYD 1998).

East River

5.36 The East River is a 16-mile long tidal strait connecting Long Island Sound to the northeast with Upper New York Bay to the south. Hell Gate, a natural rock sill, divides the East River into upper and lower segments. The Lower East River extends from the Battery to Hell Gate; the Upper East River extends from Hell Gate to the Throgs Neck Bridge. Mean river depth is about 30 ft MLW, with depths of more than 100 ft in the vicinity of Hell Gate. Depths in the Navigation Channel range from approximately 35 to greater than 60 ft MLW. The Lower East River is narrow and deep, with most of its shoreline bulkheaded and filled. Between 1850 and 1940, obstructions in the river, such as reefs, shallows, and rocks, were dredged or blasted to create a deep, continuous channel from the Battery through Hell Gate. The mean tidal range in the Lower East River decreases from 4.5 ft at the Battery to 4.1 ft in the vicinity of Newtown Creek, then increases to 6.4 ft at Hell Gate. Currents are strong through the Lower East River, ranging from 2.0 to 7.9 fps; they are strongest in the Hell Gate area because of the narrow channel. The Upper East River widens substantially between Rikers Island and the Throgs Neck Bridge, from approximately 0.5 to 1.25 miles, and is marked by large, shallow embankments at the confluences of tributaries (Flushing Creek, Bronx River, and Westchester Creek). Depths in these bays range from 1 to 10 ft MLW, with most of the areas being less than 5 ft deep. Mean tidal range at Willets Point near the Throgs Neck Bridge is about 7 ft, with tidal phases lagging those at the Battery by about 3 hrs. These differences in tidal elevation and timing cause complex flow patterns, with ebb flows being toward the Battery and flood flows being toward the Throgs Neck Bridge. However, net flow through the East River is from Long Island Sound to Upper New York Bay. Shorelines along the Upper East River are a combination of bulkheaded development and natural riverbank (USACE-NYD 1998).

Harlem River

5.37 The Harlem River is a tidal waterway that connects the Hudson River with the East River at a point 11.8 miles above the Battery near the lower end of Wards Island. This waterway, about 7.6 miles long, has an average depth of 11.3 ft MLW and a drainage basin of only about 20 square miles, including within it the northeastern quarter of Manhattan Island, the western half of the Bronx, the Tibbetts Brook drainage area in Yonkers, Randalls Island, and the western half of Wards Island. With the exception of Tibbetts Brook and Little Hell Gate, all tributaries are completely enclosed in pipes. This drainage basin is characterized as urban residential, commercial, and industrial. The principal use of the Harlem River is transportation, with the Federal government maintaining a channel 15 ft deep and 400 ft wide from the East River to the Hudson River, except in the vicinity of the George Washington Bridge and in the rock cut west of Broadway Bridge, where the channel is naturally deeper and wider (USACE-NYD 1998).

5.38 The Harlem River floods from the Hudson River to the East River and ebbs in the reverse direction. Mean tides range from 3.6 to 5.1 ft, with the average maximum tidal currents ranging from 1.7 to 4.9 fps. This waterway provides tidal volume exchanges between the Hudson River

and the East River, with the Hudson providing most of the volume. The ultimate destination for water in the Harlem River is Upper New York Bay (USACE-NYD 1998).

5.39 Historically, the Harlem River has been severely degraded by CSO and STP discharges, and some industrial discharges. Water quality was severely degraded for many years. This has limited use of the waterway primarily to transportation and transportation-related industries. There has been some use of the river for boating (USACE-NYD 1998).

Demographics

5.40 The study area contains both metropolitan and suburban areas, including the five boroughs of New York City and suburban counties in both New Jersey and New York. Since 1980, the counties of New Jersey closest to the project area (Bergen, Essex, Hudson, and Union) have experienced a decrease in population, most likely due to the suburban development in counties further from the site (such as Middlesex and Monmouth). Over this same period, Bronx, Queens, Kings, Richmond, New York and Westchester counties have all shown an increase in population (U.S. Bureau of the Census 1994). Projections for the year 2005 show a population decrease in all New York study area counties except for Bronx County, which continues to increase (Batutis and Scardamalia 1985). Population estimates for New Jersey for 1998 show an increase in populations of all study area counties except for Essex, where population is expected to decline (Table 5.1-1) (Workforce New Jersey Public Information Network 1999).

Employment

5.41 In all twelve counties included within the study area, the largest number of people were employed in the service industry. Table 5.1-2 provides information on employment sectors in the study area during 1995. For Bergen, Bronx, Kings, and Westchester counties, retail trade and manufacturing, in that order, followed services as the leading economic sectors; for Essex, Middlesex and Union Counties, the second- and third-place order was reversed, with manufacturing larger than retail. In Queens and Richmond Counties retail and transportation were large sectors, while in Hudson County, wholesale trade, together with retail and services, were the largest sectors. New York County was unique in that sectors following the service industry in importance were the financial, insurance, and real estate areas. (Geospatial & Statistical Data Center 1999).

5.42 Table 5.1-2 also shows annual wages by industrial sector for the counties of New Jersey and New York that fall within the study area. As expected, the highest total annual wages (in the range of $92 billion) were earned in New York County. Richmond County reported the lowest total annual wages, just under $2 billion (Geospatial & Statistical Data Center 1999).

5.43 The transportation sector is particularly important to this project. In 1995, 360,000 people were employed in the transportation sector in the study-area counties. The annual payroll for the transportation industry was just under $16 billion for 1995 (Geospatial & Statistical Data Center 1999).

Income

5.44 Individual and family income for counties in the study area exhibits considerable variability. Table 5.1-3 shows per capita and median family income, as well as percentage of families below the poverty line (U.S. Bureau of the Census 1994). Median household income was highest in Bergen County, New Jersey, and lowest in the Bronx, New York. Monmouth County was found to have the highest projected increase in median household income (U.S. Bureau of the Census 1999). Next to New York County, Bergen County appears to be the wealthiest county, with the highest reported per capita and median household income, and the lowest percent of families below the poverty line. Based on projections, Bergen County is expected to continue in this position (Bureau of Economic Analysis 1999). Per capita and median household income estimates show increases in income for all counties except Kings and Queens Counties, which show a decline in median household income between 1989 and 1995.

Land Use

5.45 The study area encompasses the eastern and western shores of Newark Bay; the New Jersey and Staten Island (New York) shoreline along the Kill Van Kull and the Arthur Kill; the eastern and western shoreline of Upper New York Bay, including the Bayonne/Jersey City, New Jersey, shoreline, western Brooklyn, New York, and eastern Staten Island; and the New York and New Jersey shoreline along Lower New York Bay. In general, industrial, commercial, and "limited" residential areas characterize the waterfront areas. Limited or isolated natural areas (wetlands, marshes) are found along sections of the Arthur Kill, along the eastern shore of Staten Island, and along the northern shore of New Jersey in the Sandy Hook/Raritan Bay area (USACE-NYD 1999b).

5.46 The present land use of the study area reflects the commercial ship usage of the navigation channels. Containerships and tankers use the Kill Van Kull/Newark Bay and Arthur Kill channels en route to the refineries and petroleum storage facilities located primarily along the New Jersey shoreline of the Arthur Kill and Newark Bay, including the container terminals at Howland Hook on the Arthur Kill, the Port Newark/Elizabeth Port Authority Marine Terminal on Newark Bay, and the car ports at Port Newark. Containerships and commercial vessels use Upper New York Bay channels to reach the Port Jersey facilities located in Bayonne and Jersey City, New Jersey, and the South Brooklyn facility located along the Brooklyn, New York, shoreline near the southern entrance of the East River (USACE-NYD 1999b).

5.47 In general, land use in the study area is limited to commercial and industrial uses. The proposed deepening of the navigation channels, berthing areas, and anchorages will not change land use patterns. It is projected that the increased use of the Harbor area's intermodal transportation networks will occur whether or not navigation channels, anchorages, and berthing areas are deepened to accommodate deeper-draft vessels (USACE-NYD 1999b).

Noise

5.48 Noise levels are generally expressed as a single value of broadband noise, using a frequency weighting that simulates human perception. Noise criteria or permissible sound levels are usually specified in units of A-weighted noise or decibels A (dBA). USEPA, in characterizing noise from construction equipment and operations, has found that internal combustion engines produce the prevalent noise at construction sites. USEPA has also calculated Noise Pollution Levels (NPL) as an aid in interpreting site noise. NPLs present an idea of the relative noise annoyance related to different pieces of machinery and sites in a worst-case scenario. NPLs account for the effect of continuous noise and the annoyance due to fluctuations in noise level. Typical site noise ranges from Clearly Acceptable (less than 62 dBA) to Clearly Unacceptable (greater than 88 dBA).

Noise Ordinances

5.49 All municipalities in the study area have noise-control ordinances. These ordinances often 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. Potential noise-sensitive receptors include schools, churches, residences, libraries, parks, recreational areas, hospitals, senior citizen homes, and rehabilitation centers.

5.50 The City of Bayonne and the City of Elizabeth both prohibit construction or repair activities during nighttime hours: on weekdays, no construction or repair activities may be carried on between the hours of 8:00 p.m. and 7:00 a.m. in Bayonne, or between 9:00 p.m. and 7:00 a.m. in Elizabeth. Jersey City restricts construction activities to the hours between 7:00 a.m. and 6:00 p.m. weekdays. Excessive noise is prohibited in the vicinity of schools, courts, or houses of worship while they are in use. Excessive noise near a hospital is also prohibited. The City of Newark prohibits construction activities between the hours of 8:00 p.m. and 7:00 a.m. on weekdays and Saturday, and prohibits all construction on Sunday or legal holidays. Brooklyn and Staten Island both use New York City Department of Environmental Protection (NYCDEP) Noise Code 1992. According to this code, construction is permissible only between the hours of 7:00 a.m. and 6:00 p.m. on weekdays. No unnecessary noise is permitted near schools or courts while they are in session, and none is permitted near hospitals.

5.51 Newark has adopted maximum permissible sound levels according to the source of the sound and the sound receptor category (e.g., residential, industrial). The following table lists the maximum permissible sound levels in the City of Newark by receiving property type or category:

Maximum Permissible Sound Levels in the City of Newark by Receiving Property Category					
Sound Source Property Category	Residential 7 a.m.-10 p.m.	Residential 10 p.m.-7 a.m.	Commercial All Times	Industrial All Times	Hospital Quiet Zone All Times
Residential	55 dBA	50 dBA	65 Dba	75 dBA	50 dBA
Commercial	65 dBA	50 dBA	65 Dba	75 dBA	50 dBA
Industrial	65 dBA	50 dBA	65 dBA	75 dBA	50 dBA

Source: Noise Control Ordinance of the City of Newark, 17:3A

Ambient Noise Levels

5.52 Ambient noise levels within the study area originate from a variety of sources, including commercial/industrial operations, highway traffic, railway traffic, air traffic, and shipping/boating traffic. Noise levels from these sources vary with daily and seasonal activity patterns, and to some extent with weather conditions and other seasonal patterns (e.g., tourist season).

5.53 Southeastern Staten Island, South Brooklyn, and the northeastern edge of Monmouth County (including Sandy Hook) border the Lower New York Bay region of the study area. The open water of Lower New York Bay includes a portion of the Ambrose Channel, a Federal Navigation Channel. The Verrazano Narrows Bridge, which connects Staten Island with Brooklyn, is to the north. The Belt Parkway is to the northeast. Primary sources of noise from these areas include vehicular traffic and shipping/boating activity. Commercial aircraft using Newark International Airport (approximately 8 miles northwest) and John F. Kennedy International Airport (approximately 13.5 miles east-northeast) also contribute to noise levels in the area. No large commercial/industrial complexes are located on Lower New York Bay.

5.54 Northeastern Staten Island, western Brooklyn, southern Manhattan, and eastern Hudson County form the boundaries of Upper New York Bay. Infrastructure in this area includes the New Jersey Turnpike Extension, Verrazano Narrows Bridge, Brooklyn-Queens Expressway, Staten Island Rapid Transit, and N&W rail lines. Newark International Airport lies approximately 5 miles east, and John F. Kennedy International Airport approximately 13 miles west. Primary sources of noise from these areas consist of highway and rail traffic. Several Federal Navigation Channels are within the Upper Bay. As a result, the Upper Bay is subject to heavy shipping and boating activity, which includes container/passenger ships, tugs, tour boats, ferries, and recreational boats, all of which contribute to noise levels. Also contributing to ambient noise levels are Upper New York Bay port facilities. Port Jersey, MOTBY, Brooklyn Marine Terminal, Red Hook Marine Terminal, and South Brooklyn Marine Terminal contribute noise from heavy machinery (e.g., cranes, derricks, loading equipment).

5.55 Southern Bayonne and Northern Staten Island lie on either side of the Kill Van Kull, which is the corridor between Upper New York Bay, Newark Bay, and northern Arthur Kill. In

addition, petroleum storage facilities and commercial properties associated with maritime activities are located along the Kill Van Kull. As a result, heavy shipping/boating traffic moves through the area; this is the area's primary source of noise. Highway traffic from the Bayonne Bridge, and commercial air traffic from Newark International Airport (approximately 3 miles northwest) also contribute to noise levels.

5.56 Newark Bay is bordered to the west by the Port Newark/Elizabeth Port Authority Marine Terminal and heavy-industrial areas, to the east by Bayonne, and to the south by the northern shore of Staten Island. The New Jersey Turnpike Extension and the Newark Bay Railroad Lift Bridge cross in the middle of the Bay. Newark International Airport lies approximately 1.5 miles west of the area. Primary sources of noise from these areas include highway, air, and rail traffic, and shipping/boating activity. In addition, the marine terminals contribute to the noise level through the operation of cranes, derricks, and loading equipment.

5.57 Elizabeth and the Howland Hook Marine Terminal border this portion of the study area. Infrastructure contributing to ambient noise levels includes the New Jersey Turnpike (to the west), the Goethals Bridge (to the south), and the marine terminal itself. Newark International Airport lies approximately 2 miles to the north. Shipping/boating activity is also common through the Elizabeth reach.

Noise Related to Dredging Activities

5.58 Typical construction equipment that may be used in the proposed project area includes air compressors and dredging cranes. Noise levels from these sources are expected to be similar to levels associated with heavy machinery and loading equipment already used along the industrial waterfront areas of the Port Newark/Elizabeth Port Authority, Port Jersey, South Brooklyn, and Howland Hook Marine Terminals. Typical noise levels from heavy construction equipment are listed in the following table:

Typical Noise Levels from Heavy Construction Equipment

Equipment	Distance and Sound Level (dBA)			
	0 ft	100 ft	400 ft	700 ft
Compressor	120	80	67	62
Stationary Crane	125	85	72	67
Front Loader	120	80	67	62
Truck	100	90	77	72
Pile Driver	140	100	87	82

5.59 Most dredging sites are located near areas of heavy industrial/urban activity (e.g., marine terminals). Studies have shown that ambient noise levels in the project areas are likely to be comparable to noise levels created by proposed dredging activities.

Aesthetics

5.60 Visual resources consist of important views, vistas, and both natural and manmade features that contribute to the visual character of an area. The New York and New Jersey Harbor shoreline generally reflects the commercial/industrial nature of the largest port facility on the Atlantic Coast of North America. The shoreline is characterized by extensive development, including: petroleum refining and storage facilities; several container, break-bulk, and auto marine terminals; shoreline highways; fishing and commercial piers; protected shoreline areas (riprap, debris, and bulkheads); residential areas; and parks. Some park areas along the Harbor shoreline contain sand or gravel beaches, entertainment complexes, (e.g., Coney Island Amusement Park), or attractive cover or landforms. Shorelines throughout the project area are visible to boaters in the Harbor and, in some instances, to motorists on area roadways. Existing views of the shoreline within the study area are described below.

5.61 The New Jersey shoreline of Upper New York Bay is dominated by commercial/ industrial facilities. Riprap and bulkheads predominate along the shore in this area to accommodate these facilities. Very little natural shoreline remains in this area, with the exception of wetlands to the west of Liberty Island, some interpier areas, and a small area north of Caven Point. Mudflats are found along the New Jersey shoreline of Upper New York Bay. A large mudflat is located between MOTBY and Constable Hook.

5.62 The north and south shorelines of the Kill Van Kull are lined almost entirely by bulkhead and riprap. Small fringe patches of *Spartina* may be seen in the vicinity of an oil storage facility on the north shore. The shoreline of Shooters Island, located at the western end of the Kill Van Kull, consists of gravel/sand beaches, upland and lowland vegetation, and extensive debris fields from abandoned piers and vessel repair facilities, as well as abandoned vessels. The view of the southeast shoreline of Staten Island from the Verrazano Narrows bridge southwestward to Tottenville is predominantly of sandy beaches, most of which are maintained and groomed.

5.63 Bayonne, New Jersey occupies the eastern-shore of Newark Bay. Commercial and residential structures are the primary feature of the eastern shoreline, which is protected by structures. The marine terminals at Elizabeth and Port Newark occupy a large portion of the western shoreline of the Bay. The Elizabeth Port Authority Marine Terminal is a large expanse of containers, storage facilities, and cargo/container cranes. Looking east from the pierhead line and marine terminal areas, the Bayonne shoreline is visible across Newark Bay. The Bayonne High School and administration buildings are also visible. To the north is a view of the Newark Bay Bridge. The viewshed from the Newark Bay terminal includes industrial activities, and automobile processing and warehousing facilities. Newark Bay and the surrounding area are visible from the Newark Bay Bridge.

5.64 Arthur Kill has a variety of shoreline characteristics. Commercial development along the New Jersey shoreline has resulted in a high percentage of bulkhead and riprap in that area. Wetland areas dominate the New York shoreline; oil storage facilities, power-generating facilities, and the Fresh Kills landfill are also found here.

5.65 Salt marshes, intertidal beaches, and riprap- and bulkhead-protected shorelines characterize the New Jersey shoreline from Sandy Hook to Perth Amboy. Sandy beaches cover most of the shore on Sandy Hook, while the Perth Amboy shoreline is predominantly bulkhead.

5.66 The northern section of the Brooklyn shoreline from the Brooklyn Bridge to Owls Head Park is dominated by the Brooklyn Marine Terminal and the Red Hook Container Terminal. Common shoreline characteristics include a mixture of maintained piers, rock riprap and sheetpile bulkheads, boat launches, residential buildings, and warehouses. The central portion of the Brooklyn shoreline consists of the Shore Parkway about 10 ft above the high-water mark, a landfill, and a small-boat marina. The southern section of the Brooklyn shoreline is characterized by private dwellings, the Norton Point Coney Island Light, a wide sand beach at Coney Island, and the Coney Island Amusement Park.

5.2 Navigation

Channels

5.67 Table 5.2-1 presents the existing dimensions of the New York and New Jersey Harbor navigation channels, along with their authorized dimensions.

5.68 Figure 5.2-1 depicts the locations of these channels within the Harbor area.

Anchorage Areas

5.69 At present, two Federal anchorage projects are included for consideration under the New York and New Jersey Harbor Navigation Study: the Red Hook Anchorage and the Gravesend Anchorage. A third anchorage, off the Stapleton area of Staten Island, is used extensively but is not currently designated under the Federal project. Figure 5.2-1 depicts the locations of these anchorage areas.

5.70 The Red Hook (Flats) Anchorage area is located in the Upper Bay in a shallow area surrounded by the Bay Ridge, Red Hook, and Anchorage channels. It is divided into three subsections with the designations 21A, 21B, and 21C. Area 21A is a non-Federal area encompassing approximately 350 acres with controlling depths of 10 to 14 ft. Established as an anchorage for barges, its current use is extremely limited since most of the tugs servicing barges in the Harbor have drafts of 18 to 20 ft. Section 21B, covering an area of about 700 acres, is Federally maintained to 35 ft MLW. Only vessels with drafts of 10 to 33 ft may use this anchorage. Section 21C is also part of the Federal project. It covers approximately 390 acres; project depths in the northern half of this section are 40 ft MLW, and in the southern half, 45 ft MLW.

5.71 The Gravesend Anchorage is located outside the Narrows off the southwest coast of Brooklyn. For traffic management purposes, it has the designation 49C. Project depth for the approximately 334-acre anchorage is 47 ft MLW. This anchorage is designed to accommodate

deep-draft tankers. Exposure to rough seas, distance from port facilities, and reports of difficulties securing anchors at this location makes the Gravesend Anchorage undesirable to most users.

5.72 While not a Federally authorized anchorage, an 850-acre area off the Stapleton section of Staten Island is used extensively due to its prime location and naturally deep waters (some areas in excess of 70 ft). It is divided into three subsections: 23A, 23B and 24. The Stapleton Anchorage generally ranks first in terms of user preference. Use of the area is limited to a 48-hour maximum stay, which is strictly enforced by the U.S. Coast Guard.

Traffic Management and Navigation Practices

5.73 Traffic management within the New York and New Jersey Harbor is a cooperative effort between the U.S. Coast Guard, the Maritime Association, tug companies, and docking pilots. The U.S. Coast Guard has the lead responsibility for maritime law enforcement, placement and maintenance of aids to navigation, regulation of anchorages, movement of vessels, and safeguarding life and property. The Code of Federal Regulations (CFR) specifies the operating rules under which users of the channels and anchorages must operate. This code is enforced by the Coast Guard, under the office of the Captain of the Port. As part of a major effort to improve safety and protect the environment, Congress provided funding for the Coast Guard to establish the Vessel Traffic Service in New York (VTSNY). VTSNY is designed to reduce the probability of collision or grounding by providing advance information on the movements of other vessels, traffic congestion, weather conditions, and other potential hazards to navigation. Figure 5.2-2 illustrates the area of operations for VTSNY.

5.74 The Vessel Traffic Center (VTC), located at Fort Wadsworth on Staten Island, is manned 24 hours a day by Coast Guard personnel. Vessel traffic management is accomplished via a VHF-FM radiotelephone network in concert with radar and low-light closed-circuit television. A series of thirteen remote sites (shown on Figure 5.2-2) allows low-power communications from anywhere in the VTSNY area.

5.75 Power-driven vessels more than 130 ft in length, passenger vessels certified to carry more than 50 passengers, and towing vessels engaged in towing must report positions and sailing plans to the VTSNY. They are also required to maintain a constant listening watch on the VTSNY frequency while underway and to carry a copy of the VTSNY rules on board. Power-driven vessels between 65 and 130 ft in length and floating plants and dredges are required only to maintain a listening watch of the VTSNY frequency and to carry the rules on board while underway.

5.76 Vessels in need of anchorage space request use of an anchorage through the VTC. Permission is either granted or denied for use of an anchorage, contingent upon the needs of the vessel and rules governing the use of a particular anchorage. VTC specifies sections within an anchorage for each vessel given permission to use an anchorage. Once a final position is chosen by the vessel, it is reported to VTC and recorded. While at anchor, activities such as bunkering, lightering, or movements either within or to depart the anchorage must be coordinated with VTC.

Vessel Traffic

5.77 The volume of TEUs currently flowing through New York and New Jersey Harbor is 2.4 million. In 2010 it is projected to reach 4.2 million. Growth is projected to continue at such a rate that by 2030 trade volume is expected to be 8.9 million TEUs. By the end of the study period (2060) the volume of TEUs flowing through the Harbor is projected to be 19.3 million. Similarly, the number of containership calls to the port is projected to grow to meet the trade demand. With the navigation and related improvements to the Harbor in place, 1,900 containership calls to New York and New Jersey Harbor are projected for 2010. By 2030, the number of calls is projected to increase to 2,900. At the end of the study period the number of containership calls is projected to be more than 7,000.

Buried Utilities

5.78 All channel depth alternatives for the Harbor include the relocation of two cast-iron water pipes (one 36-in. diameter and the other 42-in diameter) that are located at 53 ft and 53.7 ft (or greater) MLW, respectively, in the Anchorage Channel. These pipes cross Upper New York Bay between Brooklyn and Staten Island, the Bay Ridge Channel, the southern portion of Red Hook Flats Anchorage, and Anchorage Channel. Due to their depth and to the risk of damage during initial and future maintenance dredging, these pipes must be relocated. This relocation is a primary project cost affecting all pathways. Additional required utility relocations are listed below:

- Kill Van Kull to the Elizabeth and South Elizabeth Channels: relocation of 2,700 linear ft of 12-in diameter gas line in Newark Bay.

- Gulfport Reach of Arthur Kill for tankers and the Anchorages: relocation of 5,800 ft of 20-in or 24-in diameter oil lines at 61 ft MLW; 5,800 ft of 24-in diameter gas lines at 61ft MLW; 6,200 of 8.75-in diameter pipes at 62 ft MLW; and 6,200 ft of 24-in or 26-in gas lines at 62 ft MLW. These lines are in the Anchorage Channel.

5.3 Physical Resources

Climate

5.79 The climate of the Harbor and surrounding areas is temperate, with an average annual temperature of 52°F. January and February, the coldest months, have a mean temperature of about 31°F, and July, the warmest month, has a mean temperature of approximately 73°F. The extreme temperatures observed for the period of record are -14°F and 102°F. The average relative humidity is about 70%. The average annual precipitation is approximately 44 in.; the observed annual extreme values at an individual station were 58.7 and 32.6 in. recorded at the Battery in 1889 and 1935, respectively. The distribution of precipitation throughout the year is rather uniform, with a slightly higher amount during the summer months. Maximum

precipitation over a 24-hour period, 9.4 in., was recorded at the Battery during a hurricane in October 1903.

5.80 Two types of storms are of primary significance in the project vicinity: (1) tropical storms, which typically affect the New York and New Jersey Harbor area from July to October, and (2) extratropical storms, which are primarily winter storms. Extratropical storms (northeasters) are usually less intense than hurricanes, but tend to be of longer duration. These storms, which often cause high water levels and intense wave conditions, are responsible for significant damage and flooding.

5.81 Tropical storms form in warm, moist air masses over the Caribbean and along the intertropical convergence zone extending from the Caribbean to western Africa. Hurricanes are the most powerful tropical storms to reach the Harbor area, with wind speeds in excess of 74 mph. [Records are available for 24 hurricanes that have affected the New York Harbor area in the past century.] Heavy storm damage usually occurs when high astronomical tides and storm surge coincide. The combined water levels allow large waves to penetrate inland, resulting in extreme erosion and flooding. The relatively short duration of hurricanes often results in less damage than that of a major extratropical storm because the storm surge may not coincide with high astronomical tides and can be partly negated by coincidence with low astronomical tides. This has been the case with several hurricanes in the New York and New Jersey coastal region. Nonetheless, storms of hurricane force have the potential for causing the most severe damage.

Air Quality

5.82 The project area, located in a highly urbanized and industrial setting, is part of the major transportation corridor of the metropolitan area. Motor vehicle emissions and stationary (e.g., power generation, industrial) sources are the primary influences on air quality in the project area.

5.83 Six air pollutants have been identified by USEPA as being of nationwide concern: carbon monoxide (CO), nitrogen oxides (NO_x), ozone, particulates, sulfur oxides (SO_x), and lead. In the metropolitan area, ambient concentrations of CO, ozone, and lead are predominantly influenced by vehicle emissions, NOx and particulates are emitted from both motor vehicle and stationary sources, and emissions of SO_x and sulfates are mainly from stationary sources.

5.84 As required by the Clean Air Act, National Ambient Air Quality Standards (NAAQS) have been established for the six major air pollutants. These standards have also been established as the ambient air quality standards for the State of New York and the State of New Jersey. Primary standards are intended to protect public health, while secondary standards are intended to protect public welfare (e.g., physical damage to structures, ecological damage).

5.85 The New Jersey Department of Environmental Protection (NJDEP) and the New York State Department of Environmental Conservation (NYSDEC) operate a network of air monitoring stations to evaluate pollutants and compare them to the NAAQS.

5.86 Additionally, NJDEP has established a Pollutant Standards Index (PSI), which is based on concentrations of individual pollutants, including carbon monoxide, nitrogen oxides, suspended particulates as "smoke shade," sulfur dioxide, ozone, non-methane organic compounds, and inhalable particulates. A summary of each of these parameters for 1997 is as follows (NJDEP 1998a):

- Carbon Monoxide (CO) – The main source of CO emissions is gasoline-fueled automobiles and trucks. No contraventions of the CO standard were reported in 1997, and in fact the trend in CO concentrations in New Jersey remained within safe limits for the entire period 1987-97. Portions of the New York Metropolitan area remain classified as non-attainment areas for CO even though only one exceedance of the 8-hour standard of 9 ppm has been measured in the last 5 years.

- Nitrogen Oxides (NO_X) – Nitrogen oxides are products of combustion that are emitted in roughly equal amounts from industrial boilers and motor vehicles. Two major forms of nitrogen oxides are nitric oxide (NO) and nitrogen dioxide (NO_2). No contraventions of the nitrogen dioxide ambient air quality standards (AAQS) were reported in 1997 for New York or New Jersey. A monitoring station in Elizabeth indicated the highest NO_2 and NO concentrations in a 12-month average.

- Smoke Shade (SS) – An AAQS for this parameter has not been established, although a baseline Coefficient of Haze (COH) of 2.1 has been established as a daily average. This is considered equivalent to the New Jersey primary 24-hour total suspended particulates AAQS of 260 g/m^3. In 1997 a monitoring location in Jersey City showed the highest daily average of 2.41 COH and the highest annual average of 0.77 COH.

- Sulfur Dioxide (SO_2) – SO_2 emissions result primarily from the combustion of sulfur-containing fossil fuels. No contraventions of the standard for this parameter were reported in 1997. Trends in $S0_2$ concentrations in New Jersey from 1987 to 1997 have recently fallen to meet the National Median and have consistently been below the Health Standard. Sulfur dioxide and sulfate levels have continued to decline in the New York Metropolitan area. Sulfur dioxide measurements at all NYSDEC sulfur dioxide monitoring stations have consistently been in compliance with applicable standards.

- Lead (Pb) – Concentrations of airborne lead continue to decline since the 1976 phaseout of lead as a gasoline additive, and have consistently been in compliance with air quality standards.

- Ozone (O_3) – Ozone is produced by photochemical reactions that take place between volatile organic compounds (hydrocarbons) and nitrogen oxides on warm, sunny days. Ozone production is highest in late spring, summer, and early fall. The New York and New Jersey metropolitan area, including the project area, has been designated by USEPA as a non-attainment area for ozone.

- Inhalable Particulates (PM-10) –Although a standard was set by USEPA for Inhalable Particulates in 1986, New Jersey has still not adopted an AAQS for this parameter. No contraventions of the Federal standard have been reported, although Federal standards for Total Suspended Particulates have been contravened by New Jersey. In 1996, particulate concentrations in New York City were the second lowest recorded since sampling commenced in 1986. Despite previous problems in meeting particulates standards in the New York City area, the 1994-96 expected value indicates compliance.

- Pollutant Standards Index (PSI) – In 1997, the Southern Metropolitan Area air quality was characterized as follows:

    - Good = 146 days or 40%
    - Moderate = 198 days or 54%
    - Approaching Unhealthful = 17 days or 5%
    - Unhealthful = 4 days or 1%

5.87 Ambient air in the region is similar to that of other highly urbanized areas. Placing emission controls on automobiles and industrial sources and limiting sulfur content of fuels have helped to improve the regional air quality.

Geology

Regional Geology

5.88 Information on regional geology was obtained from published sources. In many cases, however, landform geological information may have been extrapolated across water bodies and may not be based on primary data collected in the Harbor.

5.89 The project area is located at the junction of the Newark Basin, the Manhattan Prong, and the Atlantic Coastal Plain physiographic provinces (Schuberth 1968). New York Harbor consists of a complex of bays, rivers, and estuaries that are connected to the Hudson River, the main tributary of the Harbor. The area is underlain by both bedrock and unconsolidated materials.

5.90 Bedrock underlying the project area consists of continental rift-basin sedimentary and igneous rocks of Triassic and Jurassic age, unconformably overlying folded and thrust-faulted Late Proterozoic- to Cambrian-age Serpentinite, gneisses, and schists. Poorly consolidated fluvial and marine sediments of Cretaceous age onlap the bedrock formations to the southeast. Surficial geology includes both glacial and postglacial deposits.

5.91 New York and New Jersey Harbor geological formations, from oldest to youngest, are described below.

- Member C of the Manhattan Schist (Cambrian to Upper Proterozoic). The Manhattan Schist consists of fine- to medium-grained, medium dark gray black to rusty-weathering schist and layered gneiss. It is composed of feldspar, sillimanite, garnet, muscovite, and biotite, with lesser siliceous schist, thin metaquartzite, metagraywacke, and amphibolite. It is always well foliated. Thickness may be as much as 5,200 ft (Lyttle and Epstein 1987). The Manhattan Schist is believed to have been thrust atop the older autochthonous Inwood Marble and Fordham Gneiss (Baskerville 1994).

- Serpentinite (Cambrian and Upper Proterozoic). A very large, highly sheared Serpentinite body, associated with the Hartland Formation, underlies much of Staten Island. It is light-yellowish green to dark-green, fine-grained, and massive, with a variety of Serpentinite minerals and alteration products where sheared or weathered (Drake et al. 1996, Lyttle and Epstein 1987). Schists and associated Serpentinite of the Hartland Formation are believed to have been thrust atop the Manhattan Schist (Stanford 1996, Baskerville 1994).

5.92 The Newark Basin rocks include fluvial and alluvial-fan sandstones and conglomerates and lacustrine mudstones and shales, intruded by a sill, and scattered small dikes and stocks of Diabase. Strata generally dip gently northwest. Adjacent to intrusions the sedimentary rocks are thermally metamorphosed. The sedimentary rocks are divided into three formations: the Stockton, Lockatong, and Passaic (Brunswick) Formations, all of which are part of the Newark Supergroup.

- **Stockton Formation (Upper Triassic).** An arkosic fluvial sandstone and conglomerate. Light-gray, light-grayish-brown, yellowish- to pinkish-gray, to reddish-brown; medium- to coarse-grained (Stanford 1996, Drake et al. 1996).

- **Lockatong Formation (Upper Triassic).** Primarily a gray lacustrine mudstone, but, north of Staten Island, includes a fluvial arkosic Sandstone facies (Stanford 1996, Drake et al. 1996).

- **Passaic (Brunswick) Formation (Lower Jurassic and Upper Triassic).** Reddish-brown to grayish-red siltstone and shale, with mapped sandy mudstone at places (Baskerville 1994). In the project area, includes reddish-brown fluvial and lacustrine pebbly sandstones, siltstones, mudstones, and shales, and some thin, gray lacustrine shales (Stanford 1996). The Passaic Formation generally coarsens to the north and northwest.

- **Diabase (Lower Jurassic).** Igneous intrusive rock consisting of dark-gray to black, fine- to coarse-grained Diabase. Composed largely of calcite and augite (Baskerville 1994), the Diabase is generally dense, hard, and sparsely fractured (Drake et al. 1996). Larger bodies are as much as 1,700 ft thick (Lyttle and Epstein 1987). Dikes range in thickness from 1,180 to 1,310 ft, and are several miles long (Drake et al.

1996). The most prominent igneous intrusion is the Palisades sill, which forms a resistant upland separating the Hudson and Hackensack lowlands.

5.93 Coastal Plain deposits form a seaward-thickening wedge of poorly consolidated sediments that dip gently to the east and unconformably overlie older rock units.

- **Raritan Formation (Upper Cretaceous).** Massive, crossbedded quartz sand; thick-bedded clayey silt; laminated clay and silt; and minor gravel. (Drake et al. 1996; Stanford 1996).

- **Magothy Formation (Upper Cretaceous).** Dark, micaceous, pyritic, kaolinitic, clayey silt and light-colored quartz sand with large lignitized logs (Drake, et al. 1996).

5.94 Surficial deposits in the project area are either glacial or postglacial, having been deposited either before or after the close of the most recent glaciation period, which ended in the Harbor area about 21,000 years ago (Stanford 1996, Cadwell 1989).

- **Glacial Deposits (Pleistocene).** Glacial deposits include till and stratified drift. Till in the project area forms a generally continuous layer 20 to 40 ft thick on the bedrock surface but is thin and patchy in some locations (Stanford 1996). The till is a dense, poorly sorted mix of silt and sand, with gravel and boulders and generally less than 30% clay, 10 to 20% pebbles, 1 to 5% cobbles, and scattered boulders. It includes a reddish-brown sandy silt facies, derived from erosion of the Passaic (Brunswick) Formation, and a yellow to reddish-yellow silt facies, derived from erosion of weathered Diabase and Serpentinite (Stanford 1996). The farthest advance of the Wisconsin glaciation is marked by the terminal moraine, a ridge that extends from Staten Island across the Narrows through Brooklyn and on through eastern Long Island (Cadwell 1989).

- **Stratified drift** in the project area includes (1) glacio-fluvial deposits of delta, fan, and fluvial outwash that is chiefly sand and pebbly sand with minor gravel, and (2) glacio-lacustrine deposits of clay, silt, and fine sand deposited in glacial lakes (Stanford 1996).

- **Postglacial Deposits (Holocene).** Postglacial deposits in the project area consist of sand, marsh deposits, and estuarine silt.

Site Geology

5.95 Site geology was compiled from published interpretations, with refinements based on boring investigations, preliminary results of data compilation, and draft maps and cross-sections supplied by USACE-NYD.

5.96 Some descriptions below may change, pending finalization of the data compilation. Actual locations of rock formation contacts may vary from those described because contacts between sedimentary units may be irregular, because they are often gradational over long distances, and because baked intrusive contacts may be difficult to distinguish in core samples.

5.97 Site geology for the New York and New Jersey Harbor navigation channels, berthing areas, and anchorages considered in the Plan Formulation Document are addressed below.

Ambrose Channel

5.98 In the Ambrose Channel, gray to light brown, medium to fine sand, with little or no organic content predominates, with gravel in some places (WCFS 1998a). No bedrock was encountered down to the limiting depth of the borings, 20 ft below the mudline (WCFS 1998a).

5.99 The Magothy Formation is believed to be the geologic unit underlying the Ambrose Channel (Lyttle and Epstein 1987).

Anchorage Channel

5.100 Sediments in the Anchorage Channel were found to consist almost entirely of gray, silty, fine sand and dark gray to black, low-plasticity clay with a high organic content. These clayey soils were found to predominate throughout the studied depth. Sandy areas were encountered in the vicinity of Governors Island, and coarse-grained soil was found in areas approaching the Narrows, toward the middle of the Channel. A stiff, inorganic red clay layer several inches thick is also found at some locations. No bedrock was encountered down to the limiting depth of the borings, 20 ft below the mudline (WCFS 1998a).

5.101 Bedrock underlying the Anchorage Channel is believed to be Manhattan Schist.

Kill Van Kull

5.102 Bedrock underlying the Kill Van Kull, beginning at the east, consists of: Serpentinite in the Constable Hook Reach; Sandstone of the Stockton Formation westward to Bergen Point (through the Bergen Point East and Bergen Point West Reaches); Diabase from Bergen Point to the eastern part of Newark Bay; and Shale of the Lockatong Formation, with the arkosic sandstone member of the Lockatong at Shooters Island at the confluence of the Arthur Kill, Kill Van Kull, and Newark Bay. Based upon current boring data, the Stockton and Lockatong Formations have limited outcroppings in the Kill Van Kull Channel.

5.103 Throughout the Kill Van Kull (including the Constable Hook Reach, Bergen Point East Reach, and Bergen Point West Reach), previously blasted, fractured, or moderately weathered bedrock underlies the channel.

Newark Bay to Elizabeth Port Authority Marine Terminal

5.104 Throughout the Constable Hook and Bergen Point West Reaches of the Kill Van Kull, previously blasted, fractured, or moderately weathered bedrock underlies the channel. Red-brown, fine- to medium-grained, dense to very dense sand underlies the Kill Van Kull east of the Bayonne Bridge and through the Bergen Point East Reach. (Lewis and Kummel 1950, Lyttle and Epstein 1987, Drake et al. 1996, Stanford 1996).

Newark Bay South and Middle Reaches

5.105 Based on borings and laboratory test data published by PANYNJ (1996), USACE-NYD (1997b), and on a recent boring performed by Battelle under contract to USACE, the stratigraphy at Newark Bay is as follows: (1) Black organic silt - this stratum of very soft to soft organic sediments extends from approximately 5 to 18 ft MLW; (2) Sand - a layer of loose to medium sand about 12 ft thick underlies the organic silt, extending from about 18 to 30 ft MLW; (3) Stiff clay and silt - a 45- to 60-ft thick layer of stiff clay and silt or varved silt and clay underlies the sand, from a depth of about 30 ft MLW to the top of rock; (4) Bedrock - rock at Newark Bay is red Shale.

Elizabeth Port Authority Marine Terminal

5.106 Based on reports prepared for PANYNJ by Gahagan and Bryant Associates, Inc. (1997) and Moffat & Nichol Engineers (1998), the stratigraphy at Elizabeth Port Authority Marine Terminal is as follows (NY/NJHP 1998): (1) Stiff to very stiff clay - a layer of stiff to very stiff clay with silt extends from a depth of about 41 ft MLW (mudline) to about 70 ft MLW. At some locations, a 1- to 6-ft thick layer of soft clay was encountered at the mudline; (2) Bedrock - the bedrock elevation varies from a depth of about 45 ft MLW (west section of the channel) to about 80 ft MLW. The red Shale of the Passaic (Brunswick) Formation underlies the Elizabeth Channel.

Arthur Kill – Newark Bay to Howland Hook

5.107 Bedrock underlying the Arthur Kill from Newark Bay to Howland Hook is believed to be Shale and Siltstone of the Passaic (Brunswick) Formation (Drake et al. 1996).

5.108 Based on surface information from test digs and drilling for USACE (URSGWC 1998), the Arthur Kill stratigraphy near Shooters Island is: (1) Sediment less than 0.5 ft thick; (2) Bedrock - Feldspathic sandstone of the Stockton Formation was the most common rock type encountered at each of the two boreholes drilled, but red Shale and fine-grained Sandstone with serpentine and pyrite as alteration products were also encountered. Rock Quality Designation (RQD) values ranged from 0 to 100%.

Arthur Kill - Elizabethport Reach

5.109 Four Arthur Kill borings in the Elizabethport Reach indicate the following stratigraphy (URSGWC 1998): (1) very soft, black organic silt and clay, ranging in thickness from 4 ft to about 1.5 ft in the northeastern part of the Elizabethport Reach; (2) about 1 ft of black sediment encountered in the central part of the Elizabethport Reach; (3) Bedrock - red-brown Siltstone and Shale of the Passaic (Brunswick) Formation. RQD values ranged from 0 to 79%.

5.110 Exploratory borings performed by PANYNJ for the proposed Goethals Bridge expansion encountered the following six soil and rock strata in the immediate vicinity of the Goethals Bridge, near Howland Hook (PANYNJ 1994): (1) artificial fill, sand, silt, clay, and gravel in a generally loose condition to a maximum thickness of about 2 ft; (2) organic clays and peats: soft and highly compressible tidal marsh deposits to a maximum thickness of approximately 25 ft adjacent to the Arthur Kill; (3) sand deposits: loose to medium dense sand from marine deposits of glacial origin extending eastward from the Arthur Kill and ranging in thickness from 5 to 16 ft; (4) glacial clay, silt, sand and gravel: deposits primarily of clay and silt ranging in thickness from less than 10 ft at the Arthur Kill to greater than 40 ft near the east abutment of the approach span; (5) partially decomposed or weathered Shale; and (6) generally sound and unweathered Shale, at depths of 40 ft MLW to 53 ft MLW (USACE-NYD 1997a).

Arthur Kill - Gulfport Reach

5.111 Four borings in the Gulfport Reach of the Arthur Kill indicate the following stratigraphy: (1) 1 to 2 ft of black sediment in the northern part of the reach and about 4 inches of black silty clay in the southern part of the reach; (2) 1 to 2 ft of red clay with gravel below the black clay in the southern part of the reach; (3) red-brown Shale with some Siltstone, with RQDs ranging from 0 to 20% in the southern part of the reach and 40 to 100% in the northern part of the reach.

Bay Ridge Channel

5.112 Based on recent boring logs provided by USACE (NYNJHP 1998), subsurface conditions at Bay Ridge Channel vary significantly from the east side of the channel to the west side. Subsurface soils near the east side consist mainly of dense sands underlain by stiff clay. Subsurface soils at the west side of the channel consist mainly of soft silts and clays extending to the total boring depths (about 120 ft MLW). The general stratigraphy at Bay Ridge Channel is as follows: (1) Soft black silt: a thin layer of soft black silt was found at the mudline at a depth of approximately 40 ft MLW. The thickness of this layer ranged from 2 to 5 ft near the eastern side of the channel to about 10 ft near the western side of the channel; (2) Gray-brown sand: near the eastern and northern sides of the channel, a layer of medium dense gray-brown coarse to fine sand about 20 ft thick was found below the soft black silt; this gray-brown sand was not found along the western side of the channel; (3) Soft clay: a stratum of soft gray clay was found underlying the black silt from a depth of 50 ft MLW to about 110 ft MLW near the western side of the channel. The thickness of this stratum was found to decrease to about 15 ft near the northern end of the channel. This soft clay was not found along the eastern side of the channel. (4) Stiff red-brown silty clay: a very stiff to hard layer of red-brown silty clay was found to

underlie the soft clay in the northern and eastern portions of the channel. The thickness of this stratum was found to vary from about 30 ft near the northern end of the channel to 0 ft near the middle portion. This layer was encountered to the limiting depths of the borings (120 ft MLW) near the eastern side of the channel.

5.113 Bedrock underlying the Bay Ridge Channel is likely to be Manhattan Schist. Rock was not encountered in borings.

Port Jersey Channel

5.114 Based on borings constructed as part of a channel-deepening study (USACE 1998) and also on subsurface information prepared by PANYNJ (Moffat & Nichol International 1998), the stratigraphy the Port Jersey Channel is as follows: (1) Organic silt/clay: along the centerline of the channel, a soft organic clay/silt layer, typically 5 to 10 ft thick, extends from a depth of about 35 ft MLW (mudline) to about 45 ft MLW. Near the channel slopes, this layer is generally at a depth between 10 ft MLW and 20 ft MLW and is about 4 to 10 ft thick. The organic layer at the bottom of the channel may have been deposited after the channel was dredged to its design depth (NY/NJHP, 1998); (2) Glacial soils: a red-brown, dense sand/silt layer with Standard Penetration Test (SPT) N-values ranging from 9 blows to over 100, but typically about 25; a 5- to 20-ft thick sand layer having N-values mostly above 50, indicative of a dense to very dense material; (3) Bedrock: encountered bedrock consisted of gneiss, mica schist, and red shale that were typically slightly weathered, with recoveries ranging from 0 to 40%. A 5-ft thick layer of decomposed rock was typically present between the glacial till and the bedrock. Based on the bedrock contours provided by USACE (USACE-NYD 1998), bedrock depth varies from 60 ft MLW to 120 ft MLW in the northwest to southeast direction within the channel (NYNJHP 1998).

5.115 Bedrock underlying the Port Jersey Channel is believed to be Member C of the Manhattan Schist (Lyttle and Epstein 1987). Geology of Upper New York Bay, to the east of the Port Jersey Channel, is believed to be in thrust-fault contact with Serpentinite associated with the Hartland Formation (Baskerville 1994, Drake et al. 1996).

Stapleton Anchorage

5.116 Based on subsurface investigations performed by Woodward-Clyde Federal Services for USACE (WCFS 1998a, 1998b), the stratigraphy at Stapleton Anchorage is: (1) mostly gray to brown fine sand with trace to some silt; (2) in places, a layer of gray, fine sand, 10 ft or less in thickness, overlying a layer of dark gray clay. Clayey areas were most common near the shore. No bedrock was encountered down to the limiting depth of the borings, 75 ft MLW. Average water depth of Stapleton Anchorage is 51.6 ft MLW (WCFS 1998b).

5.117 The geologic unit underlying the Stapleton Anchorage is believed to be the Raritan Formation (Lyttle and Epstein 1987).

Soils

5.118 Infilling of the project site and portions of the study area began in the late nineteenth century and continued into the 1970s. Over 1,000 acres of wetlands were filled, a 7,000-ft-long channel was created, and the bayshore was bulkheaded. Approximately 1.5 MCY of hydraulically pumped fill from the ship channel were used to fill nearby meadowlands during the construction of Newark Airport. In general, the area reflects human influences on soil development.

5.119 Soils within the Port Newark/Elizabeth Port Authority Marine Terminal project study area are classified by the Draft Soil Survey of Union County (Union County Soil Conservation Service 1991) as Urban Land, Udorthents-waste substratum, and Udorthents-organic substratum. Soils classified as Urban Land are located in areas of which more than 85% of the surface is covered by impervious structures, such as pavement and buildings. Portions of these soils that are not covered are so extensively disturbed that natural soil profiles no longer exist. The Udorthents-organic substratum refers to various fill materials overlying tidal marsh deposits; thickness and composition of this fill material varies to a great degree. The marsh soils themselves are high in organic content and are poorly drained, highly compressible, and relatively unstable. The Udorthents-waste substratum refers to deep-to-shallow fill overlying non-earthy wastes.

Steep Slopes

5.120 The project area is characterized by manmade, landfilled, and/or altered features. Topography of the project study area is level, with an approximate topographic range of 6 to 13 ft above mean sea level. No naturally occurring steep slopes exist along the channels or berthing areas considered under the NED Plan; the maximum natural grade reported is 1%, as measured from United States Geological Survey maps.

Sideslope Stability Analysis

5.121 Stability analysis of channel sideslopes has been performed by USACE on the Ambrose, Anchorage, Bay Ridge, and Port Jersey Channels using the computer program UTEXAS 3. The program considers data such as channel slope profiles, stratigraphy, soil properties, and water properties. The Spencer, Bishop, USACE, and Lowe procedures were used to obtain the lowest factor of safety for the governing cross-section of each slope. The analyses were designed to be conservative: the highest point along each cross-section and the deepest projected dredge depth were selected. The proposed channel slope angles are 1.0V to 3.0H for slopes in soils and 1.0V to 1.0 H for slopes in rock.

5.122 Minimun computed factors of safety for each channel were as follows:

Channel	Lowest Computed Factor of Safety
Ambrose Channel	1.9
Anchorage Channel	1.6
Bay Ridge Channel	2.2
Port Jersey Channel	2.1
Claremont Channel	1.6
Kill Van Kull	2.2
Newark Bay	2.3
Elizabeth Channel	3.4
South Elizabeth Channel	3.4
Arthur Kill	1.2

5.123 The lowest minimum factor of safety, 1.2, was computed for the Arthur Kill Channel. The highest minimum factor of safety, 3.4, was computed for the Elizabeth and South Elizabeth Channels. Based on these results, USACE-NYD is now in the process of re-evaluating design slope angles. Slope designs may be modified to produce higher factors of safety where desirable, such as at the Arthur Kill Channel, or to allow steeper slopes where factors of safety are high.

Groundwater

5.124 Groundwater occurs in the project area in bedrock, in unconsolidated Cretaceous deposits, and in Pleistocene and Recent deposits. A description of groundwater in each of these formations follows.

5.125 Groundwater in bedrock in the project area generally is stored and transmitted along fractures and joint openings that decrease in size and number with depth. Unfractured rock usually has negligible capacity to store and transmit groundwater. Rock types occurring in the project area include schist, serpentinite, and interbedded conglomerate, sandstone, siltstone, and shale. Schist, diabase, and serpentinite all generally do not produce enough water to be considered potential groundwater sources. They are not considered important aquifers in this area.

5.126 The Passaic Formation is an extensive and important aquifer in areas of New Jersey adjacent to the project area (Nemickas 1976). In the Passaic Formation, the groundwater system consists of a series of alternating tabular aquifers and aquicludes several tens of feet thick and dipping to the northwest at approximately 10 degrees (Carswell 1976). The water-bearing fractures in each tabular aquifer are fairly continuous, but there is poor hydraulic connection between individual aquifers. The aquifers generally extend downdip for a few hundred feet and are continuous along strike for thousands of feet. Both water-table and artesian conditions exist in the Passaic Formation, with artesian confinement caused by overlying low-permeability silt and clay.

5.127 Water quality in the Passaic Formation adjacent to the Kill Van Kull and the Arthur Kill is strongly influenced by Hackensack River and Newark Bay water quality. Water from the Passaic Formation in this area is hard to very hard and highly mineralized. Heavy pumpage has induced recharge of poor quality water, high in chloride, from these sources (Carswell 1976).

5.128 The Stockton Formation has hydrologic properties similar to those of coarse parts of the Passaic Formation. The Lockatong Formation generally yields considerably smaller quantities of water than the finer-grained part of the Brunswick.

5.129 Coastal plain deposits of Cretaceous age, consisting of interbedded clay, silt, sandy clay, sand, and gravel, unconformably overlie bedrock in the project area, dipping toward the southeast. Groundwater occurs within pore spaces between grains. Unconsolidated Cretaceous-age deposits are significant groundwater sources on Staten Island and Long Island.

5.130 Cretaceous-age deposits that are believed to occur in the project area include the Magothy Formation underlying the Ambrose Channel and the Raritan Formation underlying Stapleton Anchorage. According to preliminary cross-sections prepared by USACE, these formations are overlain by a considerable thickness of Pleistocene and Recent deposits.

5.131 Groundwater from Cretaceous deposits is generally of acceptable quality, except where saltwater intrusion has produced excessive chloride concentrations.

5.132 Pleistocene and Recent sediments in the project area include glacial till, stratified drift, sand, marsh deposits, and estuarine silt.

5.133 Till and the varved silt and clay of the glacial lake deposits that overlie bedrock characteristically have low permeability and are not important aquifers. Alluvium is thin and not widely distributed in the project area. Sand and gravel outwash deposits do yield substantial quantities of water, but the deposits cover a limited area. Quality of groundwater from Pleistocene and Recent deposits is variable. Saltwater intrusion has in some areas produced high chloride concentrations.

5.134 A variety of contaminants has been identified in shallow groundwater. This contamination has been attributed to historic urban fill materials and long-term industrial activities in the area. PANYNJ has filed a petition to reclassify the shallow groundwater beneath Newark International Airport and the Port Newark/Elizabeth Port Authority Marine Terminal; the project site is situated within a portion of the proposed reclassification area. The petition seeks to change the classification of shallow groundwater from Class-IIA to Class-IIB on the basis of it having the following five characteristics:

- as a result of past discharges, the groundwater has exhibited numerous exceedances of one or more of the groundwater quality criteria;

- groundwater quality cannot be restored using technologically (or financially) practicable means;
- there are no current or future planned potable uses for this groundwater;
- there is no significant risk of pollutant migration into adjacent non-IIB aquifers; and,
- natural attenuation can be relied upon to ultimately restore groundwater quality.

Hydrology and Tidal Hydraulics

5.135 The bays, navigation channels, harbor areas, and rivers surrounding New York and New Jersey Harbor comprise a complicated hydrologic and hydraulic system. Variations in topography, in freshwater input, in tidal energy, and in meteorological forces produce regions of different hydraulic and water quality characteristics. Prominent features of the Harbor system are summarized below.

5.136 The connectivity of the components is important to understanding the overall dynamics of the system (Figure 5.2-1). Upper New York Bay is connected to Long Island Sound via the East River, which extends from the Battery along the eastern boundary of Manhattan and the southern boundary of the Bronx. The Hudson River drains into the Upper Bay, also near the Battery. A secondary connection between the East and Hudson Rivers is provided by the Harlem River, located at the north end of Manhattan. Flowing west from the Upper Bay, the Kill Van Kull extends along the north shore of Staten Island. Near Shooters Island the channel divides into two branches. One branch extends northeast, providing access to Newark Bay and the Elizabeth Port Authority Marine Terminal and Port Newark terminals. The second branch flows westward around Howland Hook, becoming the Arthur Kill along the western edge of Staten Island. The Arthur Kill terminates near the Raritan River in the western portion of Raritan Bay. Lower New York Bay, located in the eastern portion of Raritan Bay, connects to Upper New York Bay via the Narrows, a deep passage between Ambrose Channel in the Lower Bay and Anchorage Channel in the Upper Bay. Lower New York Bay extends to approximately Sandy Hook, New Jersey. Beyond Sandy Hook the depths increase following east into New York Bight.

5.137 The Hudson River is the largest river discharging into the Harbor, with a mean annual flow on the order of 14,000 cfs as estimated from USGS streamflow data at Green Island. Other major tributaries include the Passaic and the Hackensack Rivers, which enter Newark Bay approximately one mile north of Port Newark. Annual mean flows in the Passaic and Hackensack are approximately 1,100 cfs and 100 cfs, respectively. The Raritan discharge (approximately 1,200-cfs, annual mean) is similar to the Passaic. Several minor tributaries flow into the Harbor including Second, Third, Saddle, and Rahway Rivers, each with an annual mean discharge of less than 100 cfs. Other tributaries contribute freshwater indirectly to the Harbor via the connection to Long Island Sound, which has a net discharge of relatively low-saline water to the Harbor Complex.

5.138 Numerous STPs and CSOs contribute freshwater (in addition to pollutant loads) to the system. The contribution of these sources is small compared to the river input during average

conditions, but may be proportionally greater under low-runoff conditions in some areas (Jay and Bowman 1975, Hydroqual 1991). A recent analysis of data from summer 1995, for example, showed that STP and CSO flows in the East River were on the order of 1,750 cfs at a time when the Hudson River discharge was approximately 3,725 cfs.

5.139 The New York and New Jersey Harbor tidal cycle generally responds to the tide propagating in from the New York Bight, with some amplification and small phase lags between Upper New York Bay and Newark Bay (see the table below). Significant differences in tidal range (approximately 2.5 ft) and phase (2-3 hours) exist between the Battery and Willets Point in Western Long Island Sound. The resulting water surface slope produces significant currents in portions of the East River. The Hudson River remains tidally influenced upstream to the dam at Troy, New York, a distance of approximately 155 miles. The mean tidal range in the Hudson River decreases gradually from approximately 4.5 ft at the Battery to a minimum of 2.7 ft at West Point, with a phase lag of nearly 4 hours. The range then increases again from West Point to approximately 4.6 ft at Albany.

5.140 Tidal currents in the system are variable. Maximum currents in the East River near Hell Gate can exceed 6.8 fps, as noted above. Peak, mid-channel currents in the Kills and narrow portions of the Hudson are typically on the order of 1.5 to 3.5 fps. Currents in Newark Bay reported by NOAA (1998a) are typically on the order of 1.0 to 1.5 fps, although larger values (2.7 fps) have been reported (USACE-NYD 1997a).

5.141 A summary of reported tidal elevation range and current velocity at several locations is provided in the table below (NOAA 1998a,b).

Tidal Range and Current Velocity at Selected Locations
New York and New Jersey Harbor Navigation Study

Location	Mean Range (ft)	Average Maximum Velocity (fps)	Location	Mean Range (ft)	Average Maximum Velocity (fps)
East River/ Brooklyn Bridge	4.3	4.73	Arthur Kill/ Howland Hook	5.1	2.36
Raritan Bay	4.9	1.01	Lower New York Bay/Bay Ridge	4.6	1.69
East River (Hunts Point)	6.9	2.87	Port Jersey/ Robbins Reef	4.6	2.70
Port Newark/ Newark Bay	5.1	1.18	Hudson River/ George Washington Bridge	3.9	3.72
Kill Van Kull	5.0	3.21	Passaic River/ Kearny	5.2	1.01
Arthur Kill/ Tufts Point	5.2	2.03	Hackensack River/Kearney	5.2	1.52

5.142 At subtidal timescales the wind force, density currents, and variations in freshwater flows become important factors in the Harbor circulation, particularly in areas where tidal currents are weak, e.g., Raritan Bay (Oey et al. 1985). Average (non-tidal) differences in elevation at different locations may also produce variations in net circulation, for example in the East River (Jay and Bowman 1975, Blumberg and Pritchard 1997) and around Staten Island.

Sediment Characteristics and Quality

5.143 Sediment characteristics vary widely over the project area as a result of the complex flow patterns existing in and between the Hudson River, Long Island Sound, Newark Bay, Upper New York Bay, and Lower New York Bay areas. 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. Figure 5.3-1 illustrates the distribution of sediment types in Newark Bay. 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. Figure 5.3-2 shows the distribution of sediment types in Upper New York Bay. 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 it. Extensive deposits of sand characterize the northern part of Lower New York Bay.

5.144 A variety of contaminants is found in the sediments of the Harbor. Contaminants detected in sediment samples have included: polycyclic aromatic hydrocarbons (PAHs), 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. For the purposes of this study and the DMMP, sediments are classified either as HARS-suitable or HARS-unsuitable. Determination of the suitability of material for placement at the HARS, or for other uses, is established through a tiered program of testing described in the section below. Recently deposited or shoaled fine-grained sediments are likely to require special management, whereas rock and pre-industrial sediment deposits are likely to be HARS-suitable.

5.145 Not all dredged material must be tested under ocean-disposal protocols. Material considered unlikely to meet ocean-disposal requirements, or any material to be managed elsewhere, would be tested and compared to criteria designed for the particular non-HARS option proposed.

Existing Data

5.146 As part of the DMMP, tests of sediments in the channels were performed to determine material characteristics for estimating dredging costs and the suitability for placement of the dredged sediments. Material was classified as either HARS-suitable or HARS-unsuitable. Figure 5.3-3 shows the results of this testing for the top sediment layer. While testing has been performed on dredged sediments for a number of years, databases are just now under development to better track sediment characteristics and quality.

5.147 The Harbor Estuary Program (HEP) is coordinating a regional Contaminant Assessment and Reduction Program (CARP). The states of New York and New Jersey, through NYSDEC and NJDEP, respectively, have committed approximately $25 million toward this effort. The primary objective of CARP is to assist dredged-material managers by:

- identifying and evaluating sources of contaminants that need to be reduced or eliminated to ensure that in the future, newly deposited sediments in navigational waterways will be clean enough for ocean remediation;
- defining what actions will be most effective in abating contaminant sources; and
- determining how long it will take for sediments to achieve "cleanliness"

5.148 The NYSDEC workplan *Sources and Loadings of Toxic Substances to New York Harbor* and NJDEP's *NJ Toxics Reduction Workplan* describe most of the monitoring and contaminant trackdown activities associated with the program. In addition, the State of New Jersey and PANYNJ have appropriated $2.9 million for the development of a harborwide contaminant fate and transport model. The model will be calibrated using data collected by the two states as part of the CARP initiative. USACE-NYD is providing the data management for the program and both states are funding a quality assurance and quality control program. Data, interpretations, and modeling results produced by CARP are expected to be used to track down, reduce, and prevent contamination. These coordinated efforts are excellent steps toward attaining CARP primary objectives, which will play an important role in any process that analyzes the contaminant reduction management option.

5.149 An essential element of a successful dredged material management and planning program is a reliable assessment of the proportion of dredged material that is contaminated. Ongoing collection and analysis of additional data on contaminant levels and sources will provide the basis for generation of more reliable estimates, and may be part of permit requirements. The number of samples, analytical parameters, and detection limits of such a sampling program would be determined during meetings with the approving agencies.

Water Quality

5.150 NJDEP and NYSDEC have established classification systems for the best intended uses of surface waters in the project area (Surface Water Quality Standards, NJAC 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 swimmability, and the designated uses outlined by the State. Designated uses are generally based on a set of numeric and narrative water quality criteria. The swimmability goal means having all possible surface waters of sufficient quality to allow for primary-contact recreation. The aquatic life support goal means having all possible waters of sufficient quality to support healthy and reproducing aquatic biota.

5.151 For Upper New York Bay, the NJDEP and NYSDEC classifications are SE-2 (saline, estuarine waters) and I (fishing), respectively. These waters are suitable for fishing and secondary contact recreation. The Kill Van Kull and the northern portion of the Arthur Kill are classified as SE-3 (NJDEP) and SD (NYSDEC). SE-3 waters are suitable for maintenance and migration of fish populations and secondary contact recreation. Class SD waters are suitable for fish survival. Class SD waters are characterized as waters not primarily used for recreational purposes, shellfish culture, or the development of fish life, and, due to natural or manmade conditions, cannot meet the requirements of these uses. Newark Bay, under jurisdiction of NJDEP, is also classified as SE-3. 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 waters are suitable for primary contact recreation (e.g., swimming)

Salinity

5.152 Salinity data collected during the period November 1994 through October 1995 by NYCDEP and Battelle Ocean Sciences (for NYCDEP) indicate that salinity values can vary by as much as 10 to 15 parts per thousand (ppt) at a given location as freshwater flow varies throughout the year. The table below summarizes salinity measurements in the project area from the Battelle survey. Salinity values for each region represent an average of surface and bottom water column measurements.

Battelle Ocean Sciences Survey
New York and New Jersey Harbor Salinity Values (ppt)
November 1994 to October 1995

Harbor Region	Salinity Minimum	Salinity Average	Salinity Maximum
Upper New York Bay	11.9	24.1	28.9
Lower New York Bay	19.5	26.0	31.8
Kill Van Kull	16.7	21.4	24.2
Arthur Kill	16.2	21.7	25.5
Newark Bay	13.6	19.7	23.6
Raritan Bay	20.9	24.8	27.1
Lower East River	19.1	23.2	25.0
Lower Hudson River	0.1	11.0	25.6

5.153 The Hudson River, Newark Bay, and Raritan Bay partially stratified estuaries in which salinity at the surface is typically lower than salinity on the bottom. Measurements in the project locations indicate that for the Upper Bay, differences in salinity between the surface and bottom of the water column can be nearly 10 ppt during periods of high Hudson River flows. Salinity differences are on the order of 1–3 ppt during other times of the year.

5.154 A similar pattern occurs in the northern reaches of Newark Bay. Surface salinity is lowest (2 to 20 ppt) near the mouth of the Passaic River, which has greater freshwater flow than the Hackensack River (Suszowski 1978). The vertical gradient is most pronounced in the northern part of Newark Bay, particularly near the Passaic River, and decreases to the south.

5.155 Recently, salinity data were collected throughout the study area (October 1998 through September 1999). Measurements were taken at surface, mid-water, and bottom depths. Salinity values were lowest in April, possibly due to periods of high freshwater runoff and high riverine input (as discussed above). Highest salinities typically occurred from May through August. This may be reflective of a regional drought that extended from May through August 1999. The data are summarized in the table below.

LMS Survey (for USACE-NYD)
New York and New Jersey Harbor Salinity Values (ppt)
October 1998 to September 1999

Area	Minimum	Average	Maximum
Ambrose Channel	16.4	25.1	29.6
Upper Bay Anchorage	13.2	22.3	29.1
S. Brooklyn	12.9	22.5	32.8
Port Jersey	12.5	21.7	31.1
Kill Van Kull	15.1	21.3	27.8
Newark Bay	12.7	21.3	31.4
Arthur Kill	12.3	20.9	28.7

Dissolved Oxygen

5.156 The 1994-95 Battelle study included measurements of dissolved oxygen throughout the study area. The annual summary of dissolved oxygen (DO) data is shown in the table below, along with New York and New Jersey criteria for the water quality classification. In Upper New York Bay, DO values ranged from a low of 3.4 mg/l to a maximum of 15.6 mg/l, with deep-water stations exhibiting higher values than shallow-water stations. The summer average in Upper New York Bay for 1995 was 7.4 mg/l, slightly lower than the annual average. In the Kill Van Kull and Newark Bay, values ranged from 3.8 to 11.9 mg/l, with summer averages between 4.8 and 5.6 mg/l. In the Arthur Kill, which has historically exhibited low DO concentrations, the values ranged from 3.2 to 11.6 mg/l, with annual and summer averages of 7.5 and 4.8 mg/l,

respectively. While the data indicate that DO levels in the Harbor generally exceeded the NJDEP criterion of 3.0 mg/l for fish survival, DO values have occasionally been measured below established minimum criteria in several areas.

Battelle Ocean Sciences Survey
New York and New Jersey Harbor Dissolved Oxygen Values (mg/l)
November 1994 to October 1995

Region	Minimum	Average	Maximum	New York Criterion	New Jersey Criterion
Upper New York Bay	3.4	7.7	15.6	4.0	4.0
Lower New York Bay	3.1	9.5	14.4	4.0 (I) 5.0 (SB)	NA
Kill Van Kull	3.8	7.7	15.9	3.0	3.0
Arthur Kill	3.2	7.5	11.6	3.0	3.0
Newark Bay	4.7	7.9	11.9	NA	3.0
Raritan Bay	3.8	8.3	13.4	NA	4.0
Lower East River	3.3	7.6	13.5	4.0	NA
Lower Hudson River	2.6	8.9	16.1	4.0	4.0

5.157 DO was measured throughout the study area from October 1998 through September 1999 (USACE-NYD 1999a). A summary of these data is shown in the following table. In the Lower Bay, DO values ranged from 4.7 to 11.8 mg/l. The Upper Bay was divided into three areas, Anchorage Channel, South Brooklyn, and Port Jersey. In the Anchorage Channel (Lower Bay), DO values ranged from 4.0 to 11.8 mg/l, in South Brooklyn from 2.8 to 12.1 mg/l, and in Port Jersey from 3.5 to 12.2 mg/l. DO values in the Kill Van Kull ranged from 4.3 to 11.1 mg/l. Newark Bay DO values ranged from 4.1 to 10.9 mg/l, and Arthur Kill values from 3.7 to 12.1 mg/l. At all but the Arthur Kill area, lowest DO values were found in August at the bottom of the water column. In the Arthur Kill the lowest DO was found in June at mid-depth. It should be noted that although the lowest value was at the bottom, DO was relatively constant throughout the water column.

LMS Survey (for USACE-NYD)
New York and New Jersey Harbor Dissolved Oxygen Values (mg/l)
October 1998 to September 1999

Area	Minimum	Average	Maximum	New York Criterion	New Jersey Criterion
Ambrose Channel	4.7	8.3	11.8	4.0 (I) 5.0 (SB)	NA
Upper Bay Anchorage Chan.	4	7.8	11.8	4.0	4.0
So. Brooklyn	2.8	7.5	12.1	4.0	4.0
Port Jersey	3.5	7.6	12.2	4.0	4.0
Kill Van Kull	4.3	7.2	11.1	3.0	3.0
Newark Bay	4.1	6.7	10.9	NA	3.0
Arthur Kill	3.7	7.8	12.1	3.0	3.0

Temperature

5.158 Water temperature data, collected from October 1998 through September 1999 throughout the study area, are summarized in the following table (USACE-NYD 1999a). In the Lower Bay, temperatures ranged from 4.1 to 24.4 °C. Temperature data were collected at several locations within the Upper Bay (i.e., Anchorage Channel, South Brooklyn, and Port Jersey). In the Upper Bay, temperatures ranged from a low of 3.5 °C in Port Jersey, to a high of 25.1 °C in the Anchorage Channel. At all sites discussed above, bottom temperatures tended to be higher than surface temperatures during the winter months, while the opposite was true during the summer. In the Arthur Kill, water temperatures ranged from 4.1 to 22.1 °C. Unlike the other sampling sites, surface water temperatures in the Arthur Kill tended to be slightly higher than bottom temperatures.

LMS Survey (for USACE-NYD)
New York and New Jersey Harbor Temperature Values (°C)
October 1998 to September 1999

Area	Minimum	Average	Maximum
Ambrose Channel	4.1	12.1	24.4
Upper Bay			
Anchorage	3.8	13.1	25.1
S. Brooklyn	3.9	13.5	24.7
Port Jersey	3.5	13.9	24.7
Kill Van Kull	3.9	14.9	25.3
Newark Bay	4.0	16.6	26.1
Arthur Kill	4.1	13.5	22.1

5.159 Additional water quality data collected during the Battelle study are shown in the table below. Due to construction and upgrading of water pollution control plants and implementation of CSO abatement programs, water quality has generally improved in the Harbor in recent years. While biochemical oxygen demand (BOD) is relatively uniform throughout the study area, nutrient concentrations in the western portions of the Harbor (notably the Arthur Kill) are typically higher than in Upper and Lower New York Bays. Nutrient concentrations in the Harbor have historically been high, usually above levels known to limit primary productivity (NYCDEP 1993).

Annual Average Water Quality Parameter Values New York and New Jersey Harbor Navigation Study November 1994to October 1995				
Region	BOD, Total (ppm)	Ammonia (ppm)	Nitrate/Nitrite (ppm)	Phosphate (ppm)
Upper New York Bay	1.9	0.45	0.37	0.10
Lower New York Bay	2.5	0.26	0.32	0.08
Kill Van Kull	1.8	0.59	0.67	0.14
Arthur Kill	2.3	0.90	0.71	0.19
Newark Bay	1.7	0.62	0.76	0.15
Raritan Bay	2.4	0.43	0.52	0.11
Lower East River	1.9	0.63	0.45	0.12
Lower Hudson River	1.7	0.26	0.54	0.07

5.160 Toxic contaminants known to exist in the Harbor include metals, PCBs, dioxin, pesticides, PAHs, and volatile organic compounds. In general, toxic contamination is worse in the Harbor than in New York Bight. Within the Harbor, most contamination is encountered in Newark Bay, its tributaries, and the Kills. Metals detected include mercury, at levels contravening water quality standards virtually harborwide, and copper, sometimes at levels contravening chronic standards. Cadmium, arsenic, nickel, and lead have also been detected. Elevated concentrations of contaminants (e.g., PCBs and dioxin) in certain species of fish and invertebrates taken from the Harbor estuary complex have required the issuance of health advisories for many edible aquatic species, and a commercial fishing ban upon striped bass (HEP 1996)

Hazardous, Toxic and Radioactive Waste (HTRW)

5.161 Hazardous, Toxic, and Radioactive Waste (HTRW) issues are applicable only to landside areas. Since the proposed project does not directly influence any landside areas or result in any physical changes to port facilities, there are no HTRW issues associated with this study.

5.4 Ecological Resources

Habitats

Aquatic Habitat

5.162 Aquatic habitats within the project area were identified and described based on habitat categories provided by state and Federal regulatory definitions, coastal zone management (CZM) policies, previous habitat evaluations, and the physical characteristics of the Harbor estuary. Habitat types identified were also compared to habitat descriptions provided by the National

Wetland Inventory (NWI) classification system (Cowardin et al. 1979), Wetlands of New Jersey (Tiner 1985), and Ecological Communities of New York State (Reschke 1990). Aquatic habitats within the project area, which include both marine and estuarine habitats, and manmade (i.e., cultural) and natural communities, vary in depth from shallow intertidal areas to deep-water channels.

5.163 Aquatic habitats are best defined in terms of temporal and spatial gradients and changes in water column depth, temperature, salinity, density, nutrients, and light. The water column has both horizontal and vertical gradients. Horizontal gradients include depth (decreasing landward), salinity (decreasing landward), and nutrients (decreasing seaward); while vertical gradients include salinity (freshwater runoff overlying denser saltwater), DO concentrations, nutrients, and anthropogenic wastes, which can accumulate to abnormal levels due to inadequate vertical mixing. Increases in turbidity in the estuarine water column, which may be the result of large river flow runoff or strong winds, can affect the productivity of submerged aquatic vegetation and phytoplankton through reduction of light levels necessary for photosynthesis as well as through changes in nutrient concentrations. The vertical and horizontal gradients of the water column combine to define intertidal and subtidal zones and the boundaries between freshwater, estuarine, and marine systems.

5.164 Estuarine systems consist of tidal and subtidal habitats and adjacent tidal wetlands that are generally surrounded by land but that have open, partially obstructed, or sporadic access to the open ocean. Ocean and freshwater flows mix in estuarine habitats. Estuarine habitat extends upstream and landward to where ocean-derived salts measure less than 0.5 ppt. Estuarine habitat traditionally comprises four salinity categories: oligohaline (<8 ppt), mesohaline (8-18 ppt), and polyhaline (18-30 ppt), with some eurohaline water (>30 ppt) from open-ocean embayments where high evaporation rates lead to elevated salinity levels. The estuarine environment affected by marine waters has tidally influenced boundaries. These boundaries are generally maintained by seawater that is transported through inlets mixing with freshwater supplied by land runoff. Estuarine habitats in the project area include the open-water and shoreline areas of inner Raritan Bay, Upper New York Bay, the Arthur Kill, the Kill Van Kull, and Newark Bay.

5.165 Marine habitat consists of open ocean overlying the continental shelf and its associated coastline (Cowardin et al. 1979, Tiner 1985). Parts of the project area that are considered marine include the open-ocean waters of the New York Bight Apex as well as the open-water and coastline areas of Lower New York Bay and outer Raritan Bay. Marine habitats are exposed to the waves and currents of the open ocean, and water regimes are determined primarily by the ebb and flow of oceanic tides. Salinity generally exceeds 30 ppt with little or no dilution except at the boundaries of estuarine waters. Marine systems extend from the outer edge of the continental shelf shoreward to the seaward limit of the estuarine system.

5.166 Habitats within the estuarine and marine portions of the project area vary from shallow intertidal mudflats to deep channels. Deep channels within the project area include maintained navigation channels (generally maintained between 35 and 45 ft MLW), interpier berthing areas, and naturally occurring deep-water areas. Although natural water depths in the Harbor are for the most part less than 20 ft MLW, depths in some areas exceed 90 ft MLW (e.g., the Narrows).



Navigation channels comprise a large portion of this type of aquatic habitat in the project area. [By "navigation channels" is meant all shipping channels, turning basins, and anchorage areas as designated by Federal and state authorizations and appearing on NOAA/National Ocean Survey Charts.] These habitats encompass all areas of the waterway between the top of the channel slopes on either side.

5.167 Subtidal deep habitats also include submerged structures (e.g., pile fields, wrecks), and some underpier and interpier areas, which provide habitat for most fish species, including juvenile striped bass and recently settled winter flounder (Able et al. 1995). These pile fields and interpier habitats are found throughout the project area, but are most extensive along the developed shorelines of western Manhattan and Brooklyn, the New Jersey Waterfront along the Hudson, the Arthur Kill, the Kill Van Kull, Newark Bay, and along the north shore of Staten Island.

5.168 Shallow-water habitats within the project area include both subtidal and intertidal areas. Shallow subtidal areas include the littoral zone community, extending from the low tide level to 6 feet MLW, and shoals with depths generally less than 20 ft MLW. Extensive shoal areas occur in Lower New York Bay, portions of Upper New York Bay (e.g., Jersey Flats, Bay Ridge Shoal), and Newark Bay. All project-area open water in New York State is mapped by NYSDEC as Littoral Zone (LZ) wetlands (see Wetlands). By state definition, the littoral zone is restricted to those subtidal waters less than or equal to 6 ft in depth at mean low water.

5.169 The intertidal system is defined as the area between MLW and mean high water (MHW). Saltwater marshes, mudflats, gravel/sand beaches, and rock or riprap shorelines subject to periodic tidal inundation are all examples of intertidal habitats.

5.170 Intertidal mudflats are generally broad and flat, located along shallow-water shorelines and in coastal rivers to the head of the tidal influence. When mud flats are inundated, wind and wave action may resuspend bottom sediments. Coastal mud flats are exposed at extremely low tides and inundated at high tides, with the water table at or near the surface of the substrate. Mud flats are generally unvegetated expanses of mud, organic material, fine sand, or clay; typical manmade components often observed include glass or brick fragments. They are either unvegetated or vegetated only by algal mats. Piles, logs, and pieces of metal are typically scattered on the project area mudflats; these objects provide cover for benthic organisms such as mud crabs and polychaete worms, and habitat for sessile organisms such as barnacles.

5.171 Large expanses of intertidal sand beach and unconsolidated shore are found on the eastern and southern shores of Staten Island, north and south of Great Kills Harbor, at Sandy Hook, and on the southern shore of Raritan Bay. These areas consist primarily of loose sand and stone, small patches of salt marsh, and stone or riprap groins.

5.172 Located within both the intertidal and subtidal zone are tidal creeks. Tidal creeks are relatively small, sinuous waterways that drain tidal water from the surface of coastal wetlands.

5.173 Aquatic habitats within the project area often overlap with wetland habitat types, particularly in shallow-water and intertidal areas. These shallow habitats and their locations are often defined by state and Federal agencies as part of the coastal zone and are managed under the states' Coastal Zone Management Act (CZM) and wetland protection programs. Coastal and aquatic habitats in New Jersey are defined under the CZM Location, Use and Resource Rules (NJAC 7:7E). New Jersey's location rules classify all coastal land and water locations into general areas or one or more special areas. Special areas (including water areas, water's edge areas, land areas, and coastwide areas) are those considered naturally valuable or sensitive to impact and require focused attention during project planning. Special water areas in estuarine and marine environments extend landward to the spring high water line. New Jersey special-water areas occurring in the project area include shellfish habitat, prime fishing areas, finfish migratory pathways, navigation channels, ports, submerged infrastructure routes, and intertidal and subtidal shallows. A complete listing of New Jersey special-water areas and their definitions is provided in Table 5.4-1.

5.174 Coastal and aquatic habitats in New York State are defined in regulations promulgated under the Tidal Wetlands Act (Land Use Regulations, NYCRR 661) and delineated as tidal wetlands on state inventory maps. These aquatic/wetland habitats are classified as: coastal fresh marsh; intertidal marsh; coastal shoals, bars, and mud flats; littoral zone; high marsh or salt meadow; and formerly connected tidal wetlands.

5.175 Special aquatic sites are also defined in USEPA guidelines set forth under authority of Section 404 of the Clean Water Act. These include: fish and wildlife sanctuaries and refuges designated under state and Federal laws or local ordinances; wetlands; mudflats; vegetated shallows; coral reefs; and riffle and pool complexes.

Wetlands

Introduction

5.176 Intertidal wetlands are found throughout the project area. The location, type, and condition of intertidal wetlands in the project area is summarized in the April 1999 New York and New Jersey Harbor Navigation Study Baseline Biological Reconnaissance Survey (USACE-NYD 1999a).

5.177 Virtually all wetlands in the study area have been directly or indirectly influenced by man's activities. Examples of direct impacts to intertidal wetlands include fuel spills, filling, ditching, draining, utility line installation, and blockage of tidal exchange. Examples of indirect impacts include the spread of nonindigenous vegetation, erosion from boat wakes, and sedimentation from point and nonpoint sources (roadway and parking lot runoff). Tidally influenced ditches constructed to control mosquitoes are encountered throughout the wetlands associated with Old Place Creek and the Rahway River. By hastening the rate of tidal exchange, these ditches may have facilitated the replacement of saltmarsh cordgrass (*Spartina alterniflora*) by common reed in some areas. Although these habitats have been subjected to numerous industrial and development activities, these areas are still functional, valuable wetlands. In some

areas, previously industrialized or developed shoreline areas that have been abandoned have reverted or are beginning to revert to wetland habitats. Interpier habitats that have shoaled or been filled (often by collapse or undermining of bulkheads) feature vegetated or unvegetated mudflats and, although often isolated and small, are in fact wetlands. Examples include locations at Sunset Park piers in Brooklyn and the abandoned docks at Port Ivory.

5.178 The locations of known jurisdictional intertidal wetlands in the project area are depicted on maps prepared by NYSDEC and by the National Wetland Inventory (NWI). The intertidal wetland locations in New York are reflected on the NYSDEC and NWI maps; those in New Jersey are reflected on the NWI maps only. The maps show the location, type of vegetation, and tidal regime (NWI only) of the wetlands. Since most of the wetland maps for New York Harbor are over 20 years old, the current location and vegetative class is often different from that depicted on the maps. Wetland areas may have grown in extent, or may have been reduced in size or even removed through natural processes or anthropogenic activities. Additionally, small intertidal wetlands that have recently become established and wetlands resulting from restoration and remediation projects are often not indicated on the maps.

5.179 Virtually the entire shoreline along the Hudson River, East River, and Brooklyn section of Upper New York Bay has been bulkheaded or filled. Because most of the shoreline in the project area has been filled or bulkheaded, intertidal wetlands are often found as small, scattered patches. The greatest density of large, vegetated intertidal wetlands is found in the Arthur Kill corridor on the Staten Island and New Jersey shores. This area also exhibits more shoreline erosion than any other area studied in the Reconnaissance Survey. Large intertidal wetland complexes are also found in the Arthur Kill east of Howland Hook at Port Ivory (Arlington Marsh), near the Goethals Bridge bordering Old Place Creek, on the eastern shore of the Arthur Kill near the Outerbridge Crossing, and in the tidally influenced portions of the Rahway River. The New York State Department of State (NYSDOS) lists several of the intertidal wetlands (Fresh Kills, Sawmill Creek, and Lemon Creek) as Significant Coastal Fish and Wildlife Habitats. Two significant freshwater marshes on Staten Island located near the coastal marshes are Mariners Marsh (near Port Ivory) and Goethals Bridge Pond (near Old Place Creek).

5.180 Other significant vegetated intertidal wetlands are located adjacent to Fresh Kills Creek, Smith Creek, and Woodbridge Creek, all tributaries to the Arthur Kill. Fresh Kills Creek originates in a large wetland complex along Main Creek and Richmond Creek on Staten Island; this complex includes the William T. Davis Wildlife Refuge. While portions of each creek are heavily developed, each creek functions as waterfowl and fish habitat and as a nursery area for fish species such as bluefish (*Pomatomus saltatrix*) and winter flounder (USCG 1995). The unvegetated or sparsely vegetated tidal flats and tidally influenced wetlands provide habitat for important forage fish species such as silverside (*Menidia* spp) and mummichog (*Fundulus heteroclitus*).

Dominant Vegetation and Wildlife

5.181 The dominant wetland vegetation in the project area is reflective of the wetland type and degree of human disturbance and invasion by common reed. Observations on wetland vegetation

and wildlife were made as part of the study's Baseline Biological Reconnaissance Survey in September 1998 (USACE-NYD 1999a). The wetlands in the tidally influenced creeks are characterized by an unvegetated mud flat grading to a monoculture of saltmarsh cordgrass, then to a monoculture of common reed. The saltmarsh cordgrass is typically found in the frequently inundated ("IM" wetlands on the NYSDEC maps and "E2EM" wetlands on the NWI maps) portions of the intertidal marsh; common reed is found in the upper portions of the intertidal marsh and in the high marsh. Less commonly observed plants were saltmeadow cordgrass (*S. patens*), groundsel bush (*Baccharis halimifolia*), both of which occur in the high marsh, and water hemp (*Amaranthus cannabinus*), which is found in the intertidal marsh. Common reed is an invasive species that often out-competes cordgrass in the upper intertidal area. While common reed has little food value for wildlife, it functions as cover, traps sediments, and absorbs waterborne nutrients. Common reed spreads by seed and by rhizomes (specially adapted roots), rapidly colonizing disturbed or cleared areas. The saline waters carried by mosquito control ditches in portions of the intertidal wetlands may prevent or slow the spread of common reed. In the case of common reed, ditching can serve either to facilitate or prevent its spread. When ditching serves to reduce the tidal influence and period of (saline) inundation, common reed may gain a competitive edge over saltmarsh cordgrass. However, tidal ditches of sufficent width and depth will prevent the spread (by rhizomes) of common reed. Ditching facilitates the invasion of common reed from the upland edge of the wetland, but can prevent invasion in isolated portions of the wetland.

5.182 Wildlife encountered in the vegetated intertidal marshes includes the marsh wren (*Cistothorus palustris*), red-winged blackbird (*Agelaius phoeniceus*), snowy egret (*Egretta thula*), green-backed heron (*Butorides striatus*), great egret (*Casmerodius albus*), and black-crowned night heron (*Nycticorax nycticorax*). Other birds attracted to the shallow-water areas in New York and New Jersey Harbor include seagulls (*Larus* spp.), terns (*Sterna* spp.), cormorants (*Phalacrocorax* spp.), plovers (*Pluvialis* spp., *Charadrius* spp.), yellowlegs (*Tringa* spp.), and several genera and species of sandpipers (USACE 1986a). The dominant mammal in the freshwater or brackish herbaceous marshes is the muskrat (*Ondatra zibethica*). Raccoon (*Procyon lotor*) and mink (*Mustela vison*) are also found. The only reptile commonly found in the salt marshes is the diamondback terrapin (*Malaclemys t. terrapin*); terrapins were recently observed in the Old Place Creek and Sawmill Creek drainages in the Arthur Kill (USCG 1995).

5.183 Estuarine flats (coastal shoals, sandbars, or mud flats; "SM" wetlands on the NYSDEC maps and "E2FL" wetlands on the NWI maps) are unvegetated expanses of mud, fine sand, or clay. Typical manmade components often observed include glass or brick fragments. Large expanses of sand beaches are found on the eastern and southern sides of Staten Island north and south of Great Kills Harbor. Piles, logs, and pieces of metal are typically scattered on the mudflats; these objects provide cover for benthic organisms such as mud crabs and polychaete worms, and habitat for sessile organisms such as barnacles. Invertebrates found in the wetlands are important links in the aquatic and terrestrial food chains. Other common invertebrates found in the intertidal wetlands include blue crabs, fiddler crabs (*Uca* spp), ribbed mussels (*Geukensia demissa*), periwinkles (*Littorina littorea*), various families of amphipods, sand shrimp (also called seven-spine bay shrimp [*Crangon septemspinosa*]), and grass shrimp (*Palaemonetes* spp.). Many of these species are vital converters of wetland vegetation and detritus, and in turn serve as

important food items for shorebirds and game fish. Blue crabs are commonly harvested (both recreationally and commercially) for human consumption, although both New York and New Jersey maintain health advisories regarding their consumption.

5.184 The tidal creeks in the project area, most of which are tributary to the Arthur Kill, are also part of the intertidal ecosystem. Examples include Old Place Creek, Smith's Creek, and the intertidal portions of the Rahway River. Tidal water exchange in many of the creeks is hastened by a number of drainage and mosquito ditches. The intertidal banks of many of the creeks are relatively steep and provide a limited foraging area for shorebirds and herons at low tide. Due to the high tidal current velocities within the creeks, and the steep banks, no rooted aquatic or emergent plants are found in the lower intertidal area in the creek channels. Salinity in the tidal creeks is variable and dependent upon tidal action, surface runoff, and groundwater infiltration. On most of the creeks, weirs or tidal flow gates restrict the tidal exchange and the passage of fish and aquatic invertebrates.

5.185 Some wetlands in the project area that are mapped as intertidal flats may be exposed only a few times per year during extreme (spring) tides. These areas are typically valuable foraging areas for wintering waterfowl such as canvasback (*Aythya valisineria*), greater and lesser scaup (*Aythya marila* and *A. affinis*, respectively), and bufflehead (*Bucephala albeola*). All four species are diving ducks that feed on marine invertebrates such as clams, snails, amphipods, and worms. These areas may also be used as habitat by some species of shallow-water forage fish, such as silverside, mummichog, and killifish (*Fundulus* spp). The unvegetated subtidal flats, a transitional zone between the intertidal wetlands and the channel zone, serve as a foraging and resting area for wintering waterfowl and a refugium during low tide for intertidal fish and crustaceans.

Human Impacts

5.186 Manmade debris, including demolition debris, sunken vessels, and waterborne lumber, is a common component of the intertidal wetlands. Significant portions of the western shore of the Arthur Kill, mainly near Linden and Carteret, consist of abandoned industrial facilities and the remains of their associated piers and wharves. Many of these areas have burned and the pile fields extend only one or two ft above the high water mark. Large pile fields are found on the north side of Staten Island near Port Ivory, around Shooters Island, and near the mouth of Piles Creek. The pile fields and sunken barges can function as protective structure for fish and may serve as wave attenuators to protect and foster the development of herbaceous wetlands inshore of the debris. This protective effect will gradually be lost as the wooden structures decay or are broken up by marine borers, such as isopods (*Limnoria* spp.) and shipworms (*Teredo* spp.).

5.187 Recent or ongoing disturbance of intertidal wetlands was observed primarily in the Arthur Kill during this study's Baseline Biological Reconnaissance Survey. Scouring or undercutting of the cordgrass patches was noted in several locations, mainly on the eastern shore of the Arthur Kill where boat wakes are amplified by the prevailing westerly winds. Boat wakes typically "echo" from shore to shore. Extensive bulkheading and shoreline modifications have left very few areas in the upper New York Harbor capable of wave and vessel-wake attenuation.

Tideborne debris, consisting of plant stems, piles, logs, bottles, cans, plastic, fast-food containers, and styrofoam, is frequently found near the high tide line. Deep deposits of debris often smother intertidal vegetation, particularly when large items such as piles and logs are carried into the upper intertidal (high marsh) area by storms or seasonal high tides.

5.188 Recreational use of the vegetated wetlands in the project area appears to be limited to crabbing and fishing at available access points, often through abandoned facilities or along railroad grades. Human access to the wetlands for other activities (birdwatching, hiking) is quite limited; security fences, ditches, soft sediments, and dense stands of common reed prevent or hinder public access. The restricted access often reduces the amount of illegal dumping in and adjacent to the wetlands. Where wetlands and streams are accessible (bridges, fence breaks) from frontage roads, illegal dumping of debris has often taken place.

5.189 Intertidal wetlands that are part of the ecological resources of the selected alternative are identified by channel below:

Ambrose Channel and Anchorage Channel

5.190 No intertidal wetlands are associated with the Ambrose Channel or the Anchorage Channel.

Kill Van Kull Channel

5.191 Intertidal mudflats with fringe of low and high salt marsh areas are associated with the Kill Van Kull Channel.

Arthur Kill Channel to Howland Hook

5.192 Large, vegetated intertidal wetlands are found in the Arthur Kill corridor on both the Staten Island and New Jersey shores. Large complexes of intertidal wetlands are also found along the Arthur Kill in the vicinity of the project area, east of Howland Hook at Port Ivory (Arlington Marsh), and near the Goethals Bridge bordering Old Place Creek. In addition, two significant freshwater marshes exist on Staten Island: Mariners Marsh near Port Ivory and Goethals Bridge Pond near Old Place Creek.

Howland Hook Marine Terminal

5.193 The project site includes 147 acres of developed area. Regulated waters and wetlands are limited to adjacent areas, including tidal waters of the Arthur Kill. The absence of wetlands on the 147-acre upland redevelopment site is subject to NYSDEC and USACE-NYD verification. Figure 5.4-1 shows the locations of wetlands in the adjacent areas. These wetland areas are described based on air photo interpretation and ground truthing.

5.194 NYSDEC Tidal Wetlands Maps (570-498, 568-498, 568-496, 566-498, 566-496) identify several tidal wetland types in the project vicinity, including coastal shoals, bars and mudflats

(SM), intertidal marsh (IM), high marsh or salt meadows (HM), formerly connected tidal water (FC), and littoral zone (LZ).

5.195 To the south and inland of Howland Hook is Goethals Bridge Pond, a shallow freshwater-to-brackish pond surrounded by emergent marsh dominated by common reed, with a contiguous forested area. Old Place Creek is a meandering tidal creek, with a narrow strip of intertidal marsh and areas of high marsh. These wetland and non-wetland open-space areas adjacent to the existing Howland Hook Marine Terminal are identified by USFWS as a portion of a larger "Significant Land Habitat Complex".

5.196 The study area is generally divided by Richmond Terrace with "Mariners Marsh Park" located to the south. The Mariners Marsh Park area comprises an abandoned baseball field surrounded by a mosaic of wetlands and uplands. Due to past construction and dumping activity, the area is disturbed, and several petroleum pipelines were noted traversing portions of the area.

5.197 To the south and east of the ballfield is a series of wetland areas that consist of several interconnected open water (POW) areas of varying size, each surrounded by an emergent marsh. The palustrine emergent (PEM1) wetlands are predominantly common reed, with other hydrophytes observed, including tussock sedge (*Carex stricta*), smartweed (*Polygonum* spp.), mermaid-weed (*Proserpinaca palustris*), cattails (*Typha* spp.), and three-square rush (*Schoeplactus pungens*, formerly *Scirpus americanus*). In between the open water/emergent marsh areas are scrub-shrub wetlands (PSS1), dominated at the shrub/sapling level by sweet gale (*Myrica gale*), willow (*Salix* spp.), and cottonwood (*Populus deltoides*). Dominant herbs include common reed, horsetail (*Equisetum* spp.), rush, poison ivy, goldenrod (*Solidago* spp.), Virginia creeper (*Parthinocissus quinquefolia*), and trace amounts of moss (*Sphagnum* spp.).

5.198 A deciduous wetland forest grows along the eastern boundary, north of Richmond Terrace. South of Richmond Terrace, a small intermittent stream meanders through the area. Dominant trees within the forested wetland include sour gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), black willow (*Salix niger*), and sweetgum (*Liquidamber styraciflua*). Dominant shrubs include sweet pepperbush (*Clethra alnifolia*), southern arrowwood (*Viburnum dentatum*), and elderberry (*Sambucus canadensis*). Dominant herbs observed within the wetland include cinnamon fern (*Osmunda cinnamomea*), skunk cabbage (*Symplocarpus foetidus*), spotted touch-me-not (*Impatiens capensis*), common reed, and sensitive fern (*Onoclea sensibilis*). Although much of the area was either inundated or saturated, analysis of the soils for field indicators of hydric conditions was not conclusive due to the apparent frequent deposition of new soil material in the area.

5.199 Anthropogenic activity occurred west of the ballfield, where a complex microtopography and a mixture of wetlands and uplands exists. The area is predominantly wetland with some upland inclusions. Dominant plants include American elm (*Ulmus americana*), sweetgale, and silky dogwood (*Cornus ammomum*), with an understory consisting of poison ivy, sensitive fern, rush (*Juncus* spp.), and sedge (*Carex* spp.). In some areas, common reed and cattails are found surrounding open water. Much of the area exhibited saturated or inundated soil conditions at the

time of field investigation, and was demarcated from adjacent upland areas by an abrupt change in topography.

5.200 South of the ballfield is primarily upland with some wetland inclusions. Complex changes in microtopography are seen in this area. Because of the area's complexity, intensive fieldwork would be required to determine the exact location of all wetland boundaries, including the numerous upland and wetland inclusions encountered.

5.201 A gas pipeline transects the area north of Richmond Terrace, known as Arlington Marsh. The area west of the pipeline is dominated by a marsh located within an inlet to Kill Van Kull and Newark Bay. This area is classified as estuarine intertidal, emergent, persistent (E2EM1). The dominant vegetation within the tidal portion of the marsh is smooth cordgrass and saltmeadow cordgrass. Along the upper edge of the marsh, in a zone less frequently flooded, common reed is the dominant species. This zone is classified as palustrine emergent, persistent (PEM1). A narrow area of shrub-scrub wetland occurs within the transition from upland to emergent marsh. The species within this zone include Japanese knotweed and arrowwood.

5.202 A large scrub-shrub emergent wetland extends east to the project boundary. The dominant vegetation includes common reed and bayberry (*Myrica* sp.). The intertidal zone consists primarily of cobbles in the more exposed areas and common reed within a marsh near the eastern edge of the site.

5.203 It is important to note that previous anthropogenic activity has resulted in the creation of complex microtopography and ecological conditions in many adjacent areas. This, in turn, has resulted in the formation of numerous wetland or upland inclusions within a larger dominant plant community.

Newark Bay Channel

5.204 Intertidal mudflats and a significant *Spartina* and reed wetland are associated with the Newark Bay Channel.

Port Newark/Elizabeth Port Authority Marine Terminal

5.205 This site is bordered by tidal water on the southeast and east, with some isolated wetland areas mapped to the west. The project site itself is sparsely vegetated. The NWI map classifies the adjacent tidal areas as E1OW (estuarine, subtidal and open water) and E2FL (estuarine, intertidal flats). NJDEP data also indicate a small area of herbaceous freshwater wetland. West of this open-water area and southwest of the terminal are disturbed lands that contain some tidal and freshwater wetlands. The Great Ditch discharges to Newark Bay south of the project site. Some industrial use is made of land west of the site, and some land is vacant. This vacant land appears to be predominantly uplands but also contains the Great Ditch (a tidal channel), and wetland areas. A limited assessment of this offsite adjacent area showed the presence of common reed, cattails, marsh elder/high tide bush (*Iva frutescens*), sedges, smartweed (*Polygonum* spp.), rushes (*Scirpus* spp.), and willow.



5.206 Figure 5.4-2 shows the locations of wetlands identified southeast of the project site. Wetland areas were estimated based on aerial photo interpretation and are subject to field delineation and Agency verification.

Port Jersey Channel

5.207 The 310-acre Port Jersey/MOTBY site comprises two rectangular parcels, separated by the Port Jersey channel, that extend into Upper New York Bay. The developed portion to the north, situated in both Jersey City and Bayonne, is referred to as the Port Jersey Site. The southern site, solely within Bayonne (and developed), is referred to as the MOTBY site. Both sites are associated with rectangular fill areas bordered by tidal waters. Residential land use is to the west. Land to the south contains brushland and both tidal and freshwater wetlands.

5.208 Redevelopment is proposed on existing uplands, adjacent to regulated waters of the U.S. (including wetlands within the State of New Jersey).

5.209 Figure 5.4-3 shows the location of wetlands identified in the vicinity of the project site. Intertidal mud flats are found on the north side of Constable Hook, and near the landward end of the Port Jersey Channel. Wetland areas were estimated based on site evaluations and aerial photo interpretation and are subject to field delineation and Agency verification for areas subject to permitting. Adjacent areas have been evaluated with regard to habitat types.

Bay Ridge Channel

5.210 No intertidal wetlands are associated with the Bay Ridge Channel.

South Brooklyn Marine Terminal

5.211 The project site is developed with a structural shoreline abutting most of the entire waterway. All open-water areas are designated as tidal wetlands, with a Littoral Zone (LZ) designation by New York State. Fourteen piers south of the project site cover about 42 acres of water, but no piers are found within the "site" itself. These adjacent pier-containing areas are regulated pursuant to Federal and state jurisdiction of wetlands and waters.

5.212 Section 404 of the Clean Water Act regulates waters of the U.S., which include wetlands, mudflats, etc. Based on a site survey and evaluation of aerial photographs, the project study area contains wetlands subject to Federal jurisdiction, including the adjacent intertidal areas, open water, and the water area covered by piers. USACE has scheduled removal of the piers. Two piers/fill pads that are visible on the north and south sides of the site on 1995-97 aerial photographs were not seen during a 1999 field investigation. Timber piles are all that is visible along the apparent outside edge of these former piers. The above-described features are shown in Figure 5.4-4.

5.213 A portion of the project site is currently being used as temporary car storage for local automotive dealers. The area is generally flat and largely devoid of vegetation, with some areas of pavement and other areas of compacted gravel fill. The perimeter of the site, fringed with trees, drops off steeply to the water. The wetland regulatory boundary is generally along Harbor shoreline defined by an abrupt topographical change. The intertidal area would be classified as estuarine unconsolidated shore, cobble-gravel (E2US1).

5.214 The area south of the project site (Bush Terminal), located between 39th and 50th Streets, is disturbed and there is evidence of illegal dumping activity. The intertidal area adjacent to the west and north sides of the Bush Terminal area is classified as estuarine intertidal unconsolidated shore, cobble-gravel (E2US1). Due to the presence of fill mounds and past dumping activities, microtopography is encountered in certain areas.

5.215 Along the northeastern fringe of the Bush Terminal site, the topographical change is more gradual, with a downslope to a created inlet. The substrate within the intertidal zone (E2US2/1) consists of sand and cobbles. Several species of macroalgae are growing attached to rocks in this area, including brown algae (Phaeophyta) such as rockweed (*Fucus* spp.), and green algae (Chlorophyta) such as hollow green weeds (*Enteromorpha* spp.). Along the edge of the high tide line, a narrow fringe of tidal wetlands is found, with some pockets dominated by common reed, and others by cordgrass.The wetlands described above may be seen in NYSDEC Wetland Inventory maps 584-500, 582-500, 582-502, and 584-502.

Uplands

5.216 In general, upland habitat in the New York and New Jersey Harbor study area has undergone substantial alteration as a result of urban development, commercial and industrial activities, highway construction, and establishment of parks and greenways. Due to extensive shoreline development and industrialization, upland habitat in the study area is generally limited to parks and the upland portions of wetlands and marshes. In many shoreline areas, formerly filled wetland habitat is now used for waterfront developments and industrial activities. Limited upland vegetation is evident on the islands in the Arthur Kill comprising the Harbor Heron Complex (Shooters Island and Pralls Island).

5.217 A review of the upland habitat types described in the NYSDEC document *Ecological Communities of New York State* (Reschke 1990) indicates that the plant and wildlife associations found in the study area fall under the "Terrestrial Cultural" category. Representative habitats include the "Urban Vacant Lot" which describes abandoned areas in the process of vegetative succession, and "Dredge Spoils" which describes the filled shoreline areas and created islands in the study area. The document does not contain a description for parks: maintained areas with specimen (often non-native) trees, recreational facilities, and lawns. Another common habitat (described below) is the urban non-native forest, typical of upland sites where vegetative succession has proceeded for several decades. These areas feature a dense tree canopy, seasonal cover for wildlife, and a visual and noise barrier from developed areas.

5.218 Shooters Island is situated off the north shore of Staten Island, opposite Mariners Harbor, at the juncture of Newark Bay, Kill Van Kull and Arthur Kill. The upland portion of the island (30-40 acres) supports a deciduous canopy approximately 30 ft high. The species showing greatest relative basal area dominance are gray birch (*Betula populifolia*), black cherry (*Prunus serotina*), and black locust (*Robinia pseudoacacia*) (Parsons 1994). The rest of the island is vegetated with herbaceous grasses, such as common reed, saltmarsh cordgrass, and vines (greenbrier [*Smilax rotundifolia*] and honeysuckle [*Lonicera* sp.]). Due to its inaccessibility, few mammals inhabit Shooters Island, with the most common being the Norway rat (*Rattus norvegicus*) and meadow vole (*Microtus pennsylvanicus*) (USACE 1986). The chief importance of the island has been the mixed heron rookery, although recent studies have indicated the island to have been largely been abandoned by herons (Kerlinger 1999).

5.219 Isolated wooded areas found along the edges of marshes and developed zones are dominated by non-native invasive species such as mulberry (*Morus* sp.), tree-of-heaven (*Ailanthus altissima*), Norway maple (*Acer platanoides*), and royal paulownia (*Paulownia tomentosa*) (USCG 1995). Other species encountered include box elder (*Acer negundo*), cottonwood, and honey locust (*Gleditsia triacanthos*). Additional areas of upland habitat within the project area occur in recently cleared or disturbed areas and vacant lots. Vegetation commonly consists of disturbance-tolerant, often introduced, species occurring in scattered patches. Typical plant species include goldenrod, mugwort (*Artemesia vulgaris*), Asian bittersweet (*Celastrus orbiculata*), Japanese knotweed (*Polygonum cuspidatum*), and pokeweed (*Phytollaca americana*) (USCG 1995). Common shrubs may include sumac (*Rhus* sp.), multiflora rose (*Rosa multiflora*), Russian olive (*Eleangus angustifolium*), and raspberry (*Rubus* sp.).

5.220 The edges of highways and secondary roads in the project area, including the median strip of some divided highways, are also considered upland habitat. These areas contain primarily herbaceous species, such as timothy grass (*Poa pratense*) and mugwort, or planted ornamentals. The 5- to 40-ft-wide strips parallel most roadways and may be mowed weekly along highways or annually along secondary roads during the growing season. Tree and shrub species typically planted in roadway rights-of-way include sycamore (*Platanus occidentalis*), crabapple (*Malus* sp.), sweetgum (*Liquidambar styraciflua*), forsythia (*Forsythia* sp.), and Russian olive. Street trees and trees on properties in single-family home neighborhoods provide foraging and nesting sites for several species of songbirds. Recreation fields also fall into the category of upland habitats. Unmaintained strips of shrubs or trees adjacent to highways or recreation fields can also be important nesting habitat for upland birds. Typical species include the American robin (*Turdus migratorius*), ring-necked pheasant (*Phasianus colchicus*), northern mockingbird (*Mimus polyglottos*), song sparrow (*Melospiza melodia*), and gray catbird (*Dumetella carolinensis*).

5.221 The municipal and city parks provide some of the largest and most diverse upland communities in the project area. Park areas include Central Park on Manhattan, Miller Field and Great Kills Park on Staten Island, City Park and Hudson County Park in Bayonne, and Liberty State Park and Lincoln Park in Jersey City. While mowing and human disturbance may limit use by some animals, the presence of a number of seed- and nut-producing trees and supplemental

feeding by people provides a food source for small mammals and birds. Trees consist of both native and introduced species, frequently maintained as large "specimens."

5.222 Much of the upland habitat outside the parks consists of abandoned former industrial facilities, highway cloverleaves and grades near railroad lines, and buffer areas separating developed/residential areas from wetlands, highways, or industrial facilities. The age and diversity of the plant community is typically a function of the available soil or substrate and how long plant succession has proceeded. Plant communities typically consist of relatively few species, chiefly invasive species or those that can thrive in poor soil conditions.

5.223 Abandoned buildings provide habitat (roosting, nesting, and resting) for birds and mammals. Bird species that use abandoned buildings for cover include pigeons, house sparrows (*Passer domesticus*), house finches (*Carpodacus mexicanus*), European starlings (*Sturnus vulgaris*), and owls. Chimney swifts (*Chaetura pelagica*) and swallows may use abandoned buildings as nesting sites. The roofs of abandoned (and occupied) buildings are used as resting areas by sea gulls and crows (*Corvus* sp.); and occasionally as nesting sites by common nighthawks (*Chordeiles minor*) (Andrle and Carroll 1988).

5.224 Isolation, human impact, and lack of cover often limit the value of upland habitat for wildlife. Upland habitat adjacent to wetlands or watercourses is valuable as a noise and visual buffer, and as a roosting or nesting area for wetland-dependent birds. Typical mammals in the urban upland environment include the Norway rat , feral cats, and eastern gray squirrels (*Sciurus carolinensis*). The melanistic (black) phase of the gray squirrel is fairly common in some parks.

Critical or Significant Habitats

5.225 The following section references the U.S. Fish and Wildlife Service, Significant Habitat Complexes of the New York Bight Watershed, 1997, which identifies the following as significant habitats.

Breezy Point

5.226 Breezy Point, which is made up of sand dunes, beach, and rock riprap, is located at the western tip of Rockaway Point. This area supports a high concentration of beach-nesting birds, including one of the largest piping plover nesting sites in the entire New York Bight coastal region, with an average of 22 pairs and a maximum of 33 pairs during the period 1985 to 1995. The area also supports one of the largest concentrations of least terns (*Sterna antillarum*) and black skimmer (*Rynchops niger*) colonies in the area. Common tern (*S. hirundo*) nest in large numbers on Breezy Point. Small numbers of roseate terns (*S. dougallii*) (listed as Federally endangered) began nesting at Breezy Point in 1993. Other notable nesting shorebirds include great black-backed gull (*Larus marinus*), herring gull (*L. argentatus*), willet (*Catoptrophorus semipalmatus*), and American oystercatcher (*Haematopus palliatus*). The intertidal beach is used as a foraging area for nesting and migrating piping plovers (*Charadrius melodus*) and other shorebirds (USFWS 1997).

5.227 Summer and fall bring other birds into the Breezy Point area, including migratory shorebirds, birds of prey, waterfowl, and songbirds. Workers at the raptor banding station at Breezy Point banded a total of 2,414 raptors during the period 1978 to 1987, and sighted a total of 15,715 raptors. American kestrel (*Falco sparverius*) and sharp-shinned hawk (*Accipiter striatus*) were the raptors most frequently sighted, but other sightings have included Cooper's hawk (*A. cooperii*), northern harrier (*Circus cyaneus*), osprey (*Pandion haliaetus*), peregrine falcon, and merlin (*F. columbarius*). The state-listed (endangered) peregrine falcon nests on the Marine Parkway Bridge and feeds throughout the bay (USFWS 1997).

5.228 Three species of rare plants are found at Breezy Point, including the Federally listed threatened and globally rare seabeach amaranth (*Amaranthus pumilus*) and globally rare seabeach knotweed (*Polygonum glaucum*) along the ocean beach and dune, and state-listed rare Schweinitz's flatsedge (*Cyperus schweinitzii*) on the bay side of the barrier. The proposed project will not adversely impact any of these resources at Breezy Point.

Raritan Bay-Sandy Hook Complex

5.229 The Raritan Bay-Sandy Hook Complex provides significant habitat for a number of plants, fish, and wildlife. Surveys conducted in Raritan Bay have identified over 90 species of fish, including many important forage species and species of recreational and commercial importance. Invertebrates in this area include American lobster, blue crab, horseshoe crab (*Limulus polyphemus*), northern quahog, softshell clam (*Mya arenaria*), blue mussel (*Mytilus edulis*), American oyster (*Crassostrea virginica*), and Atlantic surfclam (*Spisula solidissima*). Spawning in the shoal waters by horseshoe crab provides an important food source in the spring for migrating shorebirds. Both harp and ringed seals (*Phoca groenlandica* and *P. hispida*, respectively) are regularly sighted on the Sandy Hook Peninsula. Loggerhead turtles (*Caretta caretta*) occur off the northern tip of Sandy Hook, and Kemp's ridley (*Lepidochelys kempii*) sea turtles feed in Horseshoe Cove (USFWS 1997).

5.230 Significant migratory and midwinter concentrations of waterfowl are found in this complex. Raritan Bay is an important migratory area for many species of waterfowl on the Atlantic Flyway, with peak migration occurring in late October. Significant species include Canada goose (*Branta canadensis*), American black duck (*Anas rubripes*), canvasback, mallard (*A. platyrhynchos*), brant (*B. bernicla*), bufflehead, oldsquaw (*Clangula hyemalis*), merganser (primarily red-breasted) (*Mergus serrator*), common goldeneye (*Bucephala clangula*), double-crested cormorant (*Phalacrocorax auritus*), great cormorant (*P. carbo*), and American wigeon (*A. americana*). These waterfowl are not evenly distributed but rather tend to concentrate along the southern Raritan Bay and Staten Island shorelines and in the Shrewsbury and Navesink Rivers. Breeding birds along the bayshore include American black duck, mallard, clapper rail (*Rallus longirostris*), king rail (*R. elegans*), green-backed heron, marsh wren, and willet.

5.231 The shorelines of Raritan Bay (including both the south shore in Monmouth County, New Jersey, and the Staten Island, New York, shoreline), see concentrations of migratory shorebirds and neotropical migrant landbirds. Shorebird surveys done in the early 1980s indicated the importance of Raritan Bay for spring and fall shorebird migration, with seasonal totals of over

20,000 birds, based on weekly surveys. The peak months are June and August, and the areas of primary concentration are Great Kills on Staten Island and the flats inside Sandy Hook.

5.232 The embayment from Point Comfort to Conaskonk Point is a nearly uninterrupted salt marsh shoreline with natural creek mouths. This is an important feeding area for shorebirds. Several osprey pairs nest on poles along this stretch of marsh. Diamondback terrapin feed in the marsh and creek system and may nest in this area. Further to the west, at the Raritan River mouth, egrets and ibis are often seen foraging, probably representative birds from the Harbor Herons Complex.

5.233 Sandy Hook is an undeveloped barrier beach on the northern end of the New Jersey coastline. Currently, five beach-nesting bird colonies are known at Sandy Hook, including an average of 20 pairs of piping plover from 1985 to 1995. Productivity of piping plovers at Sandy Hook is also consistently the highest in New Jersey, with an average of nearly 1.5 chicks fledged per nesting pair, compared with the statewide average of about 1.0 chicks fledged per nesting pair. In 1995, over 600 least terns were observed nesting alongside the piping plover at the five Sandy Hook sites; this was the largest number of least terns seen nesting in New Jersey that year (USFWS 1997). Common tern also nest at one site, and black skimmer have recently been seen to nest at another beach site. Historically, the Federally listed threatened northeastern beach tiger beetle has nested at Sandy Hook (USFWS 1997). The U.S. Fish and Wildlife Service, together with the National Park Service, has successfully reintroduced this species at two locations on the northern tip of Sandy Hook.

5.234 Spring hawk counts at Fort Hancock on Sandy Hook average nearly 5,000 birds between March and May (USFWS 1997). Birds seen include kestrel, sharp-shinned hawk, northern harrier, red-shouldered hawk (*Buteo lineatus*), merlin, Cooper's hawk, turkey vulture (*Cathartes aura*), red-tailed hawk (*B. jamaicensis*), and osprey.

Harbor Herons Complex

5.235 The Harbor Herons Complex covers five islands: Shooters and Pralls Islands in the Arthur Kill, the Isle of Meadows in the Kill van Kull, and Swinburne and Hoffman Islands in Lower New York Bay. It also includes the tidal and freshwater wetlands in the northwest quadrant of Staten Island that are in the vicinity of three of the islands.

5.236 This complex is considered significant habitat by USFWS because of the presence of major nesting colonies and foraging areas for herons, egrets, and ibises. Three island colonies, or heronries, were established in the 1970s. In 1995 these heronries collectively contained nearly 1,400 nesting pairs of colonial wading birds of special regional emphasis or management concern, including, in declining order of abundance, black-crowned night-heron, glossy ibis (*Plegadis falcinellus*), snowy egret, great egret, cattle egret (*Bubulcus ibis*), yellow-crowned night heron (*Nyctanassa violacea*), green-backed heron, and little blue heron (*Egretta caerulea*) (USFWS 1997).

5.237 This Harbor Herons Complex, the largest heronry in New York State, contains approximately 25% of all the wading birds that breed in New Jersey, New York, and Connecticut (USFWS 1997). The largest number of nesting great egret, cattle egret, snowy egret, and yellow-crowned night herons in New York State are found at these colonies. In addition, over 1,000 herring gull, 30 great black-backed gull, and 140 double-crested cormorant pairs are known to nest on these same sites, making the Harbor Herons Complex one of the southernmost nesting areas for the Canadian cormorant sub-population. Adult and young herons and egrets forage extensively in the wetlands of this complex, feeding on rich concentrations of forage fish in the marshes, flats, and shallow waters of ponds and tidal creeks (USFWS 1997).

5.238 Shooters Island has not been occupied by herons, egrets, or ibis for two years in a row (Kerlinger 1999). This may be related to human activity on the island (Kerlinger 1999). Nor has Pralls Island been inhabited by herons or gulls since 1997 (Kerlinger 1999). The Isle of Meadows presently contains active heron, egret, and ibis nests (Kerlinger 1999).

5.239 A 1999 survey (Kerlinger 1999) indicated hardy populations of nesting herons and egrets, as well as herring and greater black-backed gulls, on Hoffman Island. Swinburne Island appears to be uninhabited by nesting herons, egrets, or ibis, but does provide nesting habitat to double-crested cormorants, and herring and greater black-backed gulls.

Shellfish Beds and Productive Subtidal and Shoal Areas

5.240 The nearshore and open waters of the New York Bight, including Raritan and Sandy Hook Bays, are locations of productive shellfish beds (Long and Figley 1982, Figley 1988, USFWS 1997). Distributed throughout the area, often in commercially important densities, are northern quahog, softshell clams, blue mussels, surfclams, and ocean quahog (*Arctica islandica*). A number of these species are also found in Upper New York Bay, the Kill Van Kull, Newark Bay, and the Arthur Kill, although less abundantly. Shellfish from these beds are not safe for human consumption (USFWS 1997).

5.241 Shoals and subtidal zones are areas less than 6 ft in depth that remain permanently flooded. These areas are usually marked by unconsolidated sediments of silt or sand and may contain a variety of benthic organisms such as polychaete worms, mud crabs, and other shellfish species (Lerman 1986). Within the Lower New York Bay/New York Bight area lies the highly productive Romer Shoal. This area is an important location of both recreational and commercial fisheries for weakfish (*Cynoscion regalis*), bluefish, summer flounder, striped bass, sea bass (*Centropristis striata*), tautog (*Tautoga onitis*), lobster, and blue crab. Productive shoal and subtidal areas line the study area from Upper New York Bay to the Arthur Kill, and may serve as foraging or concentration areas for fish, shellfish, and birds. Shoals and shallow water may also be used by a variety of fish species as spawning or nursery areas.

5.242 Mudflats are also located throughout the study area. Estuarine mudflats are tidally exposed, unvegetated expanses of mud, fine sand, or clay (Lerman 1986). Manmade components of these areas include pilings, derelict vessels, jetsam, and litter, all of which provide cover for benthic organisms such as mud crabs and polychaete worms, or attachment

substrates for sessile organisms such as barnacles and mussels. These organisms in turn provide forage for a number of fish and wildlife species.

Essential Fish Habitat (EFH)

5.243 Essential fish habitat (EFH) is defined under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (PL 94-265), as amended by the Sustainable Fisheries Act (SFA) of 1996 (PL 104-267), as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The SFA requires that EFH be identified for those species actively managed under Federal fishery management plans (FMPs). This includes species managed by the eight regional Fishery Management Councils (FMCs), established under the MSFCMA, as well as those managed by the National Marine Fisheries Service (NMFS) under FMPs developed by the Secretary of Commerce.

5.244 EFH designations emphasize the importance of habitat protection to healthy fisheries and serve to protect and conserve the habitat of marine, estuarine, and anadromous finfish; mollusks; and crustaceans. EFH embodies both the water column (including its physical, chemical, and biological growth properties) and its underlying substrate (including sediment, hard bottom, and other submerged structures). Under the EFH definition, necessary habitat is that which is required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. EFH is designated for a species' complete life cycle, including spawning, feeding, and growth to maturity, and may be specific for each life stage (e.g., eggs, larvae).

5.245 EFH designations are based on various levels of information available for a species' life stage distribution, abundance, and habitat-productivity relationships. Information levels include: presence/absence (Level 1); habitat-related densities (Level 2); growth, reproduction, and survival rates within habitats (Level 3); and production rates by habitat types (Level 4). Several long-standing and comprehensive sources of information are available to develop EFH designations, including the NMFS bottom trawl survey (1963-97), the NMFS Marine Resources Monitoring, Assessment and Prediction (MARMAP) ichthyoplankton survey (1977-87), the NOAA Estuarine Living Marine Resources (ELMR) program, and state or regional surveys (e.g., Connecticut Trawl Survey of Long Island Sound). For most species, the primary source of information currently used to designate EFH within the Hudson-Raritan River and Sandy Hook Bay estuary was the ELMR program (NEFMC 1998, MAFMC 1998a,b). Conducted jointly by NOAA's Strategic Environmental Assessment (SEA) Division, the Office of Ocean Resources Conservation and Assessment (ORCA), the ELMR program used both quantitative and qualitative information to develop a consistent database on the life history, relative abundance, and distribution of fish and invertebrates in estuaries throughout the nation (Stone, et al. 1994). Species information contained in the ELMR database is reported as a monthly relative abundance of each species' life stage by estuary for three salinity zones (seawater, mixing, and tidal freshwater). ELMR relative abundance was based on both quantitative studies and the professional and personal knowledge of regional, state, and local scientists and managers familiar with the species and estuaries considered. For EFH designation purposes, ELMR information is considered Level 1 (presence/absence).

5.246 A summary of those species for which EFH has been designated in the Hudson-Raritan estuary and Sandy Hook Bay is provided in Table 5.4-2 (NMFS 1999a). EFH designations have been defined for specific life stages based on their occurrence in tidal freshwater, estuarine (i.e., mixing/brackish salinity zone), or marine (i.e., seawater salinity zone) waters. EFH for most species includes both the estuarine and marine waters within or surrounding the project area. Exceptions include butterfish larvae (estuarine waters only), Atlantic mackerel juveniles and adults (marine waters only), summer flounder larvae (estuarine, marine, and tidal freshwater), and scup (marine waters only for all life stages).

5.247 NMFS (1999a) has also summarized EFH in ten-minute squares of latitude and longitude in the waters along the Atlantic coast, including inshore estuaries. A summary of these latitude and longitude squares within or adjacent to the project area is provided in Table 5.4-3. Figure 5.4-5 provides the square location and ELMR salinity zones within the Hudson-Raritan estuary and Sandy Hook Bay. Because the boundaries of the estuaries do not coincide exactly with the latitude and longitude coordinates for each square, a life-stage inclusion for a given species in the summary table may not correspond with its inclusion in the individual squares (NMFS 1999a).

5.248 A brief summary of EFH parameters for each species' life stage occurring in the project area is provided in Table 5.4-4. Of the EFH species listed, only winter flounder, windowpane flounder, and scup have EFH designated in the project area for each stage of their life cycle. Red hake, Atlantic sea herring (*Clupea harengus*), Atlantic butterfish, and summer flounder have EFH designated for larval to adult stages. Bluefish, Atlantic mackerel, and black sea bass have had EFH designated for juvenile and adult stages.

5.249 EFH that is judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation, may also be identified by FMCs and NMFS as Habitat Areas of Particular Concern (HAPC). For those types or areas of EFH to be considered HAPC the following must be demonstrated: the importance of the ecological function provided by the habitat; the extent to which the habitat is sensitive to human-induced environmental degradation; whether, and to what extent, development activities are, or will be, negatively impacting the habitat type; or the rarity of the habitat (NEFMC 1998). No HAPC have yet been identified in the project area.

Aquatic Species

Finfish

5.250 The finfish community in the project area, consisting 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 New York and New Jersey Harbor estuary serve as a spawning ground, migratory pathway, and nursery/foraging area for many fish species.

5.251 Many of the species that are seasonally abundant in the project area are transient or migratory, moving through the project area to upstream spawning grounds in the Hudson River or entering the area on a seasonal basis from nearby ocean waters. These include estuarine migratory species that use the estuary primarily as a nursery, or as a forage area for juveniles or adults.

5.252 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.

5.253 Striped bass are also among those species whose juvenile and adult life stages rely on the Harbor estuary as a nursery and forage area. Other members of this group include both marine and estuarine predators, such as winter flounder, bluefish, summer flounder, and weakfish, as well as forage species, such as Atlantic menhaden (*Brevoortia tyrannus*), mullet (*Mugil cephalus*), American sand lance (*Ammodytes americanus*), and bay anchovy (*Anchoa mitchilli*). These fish migrate in and out of the project area on a seasonal basis, depending on where they spawn (estuarine vs. marine) and when (winter vs. summer).

5.254 Relatively few species are year-round residents of the project area. Estuarine residents tolerate the naturally wide range and abrupt changes in salinity from tidal freshwater to marine environments (0.5 to 30 ppt). These species generally begin spawning in late spring and continue throughout most of the summer, following general onshore and offshore seasonal movement patterns (i.e., onshore in spring and summer, offshore to deeper waters in fall and winter). Most life stages of these species may be found in the estuary throughout the year. These species, which include Atlantic silverside (*Menidia menidia*), mummichog, striped killifish (*Fundulus majalis*), three-spined stickleback (*Gasterosteus aculeatus*), and four-spined stickleback (*Apeltes quadracus*), provide an important forage base for larger predatory species.

5.255 Previous biological investigations have characterized the seasonal distribution and composition of the fish community in various habitats and areas of the Harbor estuary. Fish sampling was conducted in the Arthur Kill, Kill Van Kull, and Newark Bay in 1984-85 (USACE-NYD 1987) and from April 1995 to March 1996 (LMS 1996). Sampling specific to Newark Bay was conducted in 1987-88 (Will and Houston 1992) and from May 1993 to April 1994 (NMFS 1994). From March 1994 to February 1995, sampling was conducted in the Arthur Kill in the vicinity of the Goethals Bridge (USCG 1995). An extensive sampling program was conducted (including both channel and shoal areas) in Raritan Bay, Lower New York Bay, and Sandy Hook Bay between January 1992 and December 1997 (Wilk et al. 1998). These studies

have been used to characterize the abundance and seasonal occurrence of blue crab and other large invertebrates collected along with fish.

5.256 The fish sampling programs described above provide an inventory of fish species that may occur in the project area. [See Appendix B-1.2.] The combined list shows the occurrence of 91 species representing 44 families from the lower Hackensack River through Newark Bay, the Arthur Kill/Kill Van Kull, Raritan-Sandy Hook Bays, and Lower New York Bay. Most species listed might be expected to occur in the project area, excluding some freshwater species that represent unique or uncharacteristic catches. A limited number of species dominate the fish community, with the vast majority of species occurring in very low numbers. Many of the marine species are semitropical forms that move north along the Atlantic coast during summer.

5.257 Twenty fish species were collected in combined samples of shoal and channel areas during the 1994-95 studies conducted in the vicinity of the Goethals Bridge (USCG 1995). The assemblage included species that have historically been common in the Arthur Kill. Most of the species found in the Arthur Kill occur in very low numbers and generally only for a short time on a seasonal basis. The greatest abundance of fishes was collected during December and January. Winter flounder dominated these catches, making up 81% and 76% of the December and January catches, respectively. Overall, winter flounder accounted for 60% of the total fish collected during the study, followed by striped bass (8.9%), Atlantic tomcod (6.4%), and grubby (*Myoxocephalus aenaeus*) (5.9%). Movements of winter flounder are highly temperature-dependent, with a seasonal migration of adults to spawn in shallow sandy bays occurring during winter when water temperatures decline. Winter flounder are thought to use the Arthur Kill Channel as a migration corridor to and from spawning grounds.

5.258 In order to describe the species composition and relative abundance of fishes in shoal areas of Newark Bay, trawl samples were collected there from April 1995 to March 1996 (LMS 1996). Four shoal areas in Newark Bay and two channel stations near the Bayonne and Goethals Bridges were sampled to provide information on the fish community both in shoals and deep water. The Goethals Bridge station was the same station used during the 1994-95 studies (USCG 1995).

5.259 In 1995-96, 27 species of fish were collected in the combined shoal and deep-water stations. Four species (grubby, scup, spot [*Leiostomus xanthurus*], and cunner [*Tautogolabrus adspersus*]) were collected only in the channel stations. The 23 species collected from the shoal stations were dominated by relatively few species. Five species (Atlantic silverside, bay anchovy, bluefish, striped bass, and winter flounder) accounted for more than 94% of the total catch. [Bay anchovy alone accounted for over 79% of the total.] Most species occurred infrequently, and in very low numbers during the 12-month long study.

5.260 Fishes among the shoal stations showed a consistent seasonal pattern, being relatively abundant from April through October but much less abundant from November through March. During the period when fish were most abundant, only four species (striped bass, winter flounder, summer flounder, and bay anchovy) occurred during each month.

5.261 As part of an evaluation of a flood control project for the Passaic River Basin, NMFS undertook a major fish sampling program in Newark Bay (NMFS 1994). This study provides additional information on species habitat preference, namely, channel versus shoal areas. Monthly fish sampling was conducted from May 1993 through April 1994. Juvenile and adult fish were sampled with bottom trawls and gill nets. Larval fish were sampled with plankton nets of two different mesh sizes. The presence of blue crabs and other invertebrates was also reported in the fish sampling gear .

5.262 In 1993-94, 28 species of fish were collected with a bottom trawl from seven shoal stations on the east side (relative to main channel) of Newark Bay. Six species (striped bass, winter flounder, bay anchovy, Atlantic herring, Atlantic tomcod, and Atlantic silverside) accounted for more than 96% of the total number collected at the shoal stations.

5.263 The seasonal occurrence of fishes on the shoals in Newark Bay was similar to that observed in the 1995-96 sampling prgram (LMS 1996). Fish were more abundant from May through October in 1993-94, with very low numbers from January through April. Abundance was low to moderate in November and December. The 1995-96 study showed a similar seasonal pattern, with slightly fewer fish in November and December and more fish in April.

5.264 Forty-three species of fish were collected at the 10 Newark Bay Channel stations in 1993-94, compared to 23 species taken on the shoals. The occurrence of species that prefer deep water, as well as increased sampling effort in the channels, accounted for the greater number of species collected in the deeper water.

5.265 Twelve species accounted for more than 96% of the catch for all channel stations combined: alewife, gizzard shad, bay anchovy, rainbow smelt, Atlantic tomcod, spotted hake (*Urophycis regia*), grubby, white perch (*Morone americana*), striped bass, weakfish, summer flounder, and winter flounder. Among the major species, striped bass, white perch, Atlantic tomcod, weakfish, and winter flounder were the most abundant. Among the 31 species found in relatively low numbers, only windowpane flounder occurred in all months.

5.266 A distinct difference appeared in the seasonal occurrence of fish between channel and shoal stations. Fish were abundant in every month at the channel stations, but nearly absent from the shoals from November through April. Striped bass and white perch were particularly abundant at channel stations during the winter months. The seasonal abundance of the 10 most abundant species at the channel stations is shown below. [Winter flounder and grubby are excluded.]

Seasonal Abundance at Channel Stations in Newark Bay 1993–94			
Species	**Season**	**Species**	**Season**
Alewife	Fall	Spotted hake	May and June
Gizzard shad	Fall and Winter	White perch	Late Fall and Winter
Bay anchovy	Summer	Striped bass	November to April
Rainbow smelt	Winter	Weakfish	August to October
Atlantic tomcod	Summer	Summer flounder	Summer

5.267 Although past studies provide species distribution and composition information for several project area reaches, information on the seasonal and spatial distribution of fish specific for all alternatives was incomplete. Information on the seasonal distribution of resident and migrant species in project alternative areas was supplemented through a biological sampling program. The year-long sampling program was initiated in October 1998 and continued through September 1999 (USACE-NYD 1999b). The program was designed to obtain information on the seasonal use patterns and distribution of the project area navigation channels, shoals, harbor berthing areas, and marine terminals by resident and migrant fish species. The program included seasonal sampling of finfish, ichthyoplankton, and benthic macroinvertebrates at fixed sampling stations within the project area.

5.268 The biological program consisted of two separate surveys, a harborwide survey and a site-specific survey. Site-specific sampling was conducted to collect information on the seasonal use and distribution of resident and migrant fish species in channel and shoal areas where previous biological sampling had not occurred or was limited. Survey stations were sited in navigation channels (i.e., harborwide stations) or near harbor berthing areas and marine terminals (i.e., site-specific stations). Sampling station locations are shown in Appendix B-1.2, and sampling schedule information is provided in Appendix B-1.2.

5.269 Between October 1998 and May 1999, 54 species of fish were collected at all stations combined. Species composition was similar to previous sampling programs conducted in the project area. A clownfish, a tropical species not previously reported in the Harbor, was collected in October at South Brooklyn. A common aquarium pet, this species was most likely abandoned in the area or may have been an odd itinerant to the project area.

5.270 Overall seasonal abundance in the project area varied, with bay anchovy and weakfish accounting for over 80% of the fish collected in October, while November and December were marked by relatively large catches of striped bass, white perch, American shad, and Atlantic silverside [See Appendix B-1.2.] Total numbers of fish declined from December through February. White perch and striped bass were the most abundant species in December and February, accounting for over 50% of the fish collected in both months. Atlantic silverside and Atlantic herring accounted for over 90% of the fish collected in January 1999. Distinct changes in species abundance during March and April reflect the seasonal movement of winter flounder,

striped bass, and spotted hake in the project area. Total numbers of fish declined again in May and June. Bay anchovy and Atlantic tomcod were the two most abundant species in both months. Overall abundance and diversity was highest in July, and remained relatively high through September. During that period, striped bass, weakfish, and bay anchovy accounted for over 70% of the fish collected.

5.271 Differences in the seasonal occurrence and abundance of fish between channel and shoal stations was similar to comparisons made previously in Newark Bay (NMFS 1994, LMS 1996). During winter months (February and March), overall catch-per-unit effort (CPUE) was lower at shoal stations as compared to channels. Striped bass, winter flounder, white perch, and Atlantic silverside were the dominant catch during this period [See Appendix B1.2.] CPUE and the number of species collected at shoal stations increased from April through September, with large catches of anadromous herring (alewife and blueback herring), striped bass, Atlantic tomcod, and bay anchovy. American shad, winter flounder, weakfish, and Atlantic herring were also collected at shoal stations during this period.

5.272 The overall pattern of species occurring at only shoal, only channel, or at both channel and shoal stations was generally similar to the results of previous sampling conducted by NMFS (1994) in Newark Bay. The largest number of species collected occurred at both shoal and channel stations, while relatively few species collected occurred only in shoal areas.

5.273 Species distribution within the estuary was generally similar between sampling areas, from October through June. CPUE was highest for several species in Newark Bay during October, December, February, and March (See Appendix B-1.2). Bay anchovy, white perch, striped bass, and winter flounder were among the species collected in large numbers. Most of these fish were collected in only one trawl sample. Bay anchovy and white perch exhibit tight schooling behavior, which often results in large individual catches. Relatively large catches of winter flounder in Newark Bay may also reflect winter flounder movement to spawning areas in the Bay. CPUE during December was also relatively high at Arthur Kill/Kill Van Kull stations compared to other stations in the project area. CPUE increased dramatically in July and August, before declining again in September. CPUE was highest at the Port Jersey and South Brooklyn stations during this period. Among the most abundant species were striped bass, weakfish, Atlantic silverside, alewife, butterfish, and bay anchovy.

Shellfish

5.274 Recent surveys, including the ongoing USACE-NYD-sponsored program, have characterized the invertebrate community of the New York and New Jersey Harbor area. Members of the shellfish community serve as an important food resource for fish, and are important recreationally and commercially; NMFS has designated EFH for several species.

5.275 Important factors influencing the distribution of shellfish are water depth and substrate type. Harbor depths range from the intertidal to deep-water. Bottom types range from soft sediments to hard rock, or manmade substrates. Table 5.4–5 describes the depth and substrate preferences of shellfish found in the study area. These preferences, as well as feeding habits, are

discussed in greater detail below.

5.276 Sixteen of the macroinvertebrate species in the study area are gastropods. Three live solely within the littoral zone. These species include the common periwinkle, white slipper shell (*Crepidula plana*), and the eastern mud whelk (*Ilyanassa obsoleta*). The common periwinkle and the white slipper shell both prefer rocks or other hard substrate. The periwinkle grazes on seaweeds and sea grasses or small plants growing on rocks, while the white slipper shell filters food from the water brought into its mantle cavity. The eastern mud whelk, which prefers a muddy substrate, is predominantly a scavenger, feeding on detritus and carrion.

5.277 Five of the gastropod species have a wider range of habitat, being found in the littoral and the sublittoral zones. Included in this group are the common slipper shell *(C. fornicata)*, channeled whelk (*Busycon canaliculatum*), New England dog whelk (*I. trivittatus*), lobed moon snail (*Polinices duplicatus*), and the northern moon snail (*Lunatia heros*). The common slipper shell, like the white slipper shell, prefers rock and other hard substrate. It, too, is a filter feeder. The channeled whelk prefers a sand or mud substrate, while the New England dog whelk prefers sand or sandy mud. Both are scavengers, and may feed on other mollusks. The two moon snail species are found on sand or sandy mud substrate. Moon snails are carnivorous, feeding on clams and other bivalves.

5.278 Three species of gastropod, the convex slipper shell (*C. convexa*), knobbed whelk (*B. carica*), and thick-lipped drill (*Eupleura caudata*), are limited to the littoral and sublitteral zones. Like the other slipper shells, the convex slipper shell is a filter feeder and lives on hard substrate such as rock or manmade structures. The knobbed whelk lives on sandy substrate, where it feeds on other mollusks or scavenges for detritus or carrion. The thick-lipped drill lives on or near oyster beds. It is a carnivore, feeding on gastropods, bivalves, barnacles, worms, and other invertebrates.

5.279 Twenty-five species of bivalve macroinvertebrates occur in the study area. Eight are commercially important species. These include the American oyster, softshell clam, Atlantic surfclam, northern quahog, ocean quahog, blue mussel, and the sea and bay scallop (the latter two *Placopecten magellanicus* and *Argopecten irradians*, respectively), with the Atlantic surfclam, ocean quahog, and sea scallop identified as EFH species. All are filter feeders. Six are found specifically in the littoral zone: the blue mussel, Atlantic ribbed mussel, Atlantic jackknife (*Ensis directus*), green jackknife (*Solen viridis*), false angel wing (*Petricola pholadiformis*), and disk dosinia (*Dosinia discus*). Blue mussels prefer hard substrate such as rock or manmade structures. Ribbed mussels may be found on rock, manmade structures, mud, or peat. The Atlantic jackknife is found on sandy bottoms, where it burrows vertically. The green jackknife is found in sand or mud. The false angel wing is found in heavy mud, clay, or peat. The disk dosinia is found burrowed in sand or sandy mud.

5.280 Four of the bivalve species in the study area live within the littoral as well as the sublittoral zone. These species are the Baltic macoma (*Macoma balthica*), northern quahog, American oyster, and softshell clam. The Baltic macoma, northern quahog, and softshell clam are found buried in sandy and muddy sediments. Unlike the other bivalves in this group, the

American oyster does not burrow, but is instead found on top of hard or semi-hard sediments.

5.281 Most bivalves in the study area are found in the sublittoral zone and deeper waters. These species include Atlantic razor clam (*Siliqua costata*), common jingle shell (*Anomia simplex*), Atlantic surfclam, glassy lyonsia (*Lyonsia hyalina*), chestnut astarte (*Astarte castanea*), wavy astarte (*A. undata*), file yoldia (*Yoldia limatula*), fragile spoonclam (*Periploma fragile*), false quahog (*Pitar morrhuanus*), northern cardita (*Cyclocardia borealis*), comb yoldia (*Y. myalis*), ocean quahog, and sea scallop.

5.282 At least 21 crustacean species have been identified in the study area. Included are opossum shrimp (*Neomysis americana*) and amphipods, which inhabit the widest range of habitats. They are found from the littoral to the neritic zone. Although considered planktonic, opossum shrimp and amphipods are often found among submerged aquatic vegetation (SAV).

5.283 Most crustaceans in the study area are found from the sublittoral zone to the deepest-water areas. Three of these species, the daggerblade grass shrimp (*Palaemonetes pugio*), the brackish grass shrimp (*P. intermedius*), and the common shore shrimp (*P. vulgaris*), live among SAV and other structures that serve as refuge from predators. Daggerblade and brackish grass shrimp both prefer brackish water, while the common shore shrimp prefers more saline waters (Wiess 1995). The seven-spine bay shrimp also lives among SAV, but is also found on sandy substrates. The flat-browed mud shrimp (*Upogebia affinis*) lives buried in the sand or mud. Two species of mud crab, the flat mud crab (*Eurypanopeus depressus*) and Harris's mud crab (*Rhithropanopeus harrisii*), occur in the study area, but are not common. The flat mud crab is found on oyster beds, where it feeds on newly settled oysters. Harris's mud crab is found in muddy substrate in areas of fresh to brackish water. Say's mud crab (*Neopanope texana*) is found on mud bottoms, and also on pilings among fouling organisms. Several species are substrate generalists, living on sand, rock, or mud. They include the blue crab, lady crab (*Ovalipes ocellatus*), long-clawed hermit crab (*Pagurus longicarpus*), and the spider crab (*Libinia emarginata*). The mantis shrimp (*Squilla empusa*) requires sand or mud for burrowing, while the Acadian hermit crab (*P. acadianus*) and Jonah crab (*Cancer borealis*) require rocks for refuge. The Atlantic rock crab (*C. irroratus*) is found on sand, rock, or gravelly substrates. The blue crab, considered a species of concern by USFWS, is discussed in greater detail below.

5.284 Two principally deep-water macroinvertebrates are also found in the study area, the American lobster and the deep sea red crab (*Geryon quinquedens*). The American lobster is found from nearshore areas to the waters of the continental slope. This species is found among rocks and other hard substrate that it uses for refuge. The deep sea red crab is rarely found in the study area because of its preference for extreme depth (130 ft and deeper). When it is encountered, it is found on silty clay and mud.

5.285 Five species of echinoderm were identified in the study area. Four of the species, Forbes' common sea star (*Asterias forbesi*), Atlantic purple sea urchin (*Arbacia punctulata*), the common sand dollar (*Echinarachnius parma*), and a Strongylocentrotid urchin, are found from the sublittoral to the neritic zones. A rare sea cucumber (*Stereoderma unisemita*) that occurs in the study area is found in deeper waters, from depths of 100 to 130 ft.

5.286 The horseshoe crab occurs from the littoral zone to the neritic zone. Two species of cephalopod, the long-finned squid (*Loligo pealei*)and the short-finned squid (*Illex illecebrosus*), are also found in the study area. Although it has been collected in Newark Bay, the long-finned squid is more commonly found in the open waters of the Atlantic, from nearshore waters to the continental slope. The short-finned squid is usually located in waters from the nearshore to the open ocean. The sea grape (*Molgula manhattensis*) is found on hard substrate such as rocks and pilings throughout the study area within the shallow waters of the littoral zone.

Recent Shellfish Surveys

5.287 Recently, surveys of the benthos were conducted in Newark Bay, the Kill Van Kull, and the Arthur Kill (LMS 1996); USACE-NYD also sponsored a Harbor navigation channel survey, in support of this impact analysis (USACE-NYD 1999b). Data from the earlier survey showed at least 19 species of macroinvertebrates in these three areas [See Appendix B-1.2.] The most abundant species in the Newark Bay area were the dwarf surfclam (*Mulinia lateralis*) (66.95% of total) and softshell clam (*Mya arenaria*) (33.36% of total). The three other taxa found in appreciable numbers were the tellinids (*Tellina* sp.), gammarid amphipods (*Gammarus* spp.), and the sea grape. These three taxa accounted for 5.29%, 4.35%, and 1.79% of the individuals collected, respectively.

5.288 When considered separately, the Kill Van Kull showed the highest diversity (16 species), followed by Newark Bay (11 species) and the Arthur Kill (7 species) [See Appendix B-1.2.] Patterns of abundance were similar to those in the overall Bay area, with the exception of sea grape abundance in the Kill Van Kull and gammarid amphipod abundance in Newark Bay. In the Kill Van Kull, the common slipper shell replaced the sea grape as the fifth most abundant species, while in Newark Bay, the solitary paper shell (*Haminoea solitaria*) replaced gammarid amphipods as the fourth most abundant species.

5.289 Surveys were conducted by (USACE-NYD 1999b) at several depths corresponding to both harborwide and specific sites (e.g., Port Jersey, South Brooklyn). Data from these surveys show a high level of shellfish diversity throughout the Harbor, regardless of depth.

5.290 Shallow-depth (shoal) locations included Jersey Flats, Constable Hook, and the Global Marine Terminal. [See Appendix B-1.2.] Data from the shallow-depth surveys showed that the dwarf surfclam was the most abundant species, accounting for 38.1% of the total shellfish collected. Two species of slipper shells, *C. plana*, and *C. fornicata*, were the second and third most abundant species. Gammarid amphipods and tellinids were also among the most abundant.

5.291 Dwarf surfclams (53.1%) and blue mussels (35.4%)were the dominant species in collections in middle depths. [See Appendix B-1.2.] The large numbers of blue mussels observed may have been due to the presence of pilings and other manmade objects in the vicinity of the sampling stations, or rock outcroppings on the channel floor. Present in much lower concentrations, but still among the most abundant, were tellinids, the white slipper shell, and gammarid amphipods. The high density of dwarf surfclams at the Port Jersey Pierhead Channel

site (PJ-2) may be due to any of several factors. Dwarf surfclams prefer sandy or mud substrates, and are a sublittoral species. Conditions to suit both these preferences exist at this site. The most likely factor, however, would be a relatively low level of disturbance in the area. Long intervals between maintenance dredging operations would allow a large population of this species to develop.

5.292 The South Brooklyn Interpier stations, Pierhead Terminal (Port Jersey) and Claremont Terminal Channel, comprised the 30-40-ft (Shallow Channel) category [See Appendix B-1.2.] Dwarf surfclams represented the vast majority of species collected at these stations (79.5% of total). Tellinids were also relatively numerous (7.3%). The remaining species encountered in relatively high abundance were softshell clams and gammarid amphipods. A high density of dwarf surfclams was noted at the Bay Ridge Channel site. Conditions in this channel are similar to those at the Port Jersey Pierhead Channel. Sediments at the Bay Ridge Channel site consist of sandy clayey silt; water depth is approximately 35 ft MLW. Long intervals between maintenance dredging operations would also allow sizeable populations of this species to develop.

5.293 The Ambrose and Anchorage channels were given the designation of deep-water stations [See Appendix B-1.2.] Once again, dwarf surfclams dominated the collections, followed by tellinids (66.4% and 14.9% of total, respectively). Blue mussels were the third most abundant species, while a Strongylocentrotid sea urchin and a hermit crab ranked fourth and fifth. As is the case with the sites described above, the sediments and depth profile of the Anchorage Channel are suitable for dwarf surfclam development. The presence of large populations of dwarf surfclams at the North Anchorage Channel site (HW-4) may also be indicative of low disturbance.

5.294 It is evident from the two studies summarized above that the dwarf surfclam is pervasive throughout the New York and New Jersey Harbor, with greatest concentrations in areas of sandy, undisturbed sediments. Gammarid amphipods and tellinids are also widespread. Slipper shells were more abundant at shallower depths. While a wide variety of other species was encountered throughout the study area, their numbers were not comparable to those of the species mentioned above. This may, however, be a result of sampling methods rather than being indicative of actual abundance.

Blue Crab

5.295 Blue crab is a euryhaline species, occurring from areas of nearly fresh water to oceanic salinities. Blue crabs play an important role in estuarine ecology, serving as both predator and prey. In portions of the New York and New Jersey Harbor, this species supports a commercial fishery, with landings of approximately 34,941 metric tons over the past ten years (NMFS 1999a).

5.296 In the Hudson River estuary, blue crabs mate from May to October in mid-estuarine waters with salinities of 10 to 20 ppt (Grosslein and Azarovitz 1982, Hill, et al. 1989). After mating, females move to high-salinity waters of the lower estuary to overwinter. The following

spring, fertilized eggs are extruded and carried approximately two weeks before hatching (Van Heukelem 1991). Newly hatched larvae are swept out to continental shelf waters, where they develop through several stages before seeking out the resources and relative safety of coastal estuaries. Final metamorphosis into the juvenile stage takes 45 to 60 days, depending on temperature (Sulkin and Van Heukelem 1986). Diet depends on larval stage. Zoeae feed on dinoflagellates and copepod nauplii (Tagatz 1968); megalopae consume fish larvae, small shellfish, and aquatic plants (Van Engel 1958). Small fish and gelatinous zooplankton prey upon larval blue crabs (Van Heukelem 1991).

5.297 Juvenile crabs frequently inhabit shallow-water habitats with SAV, which provides refuge from predation (Wilson and Able 1992). In areas that lack SAV, marsh creeks and macroalgae may serve this purpose (Wilson et al.1990, Wolcott and Hines 1990). In addition to providing refuge, marsh creeks and eelgrass habitat may serve as overwintering areas for juvenile crabs. Root mats and debris may protect crabs from the physical disturbance of ice scour and predation while they are torpid (Wilson et al. 1990). Juveniles feed mainly on mollusks, crustaceans, and fish (Millikin and Williams 1984). American eels (*Anguilla rostrata*), sand shrimp, grass shrimp, various fish species, and large blue crabs prey upon juveniles.

5.298 Juvenile blue crabs require 14 to 18 months to reach maturity, depending on the season in which they were spawned (Van Engel 1958). While adult females inhabit deeper, high-salinity waters of the lower estuary, adult males tend to remain within the estuary in low-salinity waters. Males inhabit shallow waters of creeks, rivers, and upper estuaries during warmer months and move to deeper waters to overwinter (Van Engel 1958, Van Heukelem 1991, Hill et al. 1989). Adult blue crabs feed on commercially important species such as oysters and clams, as well as on fresh and decaying fish, aquatic vegetation, and detritus (Van Engel 1958). Species that feed on blue crabs include striped bass, red drum, loggerhead and Kemp's ridley turtles, herons, and raccoons (Millikin and Williams 1984, Van Heukelem 1991, Burke 1990, Morreale and Standora 1994).

Crab Dredge Surveys

5.299 Blue crabs overwinter by burrowing into soft bottom sediments. Schaffner and Diaz (1988) found that overwintering crabs were most abundant in silty-very fine sands (40–80% sand), and were less common in finer (i.e., < 40% sand) or coarser (i.e., > 80% sand) sediments. Adult males remain in the upper estuary, while females migrate to lower estuarine or nearshore waters (Hill et al. 1989, Van Heukelem 1991). Adult blue crabs enter a torpid state during overwintering. While in the torpid state, crabs are vulnerable to activities that disrupt the sediments. To determine the relative abundance of overwintering crabs in the study area, crab dredge surveys were conducted from February through April 1999. Miller, et al. (1980) found that crab dredges are an efficient means of sampling for overwintering crabs.

5.300 Overall, the CPUE was highest at non-channel sites during February and March. The number of overwintering crabs was lowest in April, regardless of depth. Crabs were found in

very low numbers in the deepest-water stations located in the Ambrose and Anchorage channels. [See Appendix B-1.2.]

5.301 The average CPUE in shoal and shallow channel sites was generally higher than in deep channel sites. [See Appendix B-1.2.] All shoal and shallow channel sites, with the exception of the South Brooklyn interpier site (SB-1), had an average CPUE of over 5 crabs, while the deep channel sites had an average CPUE of less than 5 crabs. This may indicate a preference for relatively sheltered areas during overwintering. A comparison of shoal and shallow channel sites indicates that the South Brooklyn interpier area (SB-3) and Global Marine Terminal sites have the highest average CPUEs [See Appendix B-1.2.] It is possible that the higher number of crabs at the South Brooklyn interpier site compared to the other interpier sites could be due to avoidance of the nutrient-enriched waters of upper Gowanus Bay.

5.302 Overall results of the sampling program indicate the blue crab's preference for non-channel areas for overwintering. The lowest number of blue crabs was collected in the deeper Ambrose and Anchorage Channels and the greatest number at the shallow-water stations located at Port Jersey and the South Brooklyn interpier stations.

Commercially and Recreationally Important Species

5.303 Several commercially or recreationally important species are encountered in the study area. To the extent that fisheries are localized, species may be present but not collected on a commercial scale. Discussion will therefore be limited to those zones within the study area where commercial fisheries for a species are applicable. Similarly, recreational fisheries are localized due to concentrations of species or to local health advisories. Discussion of these fisheries will therefore be limited to those species regularly sought during recreational activities in the study area, with mention of any relevant health advisories that may be in effect.

Finfish

5.304 In the past, the Hudson-Raritan estuary has supported a number of commercial fisheries, most of which developed during the 1800s (MacKenzie 1990). Most of these fisheries were found in Lower New York Bay, Raritan Bay, and Sandy Hook Bay, including drift gill netting for weakfish and bluefish, purse seining for Atlantic menhaden, and staked gill nets for American shad and herring. Fyke nets and haul seines were used in the nearshore areas of Raritan Bay. Due to the rise of more lucrative shore-based factory jobs as well as to the scarcity of fish, most finfisheries disappeared by the 1950s (MacKenzie 1990).

5.305 During the 1920s and 1930s, bait fisheries for sandworms, bloodworms, shrimp, and mummichog also existed in Raritan Bay. Fishermen collected bait species in the intertidal shallow zones of the bay. By the 1980s, however, only a small-scale commercial bait fishery for mummichog remained (MacKenzie 1990).

5.306 Although most finfisheries in the Hudson-Raritan estuary have declined or collapsed, some persist. Commercially harvested species include Atlantic menhaden, bluefish, summer and

winter flounder, alewife, American shad, weakfish, and American eel (USFWS 1993). Commercial fisheries for these species still operate inshore, in Raritan and Sandy Hook Bays (using either staked gill nets, pound nets, or eel pots), or nearshore in ocean waters (using purse seines and otter trawls).

5.307 Only staked gill nets are allowed in Raritan Bay and Sandy Hook Bay and only in designated areas, primarily the nearshore area between Keyport and Port Monmouth and along Sandy Hook. Staked gill nets may be set from February 1 to May 15, but only for American shad.

5.308 Similarly, pound nets set in Raritan and Sandy Hook Bays are confined to designated areas (Figure 5.4-6). Once prevalent throughout Raritan and Sandy Hook Bays, few pound nets are currently erected or set in these areas (USACE-NYD 1999a). Pound nets are typically erected during April and are set through October or November. Fish collected in pound nets consist of shad, herring, and menhaden in early spring, and bluefish, striped bass, and weakfish during the summer. Other species taken include summer flounder, butterfish, northern puffer, sea bass, and blue crab. Eels are fished for using eel pots along the shoreline and in tidal creeks of Raritan and Sandy Hook Bays, usually from mid-April through late October.

5.309 Nearshore commercial fisheries, using primarily purse seines and otter trawls, exist for American shad, menhaden, bluefish, weakfish, Atlantic mackerel, silver (*Merluccius bilinearis*) and red hake, and winter and summer flounder. Most of these commercial fisheries are Federally managed by regional fishery management councils (FMCs), which determine state quotas, seasons, and size limits.

5.310 Trawling is the primary technique for demersal species (groundfish), which spend at least their adult life stage on or near the ocean bottom (USFWS 1997). Summer and winter flounder, black sea bass, silver hake, and red hake are among those demersal species commercially fished in the project area. Specific fishing grounds and gear vary with species and time of year. Primary fishing for summer flounder within the project area is between May and September, principally in deep (up to 60-ft) waters of the New York Bight Apex near the Ambrose Channel. Winter flounder is a year-round target species, with maximum harvests occuring in the spring. The species is taken throughout the region, mainly in areas of cooler water. Red and silver hake, primarily a by-catch of the summer flounder fishery, are taken from April through June near the Ambrose Anchorage area, off Rockaway Point and in the Mud Hole (Long and Figley 1982).

5.311 Selective gear such as mid-water trawl, pairs trawl, and purse seines are used to capture pelagic fish. Pelagic fish are generally schooling fish that occupy the mid- to upper water column as juveniles and adults, and are sought in the Bight (Lower Bay) portion of the study area from nearshore to the continental slope (USFWS 1997). Species included in this group that are sought after both commercially and recreationally in the study area include bluefish, Atlantic menhaden, and weakfish. Two invertebrate species included in this group (and discussed below) are the long-finned and short-finned squid.

5.312 The Hudson-Raritan estuary has been one of the most important areas for recreational

fishing in the northeastern United States. MacKenzie (1990) estimated that in the 1970s and 1980s, during fair weather weekends between March and April, over 1,000 recreational anglers used the bay waters per day. Although a large recreational fishery in Raritan Bay and adjacent waters is recognized by many, specific data regarding catch size is not available (Woodhead 1991). The recreational effort is both land- and vessel-based.

5.313 The primary species sought by recreational fishermen are the same as those sought by commercial fishermen, namely, weakfish (or seatrout), bluefish, winter flounder, summer flounder (or fluke), and striped bass (Figley 1988). Scup, spot, and mackerel are also highly prized recreational species (Long and Figley 1982). MacKenzie (1990) reported that summer flounder, winter flounder, and bluefish were the most abundant recreational catches. Fishing seasons and locations change accordingly as species migrate in and out of the bay to feed and spawn. Recreational anglers seek sea bass, scup, spot, croaker (*Micropogonias undulatus*), and tautog, with the primary fishing season usually between April and October (Figley 1988).

5.314 Figley (1988), based on surveys of recreational fishermen, mapped the primary and secondary recreational fishing areas for weakfish, bluefish, winter flounder, summer flounder, striped bass, and sea bass in Raritan, Sandy Hook, and Lower New York Bays. Survey techniques included personal contacts, mail-in responses of individual anglers, and contacts with party and charter boat captains.

Shellfish

Bivalves

5.315 Blue mussels are found in intertidal waters of New York Bay, the Kill Van Kull, and the lower Hudson River. Blue mussels form beds on hard surfaces from rocks and coarse gravel to pilings. Mussels grow largest in areas protected from fast currents and high energy (Newell 1989). Blue mussels are an important food item for many animals (mostly marine) and are also of commercial importance. Commercial catches in the New York/New Jersey area for the past ten years (1987 to 1997) totaled 412 metric tons.

5.316 The northern quahog or hardshell clam has been found in the Lower New York Bay, the Kill Van Kull, the Arthur Kill, and the Hudson River, where its depth range is from the littoral zone to 49 feet. Abundance tends to be highest in protected areas of lower estuaries (Stanley 1985). Although northern quahogs are capable of living on a variety of substrates, they have been found to prefer heterogeneous substrates such as a mud/sand mixture (Roegner and Mann 1991). Growth to maturity requires several years, and reproductive age is dependent on size (Stanley 1985). The northern quahog is the most extensively distributed commercial clam in the United States, with the fishery located primarily along the mid-Atlantic Bight (Stanley 1985). Commercial catches in the New York area for the years 1987 through 1993 were 7,982 metric tons.

5.317 The American or eastern oyster has been collected throughout New York Bay and in Newark Bay. It is found at depths ranging from the intertidal zone to 131 feet (Grosslein and

Azarovitz 1982), but typically lives in the shallow waters of estuaries, lagoons, and nearshore areas of bays (Stanley and Sellers 1986). This leaves the organisms vulnerable to urban and industrial disturbances. Oysters prefer hard substrates such as shell, rock, firm sand, or mud, where they settle in large groups, or bars. Oyster beds often provide hard substrate in areas where it is lacking, creating settlement areas for oyster spat as well as other epibenthic species (Kennedy 1991). Atlantic oysters are considered a luxury food item and support an important commercial fishery throughout the eastern seaboard to the Gulf of Mexico. Approximately 3,531 metric tons of Atlantic oysters were harvested in New York and New Jersey waters between 1995 and 1997.

5.318 Softshell clams have been collected throughout the study area to a depth of 30 feet, but can be found at depths up to 240 feet. Substrate is a primary factor influencing distribution and abundance of this species. Softshell clams prefer hard-packed sand or mud. Predation is higher in soft sediments, which are easier to excavate (Baker and Mann 1991). Softshell clams, which are limited to brackish or saline waters, reach sexual maturity at 5 years, but can be fished commercially at 1.5 years. They form the third largest commercial clam fishery in the United States. Softshell clam landings in New York/New Jersey waters over the past ten years were approximately 868 metric tons.

5.319 Bay scallop is distributed in estuaries and near-coastal waters. This species has been collected in Lower New York Bay, where it is found over muddy sand substrates in protected areas. In some areas, presence and survival may depend on SAV such as eelgrass (Fay, et al. 1983). Scallops are capable of swimming to avoid predators or poor environmental conditions. Bay scallops rank well behind sea scallops as a commercially important species. Even so, 169 metric tons were harvested in New York waters from 1987 through 1997.

5.320 The Atlantic surfclam is the largest bivalve in the study area. Surfclam beds are located throughout Lower New York Bay. They are found from the shore to a depth of approximately 144 feet (Fay et al. 1983). Distribution and abundance are strongly related to sediment type. Abundance is higher in coarse sediments than in sand or silty clay (Pearce et al. 1981). Surfclams reach sexual maturity at 2 years and commercial size at 5 to 6 years (Fay et al. 1983, Pearce et al. 1981). Commercial landings of surfclam meat in the New York/New Jersey area between 1987 and 1997 were 268,014 metric tons. The Mid-Atlantic Fisheries Management Council (MAFMC) has listed surfclams as a species for which EFH will be designated.

5.321 The sea scallop is found aggregated at depths ranging from 60 to 400 ft. Sea scallops prefer a sandy or gravelly substrate and tend to remain burrowed unless disturbed. They are capable of swimming to avoid disturbances such as predation and dredging (Mullen and Moring 1986). Sea scallops reach sexual maturity in one year, and commercial size in 5 to 6 years. Disturbances to a particular year class can therefore affect fisheries 5 or 6 years later. Between 1987 and 1997, 16,249 metric tons of sea scallop meats were harvested in New York/New Jersey waters. Sea scallops are among the managed species for which the New England Fisheries Management Council will designate EFH.

5.322 Ocean quahogs are distributed along the Atlantic seaboard from Maine to Cape Hatteras.

Found in waters from 25 to 800 feet deep, ocean quahogs burrow in medium to coarse sand, sandy mud, or silty sand (MAFMC 1998a). Ocean quahogs mature slowly: the average age at sexual maturity for males is 13 years and for females, 12.5. [The earliest known age of maturity is 7 years.] (MAFMC 1998a). Commercial landings of ocean quahog meats in New York/New Jersey waters amounted to 150,273 metric tons between 1987 and 1997. This species is among those for which the Mid-Atlantic Fisheries Management Council will designate EFH.

Crustaceans

5.323 The blue crab is found from littoral-zone depths down to 295 feet. Substrate preference varies with life stage. Areas with SAV and soft sediments are important for juvenile crabs (Hill, et al. 1989, Van Heukelem 1991), which use the vegetation as refuge from predation. Adult crabs prefer harder substrate such as sand, rock, or mud bottoms (Hill et al. 1989). Blue crabs are predators on commercially important clams and oysters, and serve as food for commercially important species such as striped bass. Between 1987 and 1997, blue crab landings—including landings of both hardshells and peelers—were reported at 31,941 metric tons in New York and New Jersey waters.

5.324 Other commercially important crab species in the study area are the Jonah crab and the Atlantic rock crab . Populations of these two species peak in Lower New York Bay at different times of the year (USEPA 1997), with abundance of Jonah crabs being greatest in late summer and abundance of rock crabs highest in the spring and early summer. In the mid-Atlantic region, Jonah crabs are generally less abundant than rock crabs (Krouse 1979). Rock crabs have been found in Upper New York Bay and Newark Bay (LMS 1990, NMFS 1994), while Jonah crabs have not. The fisheries for both these species are small in the study area. Commercial landings of Jonah crab amounted to only 86.9 metric tons over an eight-year period (1987, 1990, 1992-1997). Landings of rock crab amounted to approximately 680 metric tons between 1987 and 1997.

5.325 The American lobster occurs in coastal surf to continental slope waters of up to 2,300 ft in depth. However, this range is divided between inshore and offshore groups, with some overlap occurring (Grosslein and Azarovitz 1982). Lobsters prefer rocky or cobbled areas, but are found on other substrates as well. In inshore areas, such as Lower New York Bay, lobsters frequent areas of sand with overlying boulders (MacKenzie and Moring 1985). Seasonal distribution is related to water temperature. Migrations into the shallow waters of the Lower Bay take place in spring and summer, and correspond with spawning episodes (USEPA 1997). Most lobsters are caught in shallow inshore waters, 15 to 100 ft deep. Although the commercial fishery in the study area is not as large as those of northern New England states, landings of 28,000 metric tons have been reported from New York/New Jersey waters between 1987 and 1997.

Cephalopods

5.326 Long-fin squid and short-fin squid are both managed species that will have EFH

designated by the MAFMC. Long-fin squid are a continental shelf species, but may be found in waters as shallow as 10 ft in spring and summer (Grosslein and Azarovitz 1982). At this time egg masses are laid on the bottom, attached in clusters to rocks or submerged vegetation (MAFMC 1998b). Long-fin squid have been collected in Lower New York and Newark Bays. From 1987 through 1997, approximately 82,223 metric tons of long-fin squid were harvested from New York/New Jersey waters.

5.327 Short-fin squid is an oceanic species found in waters ranging from the shoreline to 1,200-ft depths. This species migrates between offshore and coastal waters in response to temperature. Migrations to shallower waters occur in spring, when short-fin squid may be found in coastal bays, sounds, and harbors (Grosslein and Azarovitz 1982). In the New York Bight area, abundance is highest during the summer (USEPA 1997). Insignificant numbers of short-fin squid have been confirmed in New England estuaries. Estuaries will be added to EFH for short-fin squid if abundance in estuarine waters increases (MAFMC 1998b). Between 1987 and 1997, landings of short-fin squid totaled approximately 65,731 metric tons.

Other Commercially and Recreationally Important Invertebrates

5.328 Horseshoe crabs are an important commercial species, not for consumption but for pharmaceutical use. Horseshoe crabs are used for the production of LAL (*Limulus polyphemus* Amoebocyte Lysate) a substance used to determine bacterial contamination. They are also used for bait in eel and whelk fisheries (Botton 1995). In the Lower New York Bay area, horseshoe crabs undergo a seasonal migration, moving inshore in the spring (to spawn), and offshore to continental shelf waters in the winter. In addition to being commercially important, horseshoe crabs are important environmentally, their eggs providing food for migratory shorebirds. In some areas, spawning season and migration season coincide (Botton 1995). From 1987 to 1997, commercial landings of horseshoe crabs from New York/New Jersey waters amounted to approximately 4,707 metric tons. The U.S. Food and Drug Administration requires that all crabs collected for bleeding (for LAL) be returned within 72 hours of capture (Botton 1995).

Benthos

5.329 The community of aquatic invertebrates attached to, resting on, or living in the bottom sediments is called the benthos (Odum 1971). Many benthic species are filter feeders on suspended particulate matter, or deposit feeders on soft organic sediments. These organisms, such as worms, bivalves, and shrimp, are an important food resource for fish. Since the benthos is mostly composed of sessile or relatively immobile invertebrates that cannot easily avoid intolerable conditions, the composition of the benthic community reflects prevailing habitat conditions. The habitat component that is generally most influential on species composition and distribution is substrate type (e.g., soft sediments, well-sorted sands, rocky outcrops, or manmade structures such as pilings or jetties). Other factors that affect the composition and relative abundance of the benthos are physical parameters (e.g., currents, wave action, and disturbance), chemical parameters (e.g., DO, salinity, and temperature), and life history factors, which are primarily related to reproduction.. The dependence of the benthic community on bottom sediments for food and shelter, therefore, makes benthos analysis an important consideration in

the evaluation of a dredging project.

5.330 Coch (1986) found that Newark Bay sediment patterns were influenced at the northern end by the rivers, and at the southern end by the Lower and Upper Bay as well as by oceanic forces. An input of sandy clayey silt (from the Passaic River) was found in the northwest, and an input of clayey silty sand (from the Hackensack River) in the northeast. Sandy clayey silt underlay the central part of the Bay, grading southward into clayey silty sand and sandy clayey silt where it connects with the Arthur Kill and the Kill Van Kull. Tidal interchange with the Lower and Upper Bay through the Arthur Kill and the Kill Van Kull results in coarser sediments in the southern portion of the Bay.

5.331 The benthic fauna of Newark Bay was surveyed during 1985, with samples collected at 30 stations throughout the western and southern half (northern limit: Port Newark) and in the Kill Van Kull in the vicinity of Shooters Island (USACE-NYD 1987). Benthic sampling, which was conducted during the spring (Cerrato 1985) and summer (Chezik 1985), covered an equal number of sampling stations from shallow water (7-18 ft) and deeper water (33-40 ft). A listing of Newark Bay benthic fauna by 1985 sampling month, with the dominant species designated, is presented in Appendix B-1.2. In general, greater numbers of organisms and species were recorded during the summer sampling program, with a significant difference ($\alpha = 0.5$) noted for the shallow-water stations.

5.332 Overall benthic organism abundance in Newark Bay was classified as moderate. The Newark Bay benthic community appeared from this survey to be dominated by polychaete worms, which are habitat generalists and which exhibit high tolerance to environmentally stressful conditions such as low DO levels. Two polychaete worms, *Streblospio benedicti* and *Sabellaria vulgaris*, as well as the softshell clam, were dominant during both the spring and summer periods. Three polychaete worm species, *Scolecolepides viridis, Nereis succinea*, and *Polydora ligni*, were dominant in the spring, being replaced by *Spio setosa* (polychaete), *Balanus improvisus* (barnacle), and *Molgula manhattensis* (tunicate) during the summer. A high degree of variability was observed in individual species abundance levels between the shallow- and deep-water stations, although no significant difference was detected in abundance or species representation between the two habitat types. Physical and chemical parameters measured during these studies included water temperature, salinity, and DO. Since all three parameters were similar at the shallow- and deep-water stations, it was concluded that none of the three was limiting to the development of the benthic community. Stations characterized by finer-grained sediments in the center of the Bay exhibited lower species numbers and lower overall abundance. The moderate organismal abundance and generally low species diversity in the benthos suggest that Newark Bay is a stressed environment where the development of the benthic community is restricted (USACE-NYD 1987).

5.333 Twenty-five stations (18 channel stations and 7 shallow-water stations) located in the northern and central sections of Newark Bay were sampled for benthic macroinvertebrates during 1993 and 1994 (NMFS 1994). Bottom sediments at the northern end of the Bay near the mouth of the Passaic River consisted primarily of soft, black, silty clay; north of the two bridges

the bottom sediments were soft, with varying amounts of gravel, shell, sand, silt, and clay. South of the bridges the bottom sediments in both the channel and shoal stations were light, soft silt and clay, with some shell fragments. Samples collected at channel stations located opposite the Elizabeth Port Authority Marine Terminal usually contained lumps of thick, hard, red clay. Benthic fauna collected, including designation of dominant species, is presented in Appendix B-1.2. As noted in the benthic study conducted during 1985, the benthos at both shallow-water and channel stations was similar in species composition (dominated by polychaete worms) and exhibited similar seasonal abundance patterns. It was determined that the Newark Bay benthic community exhibited lower overall abundance and lower species diversity than the benthos of Upper New York Bay.

5.334 Lawler, Matusky & Skelly Engineers LLP (LMS) conducted a Newark Bay benthic sampling program for PANYNJ from April 1995 through March 1996 (LMS 1996). Seven stations were sampled: five in Newark Bay, including stations in the immediate vicinity of the proposed Newark Bay Combined Disposal Facility (NBCDF) site, and two outside the Bay, one near the Bayonne Bridge (Kill Van Kill) and the other near the Goethals Bridge (Arthur Kill). Total abundance by species for the five Newark Bay stations is presented in Appendix B-1.2; monthly abundance by species for all stations combined over the 12-month study period is presented in Appendix B-1.2.

5.335 Polychaetes dominated the benthos collected at the Newark Bay stations. Six species of polychaete worms were among the ten most abundant benthic invertebrate species identified in the Bay samples. The dominant species collected was the polychaete worm *Scoloplos* sp., which accounted for 28.5% of the total. The five other polychaetes found in the most abundant 10 benthic invertebrate species were *S. benedicti* (rank = 2, 23.7% of the total), the family Paraonidae (rank = 4, 7.0% of the total), the family Phyllodocidae (rank = 8, 1.7% of the total), *Glycera* sp. (rank = 9, 1.7% of the total), and *P. ligni* (rank = 10, 1.6% of the total). The other species rounding out the top 10 benthic invertebrate species by abundance included two bivalves, the dwarf surfclam (rank = 3, 15.4% of the total), and the softshell clam (rank = 6, 4.4% of the total); the estuarine isopod *Cyathura polita* (rank = 5, 5.8% of the total); and the cumacean *Oxyurostylis smithii* (rank = 7, 1.9% of the total). Species composition and abundance patterns were similar among the five Newark Bay stations (LMS 1996).

5.336 Similar trends were observed in the benthic samples from the Arthur Kill (Bayonne Bridge) and Kill Van Kull (Goethals Bridge) stations [See Appendix B-1.2.] Of the ten taxa that were numerically abundant at the Arthur Kill site, six were polychaetes. The polychaete *S. benedicti* accounted for 79% of the total number of organisms collected. The other five abundant polychaetes were Phyllodocidae (rank = 2, 4.77% of total), *Scoloplos* sp. (rank = 3, 3.62% of total), Paraonidae (rank = 5, 1.99% of total), Oligochaeta (rank = 6, 1.64% of total) and *P. ligni* (rank = 7, 1.09% total). The other benthic species in the top ten in abundance at the Arthur Kill site included two bivalve mollusks, the softshell clam (rank = 4, 2.08% of total) and the dwarf surfclam (rank = 8, 0.84% of total), the cumacean *Leucon americanus* (rank = 9, 0.78% of total), and the isopod *Edotea triloba* (rank = 10, 0.68% of total) (LMS 1996).

5.337 At the Kill Van Kull site, seven of the ten most abundant taxa were polychaetes. Of these

polychaetes, *S. benedicti* accounted for 49.14% of the total number of organisms collected. The remaining six were *S. vulgaris* (rank = 2, 29.47% of total), Paraonidae (rank = 3, 5.56% of total), *Scoloplos* sp. (rank = 5, 1.71% of total), Phyllodocidae (rank = 7, 1.57% of total), Oligochaeta (rank = 9, 1.10% of total), and *N. succinea* (rank = 10, 0.73% of total). The remaining benthic species that were among the ten most abundant taxa at the Kill Van Kull site included two bivalve mollusks, the dwarf surfclam (rank = 4, 1.82% of total) and the softshell clam (rank = 6, 1.67% of total), and the amphipod Aoridae (rank = 8, 1.42% of total) (LMS 1996).

5.338 As noted for the Newark Bay sampling programs, where water depths and sediment types are similar, polychaete worms dominate this Arthur Kill (Bayonne Bridge) benthic community. Among the more abundant polychaete taxa were *S. benedicti*, *Scoloplos* sp., and *Phyllodoce arenae* (USCG 1995). Oligochaete worms were found to be the second most abundant group, followed by burrowing cumacid shrimp. In Old Place Creek, polychaetes were also the dominant group and oligochaetes were found in most samples. However, relatively more bivalves and isopods were found, since the sediments here are firmer with more sand, bits of brick-like material, and clay. The benthic invertebrate taxa collected are presented in Appendix B-1.2. The shallow-water benthic community in the soft sediments near the Goethals Bridge was similar to the community of Newark Bay in terms of species type and seasonal abundance patterns. Temporal and spatial variability, primarily related to reproduction patterns, was noted in the seasonal collections. A stable community dominated by detritivores, however, was found throughout the sampling area.

5.339 Intricate flow patterns between the Hudson River estuary, the East River, the Kill Van Kull, and the Atlantic Ocean through The Narrows complicate the sediment patterns of Upper New York Bay (Coch 1986). Coarse-grained facies, such as gravelly silty sand, silty gravelly sand, clayey silty sand, and silty sandy gravel, underlie the central part of the northern portion of the Upper Bay. The intense bottom currents characteristic of this area cause this complex pattern. In contrast, sandy clayey silts underlie the shallower and calmer areas along the New Jersey, Queens, and Brooklyn shorelines. Clayey silty sand is found on the bottom of the central portion of Upper New York Bay and into the mouth of the Kill Van Kull. These sediments grade into a sand facies toward The Narrows and are bordered in The Narrows by silty sands on the east and west sides. Gravelly sands bordered on the west by sandy clayey silts and on the east by clayey silty sands underlie the channel south of The Narrows. These facies grade into the coarse-grained sands of the northern portion of the Lower Bay.

5.340 Benthos samples were collected from August 1975 to June 1976 in the vicinity of Liberty State Park in the Upper New York Bay Harbor (TI 1976). The polychaete worm *S. benedicti* strongly dominated the benthos (57.0% of the annual mean total number of organisms collected per square meter); other polychaetes accounted for 5.7% of organisms collected per square meter. Tubificid worms made up an additional 31.3% of the benthos, leaving a mere 6.0% of the community to be made up by other taxa. A distinct temporal variation appeared in the structure of the benthic community in relation to sewer outfalls, concentrations of waterfowl, and a nutrient-rich *Spartina* marsh. The areas around sewer outfalls, for example, exhibited very low benthic abundance in the summer, but showed an increase in numbers during the winter, apparently the result of the normal increase in DO concentrations in colder water. Fecal

contamination from waterfowl also appeared to decrease abundance of benthic organisms, but to a lesser degree. The increased availability of nutrients from the marsh may have increased the numbers of benthic organisms near the marsh shoreline.

5.341 Coch (1986) noted that Lower New York Bay contained three distinct sediment regions separated by narrow gradational facies. The three regions were the apex of the New York Bight in the north and northeast, Sandy Hook Bay in the south, and Raritan Bay in the west. Sands with aprons of gravelly sands and patches of sandy gravel covered most of the bottom of the northern portion of Lower New York Bay. These facies graded into the sands covering the apex of the New York Bight to the east and southeast. Silty sands were observed to underlay Sandy Hook Bay and to grade into sands along the shoreline of New Jersey and Sandy Hook. Sandy clayey silt covered the bottom of Raritan Bay, extending into the Raritan River estuary to the west and into the Arthur Kill to the northwest. These sediments graded into the sands of the northern Lower New York Bay to the northeast and of the New Jersey coast to the southeast.

5.342 A regional study of the benthos in Lower New York Bay was conducted seasonally in 1986-87 (Cerrato et al. 1989). Eighty-four sites were sampled. These extended from Raritan Bay across to Sandy Hook, up to Rockaway Point, and across to the Verrazano Narrows. Sediments proved to be variable, ranging from 100% sand and gravel to silty clay. The amphipod *Ampelisca abdita* accounted for 55.8% of the total number of organisms collected, and the blue mussel ranked second at 18.6%. Other abundant species included the polychaetes *Asabellides oculata* and *Heteromastus filiformis*, the softshell clam, the common slipper shell, and the amphipods *Corophium tuberculatum* and *Elasmopus levis.*

5.343 Benthic studies of lower New York Bay/Raritan Bay were carried out in 1989 as part of an environmental study related to the expanding and deepening of the Raritan Bay anchorages (USACE-NYD 1994a). Anchorage sites in the study area were found to be composed of 65% silt with varying amounts of sand and clay. The average sand:silt:clay ratio is 16:65:19. A diverse benthic community was found in Raritan Bay/Lower New York Bay. The benthos was dominated by *A. abdita*, a tube-dwelling amphipod (55.8% of all individuals collected). Polychaete worms ranked fourth in overall abundance.

5.344 From November 1998 through September 1999, USACE-NYD (1999b) conducted seasonal surveys throughout the Harbor. The survey stations may be separated by depth into four categories: shallow (0 to 15 ft), middle-depths (shallow channels), 30- to 40-ft depths, and deep (>40 ft). The results of the survey are discussed below.

5.345 Shallow-water stations were established in the Jersey Flats, at Constable Hook, and at the Global Marine Terminal. [See Appendix B-1.2.] A total of 62 taxa were collected at these stations. The polychaete worm *S. benedicti* accounted for 25.2% of the total number of organisms collected. The next two most abundant taxa in the area were the polychaete worm, *L. fragilis* (10.6% of total) and the dwarf surfclam (8.9% of total). The remaining taxa among the top ten, in order of abundance, were as follows: Paraonid and Phyllodocid polychaete worms, the white slipper shell (*Crepidula plana*), the polychaete worm *Glycera* sp., an Orbiniid polychaete worm and the common slipper shell (tied for abundance), oligochaete worms, and the chink snail

(*Lacuna vincta*).

5.346 Sixty-four taxa were collected at middle-depth stations. [See Appendix B-1.2.] The dwarf surfclam accounted for 33.3% of the total number of organisms collected at these stations. The next three most abundant species were the polychaete worms, *S. viridis* (13.3% of total), *S. benedicti* (12.2% of total), and Ampharetid polychaetes (8.9% of total). The species fifth in abundance was the polychaete worm *L. fragilis*. The remaining taxa present in appreciable numbers included tellinid bivalve mollusks, the cumacid *Leucon americanus*, the amphipod *A. abdita*, and Orbiniid polychaetes, and the polychaetes *Glycera* sp., and *Nephtys* sp.

5.347 Thirty- to 40-ft (shallow channel) stations consisted of the Port Jersey Pierhead Channel, the Claremont Terminal Channel, and the Gowanus Bay Interpier (3 sites). [See Appendix B-1.2.] A total of 65 taxa were collected at these stations. The two most abundant species at these locations were the blue mussel, *Mytilus edulis* (29.5% of total), and the dwarf surfclam (29.3% of total). The third most abundant species was the polychaete worm, *S. benedicti* (10.9% of total). The polychaete worm *Nereis* sp. was fourth most abundant, and the tellinid bivalve mollusks were fifth. The remaining taxa among the top ten in abundance were the polychaete worm *L. fragilis*, the barrel bubble (*Acteocina canaliculata*), the amphipod, *A. abdita*, the polychaete worm, *Glycera* sp., and the white slipper shell.

5.348 Deep-water stations were located in the Ambrose Channel North, and at two locations in the Anchorage Channel. [See Appendix B-1.2.] These stations showed the greatest diversity, with a total of 78 taxa collected. The three most abundant taxa in this area were the dwarf surfclam (49.3% of total), the tellinid bivalves (11.1% of total) and blue mussels (5.6% of total). Polychaete worms made up the next four taxa in highest abundance. These were *Nephtys* sp., *S. Benedicti,* Ampharetidae and *P. gouldii*. The remaining taxa were, in order of abundance: the amphipod *A. abdita*, a Strongylocentrotid sea urchin and the polychaetes *Glycera* sp. and Spionidae.

5.349 Overall, polychaetes were the most abundant taxa, comprising 25.8% to 37.0% of benthic species collected. Sixteen to twenty-seven polychaete species were identified in samples taken throughout the Harbor. The predominance of polychaetes regardless of depth indicates that these members of the benthic community are well established throughout the Harbor. Bivalves were also quite abundant. Bivalves ranked second in abundance for three of the four depth classes: mid-depth, 30-40 ft. depth, and deep water. Ten to twelve different species of bivalves were identified. Amphipods were the second most abundant group for the shallow-water class, ranking third for the remaining classes. Five to 13 species of amphipod were identified at the various sites. Gastropods and decapods were also abundant, but not to the extent of the groups discussed above.

5.350 Presence of species is often related to sediment type. Sediment characteristics for the 1998-99 study of the New York/New Jersey Harbor area are displayed in Table 5.4-6 for each station sampled.

Marine Mammals

5.351 Seventeen species of marine mammals are found in the New York and New Jersey Harbor or in the immediate offshore vicinity (Table 5.4-7). These species are described in greater detail below. Six of these species are listed as Federally endangered or threatened. These include: blue whale, finback whale, humpback whale, northern right whale, sei whale, and sperm whale.

Cetaceans

Northern Right Whale (*Eubalaena glacialis*)

5.352 The northern right whale, a baleen whale, is listed as endangered, although it is sighted yearly along the southern coast of Long Island. Most sightings are between March and June. Northern right whales feed on large blooms of copepods (Sadove and Cardinale 1993).

Fin Whale (*Balaenoptera physalus*)

5.353 The fin whale, also a baleen whale, is found in the New York Bight year-round. From January through March fin whales are found within one mile of shore, the closest they get throughout the year. During the winter they are usually found in groups of three or four individuals, although in summer, aggregations of over 200 individuals are not uncommon. All age classes are found in the region, and some evidence of calving within the New York Bight has been reported, although not confirmed (Sadove and Cardinale 1993).

5.354 The fin whale has the greatest speed of all whales, with the capacity for sustained swimming at 12 knots and sprinting at up to 30 knots. It grows to 80 ft, and can weigh up to 50 tons (TQD 1999). The fin whale consumes a variety of prey items, including herring, mackerel, American sand lance, squid, butterfish, menhaden, and zooplankton (TQD 1999, Sadove and Cardinale 1993).

Minke Whale (*Balaenoptera acutorostrata*)

5.355 The minke whale, a small baleen whale, is the second most abundant mysticete in the New York Bight. It is found regularly near the coast and occasionally in the Peconic estuary, Long Island Sound, and Great South Bay. Minke whales have been sighted throughout the year, but more often during the summer months. Minke whales are usually found singly or in small groups of up to 20 individuals. (Sadove and Cardinale 1993).

5.356 The minke whale is the smallest of the rorqual family, averaging 25 to 30 ft in length. They prefer shallow water, estuaries, rivers, and inland seas. Minke whales feed primarily on planktonic crustaceans, but temperate populations also eat fish and squid (MBGnet 1999a). The minke whale is known to feed on herring, pollock, and sand lance (Sadove and Cardinale 1993).

Sei Whale (*Balaenoptera borealis*)

5.357 Over the past eight years, the sei whale, also a baleen whale, has been sighted infrequently. The sei whale was listed as endangered in 1970. It is thought that sei whales may be cyclical visitors to the New York Bight area. They have been observed individually and in small groups of up to 10 individuals. Adults reach a length of up to 60 ft, making them the third largest of the whales seen in the New York Bight. Although they may feed in the company of other baleen whales, sei whales range more widely (although tending to remain in temperate waters). The sei whale is more euryphagous than the fin whale, appearing to prefer copepods to krill and small schooling fishes such as anchovies and sauries. Although it is difficult to arrive at a population estimate due to a lack of sightings, regional population is thought to be less than 150 (Sadove and Cardinale 1993).

Blue Whale (*Balaenoptera musculus*)

5.358 Blue whales are rarely sighted in the region. Any confirmed sightings of this largest of whales have occurred at least 25 miles south of Montauk Point, and have been of single individuals, greater than 60 ft in length (Sadove and Cardinale 1993).

5.359 The blue whale, a baleen whale, is the world's largest mammal, ranging from 80 to 105 ft in length and over 146 metric tons in weight. The blue whale is a highly selective feeder, feeding on small planktonic crustaceans. Blue whales feed almost entirely during the summer months when they are in polar waters, taking up to 4.1 metric tons of small shrimp per whale per day. In autumn, they migrate toward the equator, but eat virtually nothing while in warmer water (MBGnet 1999b).

5.360 The blue whale mates while in warmer waters. Gestation lasts 11 or 12 months and calves are born the following year, also in relatively warm water.

Humpback whale (*Megaptera novaeangliae*)

5.361 The humpback whale, another baleen whale, is one of the few species that have been observed frequently in the western portions of Long Island inclusive of New York Harbor and the surrounding shore. Humpback whales are regularly found in shallow water. They are most common in the Bight area between June and September. During this time they are often sighted in cow/calf pairs. During the winter months, sightings are mostly of solitary juveniles, often traveling with fin whales (Sadove and Cardinale 1993).

5.362 Major prey items of the humpback whale include sand lance, krill, sardines, and anchovies, which they capture by creating a bubble net (MBGnet 1999c). Populations feed in the polar regions during the summer months, migrating to tropical breeding areas during the winter. Gestation takes 11 to 12 months, and a mother feeds her calf for almost a full year.

Sperm Whale (*Physeter catodon*)

5.363 Although the sperm whale, a toothed whale, is most often found in very deep waters, it has been a common visitor to the New York Bight in as little as 60 ft of water. Sperm whales are found in the area between May and June, and then again in October. Regular sightings have been recorded for the last 10 years. Sperm whales have been sighted in groups of up to seven individuals, although never with calves in the New York Bight (Sadove and Cardinale 1993).

5.364 Sperm whales grow to 40 to 65 ft long, and the males are generally larger than the females. They feed on large, deep-water squid as well as on some fish, lobsters, and plankton. Male sperm whales migrate toward the arctic during the spring; females and young remain in temperate waters. Females give birth after a gestation period of 14 to 16 months (MBGnet 1999d)

Bottlenose Dolphin (*Tursiops truncatus*)

5.365 Bottlenose dolphins include 2 subspecies, an inshore and an offshore. The inshore subspecies appears more seasonally than the offshore, occurring in the study area during June, July, August, and September. Groups of both subspecies are usually small, with a mean number of 20, although larger groups of over 200 individuals have occasionally been sighted (Sadove and Cardinale 1993).

5.366 The bottlenose dolphin can reach a length of 12 ft and a weight of 400 lbs. It is known for its swimming abilities, having been clocked at speeds up to 15 mph. Bottlenose dolphins feed on various organisms, including mullet, gizzard shad, squid, and eels (Dolphins 1999a). In the project area, they are believed to feed mostly on squid and herring (Sadove and Cardinale 1993). They either swallow their prey whole, or bite it in two before swallowing (Dolphins 1999a).

5.367 Communication among bottlenose dolphins is effected by a combination of sounds, body movements, tactile contact, and chemical signals. The animals are known for their use of echolocation to determine the placement of objects surrounding them (Dolphins 1999a).

Common Dolphin (*Delphinus delphis*)

5.368 The common dolphin is abundant in the study area throughout the year, although it is found closest to shore (in waters at least 30 ft deep) from March through June. These animals are most often seen in groups of from 50 to 200 individuals, including all age classes, with young calves more prevalent in May and June. Common dolphins have been observed feeding on herring, mackerel, and squid, depending on availability. Local population estimates are between 5,000 and 10,000 individuals (Sadove and Cardinale 1993).

5.369 The common dolphin can grow to 8 ft and weigh as much as 200 pounds. Swim speeds above 30 mph have been reported, although more conservative estimates place maximum swim

speed at 25 mph. Common dolphins are prey to killer whales, which circle groups of them prior to attacking (Dolphins 1999b).

Striped Dolphin *(Stenella coeruleoalba)*

5.370 Although striped dolphins are not usually seen in less than 300 ft of water, they have been sighted in the nearshore zone of the New York and New Jersey Harbor estuary area (USFWS 1997). The striped dolphin is in the area usually during late winter and spring. Sightings are usually of groups of 200 or more, including all age classes. Since they are brief residents in the area, they are considered migratory. No direct observations of feeding are available, but stranded individuals have given evidence that the species feeds on squid almost exclusively (Sadove and Cardinale 1993).

Harbor Porpoise (*Phocoena phocoena*)

5.371 The harbor porpoise is usually seen inshore in small groups of up to 3 animals. When observed in the open ocean, group size may range up to 12 individuals. Single individuals are most often sighted from March through June, close to shore. No direct observations of feeding have been made in the New York and New Jersey Harbor area, although stranded individuals have given evidence that squid or herring is the major prey species. Although population estimates are crude, there appear to be at least 50 individuals present inshore during the winter months (Sadove and Cardinale 1993).

Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

5.372 The Atlantic white-sided dolphin is very common within the New York Bight area. It is found along the coast during almost all months of the year. White-sided dolphins seem to congregate in a few local groups that occasionally aggregate. They have been observed to be most abundant in areas of less than 230 ft of water. They are most numerous from March through July when they are found in groups of 5 to 150 individuals. These groups include all age classes, with young calves seen in the spring. White-sided dolphin population in the Harbor area is estimated at 3,000 (Sadove and Cardinale 1993).

Pinnipeds

Harbor Seal *(Phoca vitulina)*

5.373 The harbor seal is the most common seal species in the region. Harbor seals are known to remain in the region year-round. All age classes are seen, including juveniles. Harbor seals are most abundant November through May. Their distribution appears linked to 25 major haul-out sites in the region, where from 20 to 350 individuals have been seen to haul out. These haul-out areas are located in Jamaica Bay, on Sandy Hook and Staten Island, and on the Westchester and Connecticut shorelines of western Long Island Sound. The harbor seal grows to about 5 ft in length. Harbor seals have been observed feeding on herring, mackerel, squid, flounder, green crabs, mussels, cod, and whiting. The present winter population of harbor seals is estimated at

1,890. Both their numbers and their areas of occupation within the Harbor system have been expanding, particularly during the winter months (Sadove and Cardinale 1993).

Grey Seal *(Halichoerus grypus)*

5.374 The grey seal is also abundant in the region. Pups and juveniles are most commonly observed, although adults have occcasionally been sighted. Grey seals are most abundant from January through April. Although population has apparently not been estimated, it has been observed that the number of grey seals sighted and stranded have shown a gradual increase in recent years. This is thought to be related to an increase in the population overall (Sadove and Cardinale 1993).

Harp Seal *(Phoca groenlandica)*

5.375 The harp seal is found in the area from late November through mid-May, with no more than two harp seals seen in one location at a time. The species is slowly becoming more abundant locally: it is now the second most commonly stranded seal species in the area. Almost all strandings are of juveniles. Limited observations of feeding indicate a preference for herring or squid. The North Atlantic population is estimated at over 2,000,000; the regional population, about 100 (Sadove and Cardinale 1993).

Ringed Seal *(Phoca hispida)*

5.376 The ringed seal has been sighted only during January through April in the Harbor area, and all sightings have been of single animals unassociated with members of other seal species. Most sightings have been of juveniles, although adults have also been observed. Based on evidence from stranded individuals, sardines and small schooling fish are favored prey. The species is thought to be extraliminal to the area (Sadove and Cardinale 1993).

Hooded Seal *(Cystophora cristata)*

5.377 The hooded seal is similar to the ringed seal in distribution and habitat requirements. It is also an extraliminal species regularly found in the Harbor area from January through April. One significant difference from the ringed seal is that no adult hooded seals have been observed or stranded in the area (Sandove and Cardinale 1993).

Terrestrial Species

Avifauna

5.378 Birds of the world may be divided into large regional groups called avifaunas, with the Nearctic avifauna encompassing North America. The component of the Nearctic group found in the New York and New Jersey Harbor area is listed in Table 5.4-8 and discussed in the following section.

Ducks, Ducklike, and Miscellaneous Waterfowl

5.379 Birds in this group, which includes loons, grebes, cormorants, swans, geese, ducks, coots, and gallinules, spend most of their time in and around water. All species in this group derive their food items from the water. The primary use of the New York and New Jersey Harbor by waterfowl is for resting and feeding during the fall migration, and as a wintering area.

5.380 The migratory and midwinter concentrations of birds in this group are significant in the New York and New Jersey estuary, specifically in the Arthur Kill complex and the Raritan Bay-Sandy Hook complex. Nesting waterfowl in the Arthur Kill complex include American black duck, gadwall (*Anas strepera*), mallard, green-winged teal (*A. crecca*), blue-winged teal (*A. discors*), Canada goose, and wood duck (*Aix sponsa*), as well as Virginia rail (*Rallus limicola*), common moorhen (*Gallinula chloropus*), American coot (*Fulica americana*), and pied-billed grebe (*Podilymbus podiceps*) (USFWS 1997). The combination of location, productive wetlands, flats, and water makes Raritan Bay an important migratory area. Waterfowl are not evenly distributed throughout Raritan Bay, but tend to gather along the southern Raritan Bay and Staten Island shorelines (USFWS 1997).

Diving Ducks

5.381 Many diving ducks overwinter in coastal areas; others overwinter on large water bodies, such as lakes, impoundments, and slow-moving rivers where fish and invertebrates are plentiful. Diving ducks begin the fall migration to overwintering areas in October and November after recruitment of young. Large concentrations move south to open-water areas in the northeast and mid-Atlantic states, where they overwinter (Bellrose 1980).

5.382 Large overwintering rafts of diving ducks forage and rest within the New York and New Jersey Harbor area. The arrival date is dependent on species and winter conditions, which vary from year to year. About 15 species of diving ducks may be expected to pass through and use portions of the New York and New Jersey Harbor area for migration stopovers and for overwintering (Nichols 1995).

5.383 The northward migration from the New York and New Jersey Harbor area begins as early as February for some species, but for most occurs in March. Most canvasbacks, greater and lesser scaups, and buffleheads are found in large numbers in the New York and New Jersey Harbor area from late November through March (TI 1976). Overwintering scaup populations, which have increased in the Raritan-Sandy Hook complex, make up a significant component of the diving ducks using the Atlantic flyway (USFWS 1997).

5.384 Diving ducks move throughout the Hudson-Raritan estuary daily in search of food and protected resting areas. Large, shallow, open-water estuarine areas with abundant food supplies (primarily bivalves) are preferred foraging sites for these species (Stott and Olson 1973). Benthic worms, isopods, amphipods, snails, shrimp, crabs, and small fish are also eaten by the many species of diving ducks that overwinter along the east coast (TI 1976, Stott and Olson 1973).

Dabbling Ducks, Geese, and Swans

5.385 Dabbling ducks breed and overwinter in the New York and New Jersey Harbor area. Mallards and American black ducks are common nesters in this area, with occasional nesting by gadwall, green-winged teal, and blue-winged teal (Andrle and Carroll 1988). Overwintering species include gadwalls, American black ducks, common pintails (*Anas acuta*), and mallards (TI 1976; LMS 1984a, 1984b, 1987). Wintering dabbling ducks and geese of regional importance occurring in the open waters and marshes of the Arthur Kill complex include brant, American black duck, gadwall, Canada goose, mallard, and American wigeon (USFWS 1997).

5.386 At one time, the American black duck was the most common duck breeding in the Harbor (Eaton 1910). The American black duck population, however, began a rapid decline during the 1950s and 1960s, with much of this decline blamed on the increasing population of breeding mallards (Smith and Ryan 1978). The hybridization between mallards and black ducks is partially responsible for the decline; other causes appear to be habitat loss, toxicants, excessive hunting, and acid rain (Andrle and Carroll 1988).

5.387 The American black duck population that makes use of coastal saltmarsh habitat in the New York and New Jersey Harbor area has remained stable, while inland populations have declined (Bull 1974). The black duck breeds in a variety of habitats, from coastal saltmarshes and brackish tidal marshes to freshwater marshes, bogs, lakes, ponds, streams, and wetlands of inland hemlock and northern hardwood forests (Stewart 1958). Nests are found on the ground in dense vegetation, along the edges of wetlands, or along water (Andrle and Carroll 1988). The nest generally consists of a depression (made by the female) lined with vegetation and down (Andrle and Carroll 1988).

5.388 Both mallards and American black ducks may be expected to use wetland habitat in the project area.

5.389 As with diving ducks, the presence of this species in the project area is dependent on availability of food and appropriate nesting and resting habitats (Howe, et al. 1978). These species would make relatively little use of the open water in the channels, preferring the more protected shoreline areas.

Cormorants

5.390 Two species of cormorants, the double-crested and great, occur in the New York and New Jersey Harbor area. Both cormorants forage on fish caught by diving from the surface of the water and swimming in pursuit (Terres 1980).

5.391 The double-crested cormorant is a colonial nester, preferring isolated undisturbed islands (Andrle and Carroll 1988). Within the project area it has been observed nesting on Shooters Island (Andrle and Carroll 1988). A total of 140 double-crested cormorant pairs have been counted nesting in the Arthur Kill Complex. (USFWS 1997).

5.392 The great cormorant is not a local nester and does not occur in the New York and New Jersey Harbor area during the breeding season; it is a winter resident (Bull 1974). Great cormorants may forage in the Harbor area, but they were not observed during the 1995-96 seasonal surveys (LMS 1996).

American Coot

5.393 The American coot may breed in the New York and New Jersey Harbor area (Andrle and Carroll 1988). The American coot prefers open-water habitat in wetland areas (USFWS 1986).

Aerialists

5.394 Aerialists, namely seabirds, include shearwaters (*Puffinus* sp.), storm petrels (*Oceanitus* sp.), gannets (*Morus* sp.), gulls, terns, and skimmers.

5.395 Shearwaters and storm petrels are tube-nosed pelagic (open ocean) seabirds, ranging in size from relatively small to relatively large. They tend to have long wings that are used for soaring and long distance flights over the ocean. Fish is their main food source, and they may fly great distances in search of it. Shearwaters and storm petrels have been sighted in the New York and New Jersey Harbor area, but they do not use the project area for nesting or breeding.

5.396 Gannets are medium-sized (35–40 in. wingspan) aquatic birds that feed by diving for fish. Most often seen over the open ocean, this species sometimes frequents large bays (Collins, Jr. 1981).

5.397 Gulls, terns, jaegers, skuas, and skimmers characteristically are long-winged, web-footed and relatively short-legged birds. Depending on the species, they obtain their food on either water or land. Birds of this group have a variety of feeding styles. Generally gulls scavenge the shoreline for anything edible, while terns dive for fish swimming near the surface of the water, and skimmers touch the surface of the water, catching small fish with their bills. Predators and thieves, the jaegers either steal their food from other birds or prey on the birds themselves. They also prey on rodents (Gill 1990).

5.398 Several species of terns and gulls forage and nest in the New York and New Jersey Harbor area. Herring gulls and great black-backed gulls are known to nest on various islands in the Harbor Herons Complex (Kerlinger 1999). Ring-billed (*Larus delawarensis*), laughing (*L. atricilla*), and Bonaparte's (*L. philadelphia*) gulls are also known to rest and forage in the New York and New Jersey Harbor (LMS 1996, Parsons 1994). These species move about the area in search of food, including fish and invertebrates, many of which are dead or dying. Resting/roosting sites include uplands, parking lots, and roofs of buildings. Foraging sites also include upland areas along shorelines, and landfills containing discarded food.

5.399 Least tern, common tern, and black skimmer may be found nesting in large numbers on Sandy Hook and Breezy Point (USFWS 1997). In addition, small numbers of Forster's tern

(*Sterna forsteri*), gull-billed tern (*S. nilotica*), and the Federally listed (endangered) roseate tern may be found nesting in the New York and New Jersey Harbor area. Goethals Bridge Pond is an important feeding area for migratory shorebirds, particularly common tern and least tern (USFWS 1997).

Long-legged Wading Birds

5.400 The Arthur Kill Complex plays a significant role in the nesting and foraging of herons, egrets, and ibises (USFWS 1997). As of 1995, three island heronries, Shooters Island, Pralls Island, and the Isle of Meadows, collectively contained nearly 1,400 nesting pairs of colonial wading birds, including black-crowned night heron, glossy ibis, snowy egret, great egret, cattle egret, yellow-crowned night heron, green-backed heron, and little blue heron. The three islands comprise the largest heronry in New York State (USFWS 1997). However, recent investigations have shown that Shooters and Pralls Island are devoid of heron and egret nests (Kerlinger 1999).

5.401 The wetlands in the Arthur Kill Complex, namely, the marshes, flats, and shallow waters of ponds and tidal creeks, are used by herons and egrets to forage for fish (particularly mummichog and Atlantic silverside) and invertebrates like grass shrimp (USFWS 1997).

5.402 The green-backed heron may breed in the New York and New Jersey Harbor area (Parsons 1994, Andrle and Caroll 1988), with one to nine breeding pairs reported since the first breeding pair was recorded in 1982 (Parsons 1994). The great blue heron is considered a nonbreeding summer visitor to the coastal lowlands (Andrle and Carroll 1988). Only two possible nesting records for great blue heron were identified on Staten Island (Andrle and Carroll 1988). Great blue heron have not been recorded nesting on Shooters Island since surveys began in 1974 (Parsons 1994).

5.403 Of the two heron species, only the great blue heron can forage in deeper-water areas and sometimes uses open bays. The green-backed heron prefers tidal creeks and shorelines, where it can forage in more closed situations, often using sticks or banks as forage platforms rather than standing in water (Palmer 1962).

Shorebirds

5.404 This group of birds, small to medium-sized wading birds with slender, probing bills and thin legs, includes rails, oystercatchers, avocets (*Recurvirostra* sp.), stilts (*Himantopus* sp.), plovers (*Pluvialis* and *Charadrius* spp.), various genera and species of sandpiper, snipe (*Gallinago* sp.), and phalaropes (*Phalaropus* spp.). Members of this group feed by wading in shallow water or along the edge of the water, using their slender bills to probe in mud or sand or to pluck prey from the surface of the ground (Gill 1990).

5.405 A variety of small wading birds, including plovers, woodcock (*Scolopax* sp.), snipe, turnstones (*Arenaria* sp.), sandpipers, yellowlegs (*Tringa* spp.), dowitchers (*Limnodromus* spp.), dunlin (*Calidris alpina*), and sanderling (*C. alba*), migrate through the New York and New Jersey Harbor area. Sandy Hook and Breezy Point support some of the largest nesting

populations of piping plover in the region (USFWS 1997).

5.406 Three species of rail, Virginia, clapper, and Sora (*Porzana carolina*), may breed in the New York and New Jersey Harbor area. The rail species occur in marshes. Rails seldom venture out of marshes or their muddy borders (USFWS 1986).

5.407 Small wading birds nesting in the Goethals Bridge Pond area include black-bellied plover (*Pluvialis squatarola*), red knot (*Calidris canutus*), pectoral sandpiper (*C. melanotos*), semipalmated sandpiper (*C. pusilla*), and sanderling (USFWS 1997).

Fowl-like Birds

5.408 Fowl-like birds include turkeys, grouse, pheasants, quails, and partridges. They are non-migratory, medium to large terrestrial birds (Gill 1990). Although ring-necked pheasant, ruffed grouse (*Bonasa umbellus*), and northern bobwhite (*Colinus virginianus*) have been sighted in the New York and New Jersey Harbor area, they all prefer upland habitats, ranging from deciduous forests to cultivated and non-cultivated areas (USFWS 1986).

Raptors and Owls

5.409 Raptors include hawks, falcons, eagles, osprey, and vultures. All birds from this group that are found in the New York and New Jersey Harbor area are carnivorous, feeding on other animals, including fish, small mammals, and birds.

5.410 Two falcons, the American kestrel and the peregrine falcon, nest and forage in the New York and New Jersey Harbor area. In 1994, eleven territorial pairs of the state-listed (endangered) peregrine falcon were known in the New York City area. This included seven pairs nesting on bridges and four pairs nesting on buildings in Manhattan. These manmade surrogates for cliffs have proven highly attractive to peregrines, primarily due to the high populations of rock dove and other birds found in the urban environment (Snyder 1997). The American kestrel generally forages over open fields, where it feeds mainly on small terrestrial vertebrates and invertebrates (Terres 1980).

5.411 In addition to the peregrine and American kestrel, breeding birds of prey in the New York and New Jersey Harbor area include northern harrier, osprey, and common barn owl (*Tyto alba*). Overwintering birds of prey include northern harrier, rough-legged hawk (*Buteo lagopus*), American kestrel, common barn owl, short-eared owl (*Asio flammeus*), long-eared owl (*A. otus*) and peregrine falcon.

5.412 Other raptors, including sharp-shinned, Cooper's, red-shouldered, and broad-winged (*B. platypterus*) hawks, are present during migratory periods, along with the occasional bald eagle or merlin. Northern harriers forage over many of the wetland marshes in the Arthur Kill Complex (USFWS 1997). Red-tailed hawks forage in uplands and wetlands, mostly on vertebrates (Terres 1980). Ospreys prey almost exclusively on live fish and are dependent on a healthy fish population for their existence (Sullivan 1991). Populations of small mammals and songbirds in

the New York and New Jersey Harbor area provide a rich food source for both resident and migratory raptor populations (USFWS 1998a).

Songbirds

5.413 Members of this group include perching birds, cuckoos, nighthawks, swifts, hummingbirds, kingfishers, and woodpeckers. Many songbirds are migratory, moving between breeding grounds and wintering areas each year (USFWS 1986). The New York and New Jersey Harbor area occupies a key location for migrating birds, as evidenced by the large number and variety of birds seen in the various open spaces within the area. Breeding Bird Atlas data from New York and preliminary Atlas data from New Jersey indicate that 172 species of birds are probable or confirmed breeders in the area, including 92 Passeriformes (perching birds). The diversity of breeding species found is indicative both of the diversity of habitats found here and the mix of northern and southern species. Many species breed on the periphery where there is suitable habitat. USFWS (1998a) identified and described songbird species that are common breeders in urban areas of the New York and New Jersey Harbor area. Species identified include the song sparrow, American robin, gray catbird, yellow warbler (*Dendroica petechia*), and red-winged blackbird. Grassland birds such as the grasshopper sparrow (*Ammodramus savannarum*), savannah sparrow (*Passerculus sandwichensis*), and bobolink (*Dolichonyx oryzivorus*) are rare breeders in the region and, while absent throughout urban areas, are found in a few locations such as Floyd Bennett Field, where grassland habitat is being actively managed and maintained. Analysis of eleven Christmas bird counts for urban areas during the period 1961-88 indicated about 277 species wintering in the area, with approximately 100 species commonly observed. An analysis of the top 100 species indicated that twice as many terrestrial species were declining as were increasing, while the opposite was true for aquatic birds.

Amphibians and Reptiles

5.414 The amphibians and reptiles of the New York and New Jersey Harbor area have been affected by port development and population growth. Terrestrial and wetland habitats have been lost or adversely impacted due to housing and industrial development, parking lots and roadways, filling, drainage for mosquito control, and bulkheading for shoreline protection. Aquatic habitats have also been lost through dredging, filling, and sedimentation. Predators that adapt well to industrial and residential growth, such as raccoon, opossum, skunk, cats, and dogs, have severely depleted or extirpated local amphibian and reptile populations.

5.415 The general lack of breeding sites for amphibians (semi-permanent pools, small ponds and lakes with few predators) has served to limit their success in the New York and New Jersey Harbor area. Breeding sites in areas 3 ft or less above MHW and irregularly flooded by high tides are referred to as supra-tidal. . Supra-tidal habitats, including pools, wetlands, uplands, and floodplains, are important habitats for reptiles and amphibians and warrant conservation and restoration (Kiviat 1998). Observations in tidal freshwater habitats compiled by Kiviat (1998) indicate an increase in species diversity between intertidal and supra-tidal areas of Hudson River freshwater tidal marshes. Up to five species of amphibians were found breeding in supra-tidal pools while only green frogs (*Rana clamitans*) were found in intertidal pools and marshes.

Species diversity may be reduced in brackish and marine tidal areas. Above this level are freshwater pools that are infrequently affected by natural factors, including salt spray and hurricanes, that have resulted in abnormally high tidal waters. Once contaminated by salt, these areas are slow to recover, and species lost may not return.

5.416 Today, amphibians and reptiles are distributed in portions of the project area where weak developmental effects have ensured the continuance of habitat. This has resulted in a very limited distribution of many amphibians and reptiles that may once have been common in the project area. Efforts have been made, generally in public parks and wildlife refuges, to reintroduce species lost from formerly occupied sites.

5.417 Tidal salt/brackish marsh areas are not recognized for providing habitat for amphibians or reptiles. Mitsch and Gosselink (1993) did not include amphibians and reptiles in their list of wildlife species using tidal salt marshes. DeGraff and Rudis (1986) show three reptiles (common snapping turtle [*Chelydra s. serpentina*], spotted turtle [*Clemmys guttata*], and eastern painted turtle [*Chrystemys picta*]) and no amphibians selecting brackish tidal habitats. Kiviat (1998) suggests that snapping turtles may have difficulty tolerating extended periods of high salinity at Piermont Marsh, Hudson River (River Mile 26) during the summer. Dr. Edward Johnson of the Staten Island Institute indicates that northern diamondback terrapins are common in tidal brackish habitats, although historical records indicate that the spotted turtle and eastern mud turtle (*Kinosternon s. subrubrum*) were also once found in tidal brackish habitats on Staten Island. He indicates that amphibians found near the tidal brackish marshes are always in freshwater areas of the wetlands. This can include areas where freshwater is trapped in depressions above the high spring tide level. Weiss (1995) states that most amphibians cannot tolerate high salinities or very dry environments. No amphibians live in marine waters and only a few (spring peeper [*Pseudacris c. crucifer*], red-backed salamander [*Plethodon cinereus*], American toad [*Bufo a. americanus*], Fowler's toad [*B. woodhousii fowlerii*], eastern spadefoot toad [*Scaphiopus h. holbrookii*], and spotted salamander [*Ambystoma maculatum*]) regularly occur along the coast. Weiss (1995) lists several reptiles that occur near coastal areas, including common snapping turtle, eastern box turtle (*Terrapene c. carolina*), spotted turtle, eastern painted turtle, northern diamondback terrapin, hognose snake (*Heterodon platirhinos*), smooth green snake (*Opheodrys vernalis*), black rat snake (*Elaphe o. obsoleta*), northern black racer (*Coluber c. constrictor*), northern water snake (*Nerodia s. sipedon*), northern brown snake (*Storeria d. dekayi*), eastern ribbon snake (*Thamnophis s. sauritus*), and eastern garter snake (*Thamnophis s. sirtalis*).

5.418 Several species that are tolerant of brackish water include common snapping turtle, diamondback terrapin, mud turtle, spotted turtle, red-backed salamander, southern leopard frog (*Rana u. utricularia*), and spring peeper. These species might occur in the New York and New Jersey Harbor area in suitable habitats. The literature does not provide salinity ranges for these species. The diamondback terrapin is the only amphibian species found regularly in brackish waters.

5.419 Of the amphibians and reptiles noted by Barclay and Squires (1991) at specific locations in the study area, many have been extirpated or are now uncommon. The NYSDEC Amphibian

and Reptile Atlas Project has documented 33 species that occur in New York counties adjacent to the study area (NYSDEC 1999). A composite of all the species listed in these two sources is provided in Table 5.4-9.

5.420 The following describes the habitats of selected species that are representative of the study area. The spotted salamander, southern leopard frog, and eastern spadefoot toad are vernal-pool breeders having different niches. The spotted turtle and eastern mud turtle are marsh turtles that have different habitat requirements. The northern diamondback terrapin is the only true brackish-water species discussed. The eastern box turtle and northern black racer, two terrestrial reptiles, were selected and discussed because their habitats are different from the more aquatic species.

Habitats of Selected Reptiles

Spotted Salamander

5.421 Spotted salamander habitat consists of well drained upland deciduous woods with vernal/ephemeral or permanent pools or ponds for breeding (NYSDEC 1993a). These water sources may be located in open areas adjacent to woodlots. Spotted salamanders are found in deciduous and mixed (hardwoods and hemlock) woods containing ponds, slow streams, vernal ponds, sphagnum-bordered pools, swampy holes of decaying leaves, or pools in and along old roads. Adults are highly fossorial and may be found in and under decaying logs and wet leaf litter, railroad ties, in mammal-excavated or self-excavated burrows, or in other fossorial situations.

5.422 Breeding habitat requirements are similar to those of other ambystomid salamanders. Adults and various larval stages may be found in ephemeral or permanent water sources containing vegetation (live and decaying) that is used as cover, foraging area, or egg deposition site. Spotted salamanders also have great pioneering capabilities, and breeding has been documented in concrete, leaf-filled swimming pools, in roadside ditches, and in woodland road ruts. They may be found up to 600 ft from breeding sites (Madison 1997).

Diamondback Terrapin

5.423 The diamondback terrapin is a diurnal turtle of salt marshes, brackish water areas, and estuaries; it prefers salt marshes, brackish waters of coastal rivers, estuarine areas, tidal creeks of coastal areas, tidal flats and protected lagoons, or barrier beach ponds, depending on the salinity of the water (NYSDEC 1993b). Diamondback terrapins may be found in the project area during movements to and from wintering and nesting sites and while foraging.

5.424 The northern diamondback terrapin emerges from its winter sites in early May (NYSDEC 1993b). Seasonal activity ranges from late-April and May to mid- to late November. Diamondbacks breed immediately after emergence in the northern parts of their range. Gravid females migrate from the breeding areas to find suitable nesting sites, which are located in open areas on sandy hummocks or dunes above the high-tide mark. Many nests have been found on

dike roads. The eggs are deposited between May and June. Incubation time is highly variable and dependent on temperature, although in the northern parts of the range the eggs are generally incubated for 90 days and hatch sometime in September. Young then move to overwintering areas.

5.425 Winter months are spent concealed in muddy bottoms of streams or ponds, buried in creek banks, or refuged in undercut banks (NYSDEC 1993b). Adults of the species are primarily carnivorous, but will occasionally scavenge. Stomach analysis has shown food items to include snails, crabs and other crustaceans, marine annelids, and mollusks. Some turtles may take vegetable matter such as the tender shoots and rootlets of marsh plants.

Eastern Mud Turtle

5.426 The mud turtle prefers shallow, slow, or non-flowing fresh or brackish water with a soft bottom and abundant aquatic vegetation (often the case in salt marshes) (NYSDEC 1993c). Individuals may also be found in wet meadows, bayous, lagoons, and marshy areas, or in sloughs, backwater swamps, and sinkholes. Wintering sites include mud or muskrat burrows, marshes, leaf piles, or in field edges, buried below the frost line. Nest sites include piles of rotting vegetable debris, rotted wood, or small depressions in the soil.

Southern Leopard Frog

5.427 The southern leopard frog may be found in any freshwater or slightly brackish habitat (NYSDEC 1993d), including marshes, ponds, canals, river swamps, flooded roads and ditches, bays, and small pools. Adults migrate from the breeding areas in the summer months to moist vegetated lands such as pastures, meadows, and woods. In New York and New Jersey, this species is found in damp, grassy areas around ponds, streams, and swamps.

Spotted Turtle

5.428 Spotted turtles are found in a variety of habitats, including wet meadows, small ponds, marshes, slow sections of small rivers, flooded fields, and other ephemeral aquatic areas (NYSDEC 1993e). Spotted turtles aestivate, and may remain in a particular area for up to 2 weeks. Aestivation sites include moist areas under dead and loosely matted reeds, grasses, and ferns, in moist decaying plant matter, in dark rich detritus shielded by a dense tangle of vegetation, and in puddles. Individuals have also been found aestivating in drier locations under leaves and dead vines.

Eastern Box Turtle

5.429 Eastern box turtles prefer old field habitat and deciduous forest edge, including powerline cuts and logged-over woodland. Pastures and marshy meadows are also frequently used (Klemens 1993). Box turtles are strictly terrestrial, but are never found far from some source of water, usually a pond or small stream (NYSDEC 1993f). Most individuals are quite sedentary, occupying a home range averaging 100-750 ft in diameter. Some individuals, however, are

transient and do not establish a home range.

Black Racer

5.430 Black racers are encountered in a variety of habitats (NYSDEC 1993g). Individuals may be found in grassland/woodland borders, swamps and marshlands, around old fields and farm buildings (usually under some sort of cover such as sawdust piles, stones, boards, tinsheets, or tarpaper, or along stone walls. Individuals have been found in xeric oak-hickory forests, in abandoned orchards, and in riparian thickets. Racers use a variety of sites for hibernacula such as rock crevices, talus, and mammal burrows. Racers often share den sites with other snakes, including copperheads, black rat snakes, timber rattlesnakes, and garter snakes.

Eastern Spadefoot Toad

5.431 The eastern spadefoot toad is found in areas conducive to burrowing, such as sandy or loose soils with leaf litter located in open forest (pitch pine/scrub oak barrens), or in sparse shrub growth (NYSDEC 1993h). Breeding sites include any area within the toad's range where a temporary (vernal) pool or pond (roadside ditches, low fields, potholes, drainage basin) can be maintained .

Terrestrial Mammals

5.432 Several terrestrial mammalian species occur in the New York and New Jersey Harbor area. The main limitations to their occurrence relate to habitat: habitat reduced or disturbed by humans and their pets, restrictions to movements between areas of suitable habitat, and mortality due to vehicular traffic. A list of mammals likely to be found in the study area based on surveys conducted by USACE and NJDEP may be found in Table 5.4-10 (USACE-NYD 1997b, NJDEP 1999a). It is possible that other species, as yet unreported, may occur in the area.

5.433 The most abundant small mammals are those that have adapted to human habitation, such as the meadow vole, cottontail rabbit (*Sylvilagus floridanus*), gray squirrel, raccoon, muskrat, opossum, white-footed mouse (*Peromyscus leucopus*), and eastern chipmunk (*Tamias striatus*). Mammals introduced by humans include house mouse (*Mus musculus*), Norway rat, and feral dogs and cats. Bats that migrate through the area include the little brown bat (*Myotis lucifugus*), silver-haired bat (*Lasionycteris noctivagans*), red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*). Large mammals are absent from the urban centers, although white-tailed deer (*Odocoileus virginianus*) occur on abandoned land in wetland areas and are common in the suburban outskirts. Fox, mink and coyote (*Canis latrans*) occur in more isolated portions of the area.

Threatened and Endangered Species

5.434 Information on threatened and endangered species in the New York and New Jersey Harbor area was obtained through correspondence with USFWS, NMFS, NYSDEC, and NJDEP.

5.435 Federal and state-listed threatened or endangered species are a primary concern because these species are important on a regional basis and they may be especially vulnerable to habitat disturbance and loss. Threatened and Endangered Species (TES) and rare species that were identified by Federal and state agencies are listed in Table 5.4-11. There are 182 TES listed for the New York and New Jersey Harbor area, including 5 mammals, 27 birds, 4 reptiles, 3 amphibians, 1 fish, 5 invertebrates, and 126 plants (USFWS 1998b, NJDEP 1998b, NYSDEC 1998, NMFS 1996b). Many of the plant species were identified from historic files and may have been eliminated from the area since last observed. These species, observed during the late 1800s and early 1900s, are not considered in this evaluation. Several TES vertebrate and invertebrate species are also unlikely to occur in the area because their normal distribution does not include the New York and New Jersey Harbor area. These species generally occur away from the project area in marine habitats off the coasts of New York and New Jersey or in the interior sections, where there is less development. Other than marine mammals and turtles, no TES mammals, reptiles, or amphibians are known to occur in the project area.

5.436 The following are discussions of those species that might actually be found in the New York and New Jersey Harbor area. These species are distributed in portions of the project area where habitat remains, largely because development (or its effects) has been limited . These areas include wetlands as well as isolated areas where development was not practical. Recent changes in wetland laws have eliminated development in protected areas, providing some protection for TES. Other areas that escaped development are protected public lands and some private lands. These areas include beaches, isolated intertidal zones, and other undisturbed areas. This results in a very patchy distribution for most TES that historically may have been common in project-area habitats.

Birds

Pied-billed Grebe

5.437 The pied-billed grebe is listed as an endangered species in the state of New Jersey and as threatened in New York State. Its population has been reduced largely through an increase in recreational activities and human disturbance..

5.438 Pied-billed grebes are found in ponds, sloughs, and marsh inlets, and along edges of rivers, lakes, and reservoirs (NYSDEC 1993i). An aquatic bed of vegetation and deeper, open water are necessary for foraging. Emergent vegetation more than 100 ft from the shore provides protected nesting sites (Gibbs and Melvin 1992a).

5.439 In the project area, grebes arrive in early April to begin nesting. Nests are placed at the edge of dense vegetation and water, allowing unseen approaches and exits (Connor 1988). A nesting pair builds a floating nest consisting of live and rotting plant material and mud. It is often anchored to emergent live vegetation. Nests are built in shallow water surrounded with dense vegetation. Surrounding vegetation commonly consists of cattail and bulrush, which serves to anchor the nest, break waves, and conceal it from predators (Forbes et al. 1989). Pied-

billed grebes raise one or two broods per season, each clutch having from 2 to 10 eggs (NYSDEC 19931).

5.440 Fall migration from the New York and New Jersey Harbor area to overwintering areas begins in late August and continues through the end of September (Bull 1985).

Least Tern

5.441 The least tern, listed as endangered in New Jersey and New York, is the smallest tern found in the New York and New Jersey Harbor area (Andrle and Carroll 1988).

5.442 The least tern is locally common in coastal areas, where it nests on beaches, dredged material disposal sites, and in other open shoreline zones. (Peterson 1988). It also nests in parking lots, on rooftops, at airports, and on road shoulders (Downing 1973, Fisk 1975, Jackson and Jackson 1985, Atwood et al. 1979, Anderson 1972). Least terns usually nest in colonies of fewer than 25 breeding pairs (Peterson 1988a).

5.443 Nest sites are often close to water (Carreker 1985). Coastal least terns commonly breed near shallow waters of estuaries and bays (Massey 1971, Dorr 1976, Erwin 1978, Thompson 1982). In North Carolina, of 61 observed colonies, all were within 850 ft of a large expanse of shallow water (Jernigan et al. 1978).

5.444 Least terns forage over shallow-water areas such as nearshore ocean (Collins et al. 1979, Atwood and Minsky 1983), estuaries, lagoons (Wilbur 1974), rivers, streams, lakes, ponds (Hardy 1957), channels (Collins, et al. 1979, Atwood and Minsky 1983), and canals (Fisk 1975). Least terns are opportunistic foragers, exploiting most species of fish that are found near the surface within a certain size range (Moseley 1976, Tomkins 1959). Since least terns forage wherever prey occurs, the movements of prey species make it difficult to delineate foraging localities (Atwood and Minsky 1983).

5.445 No least tern nesting sites are presently reported in the New York and New Jersey Harbor; nesting has, however, been reported just east of the study area (Andrle and Carroll 1988). Within the project area, suitable habitat for nesting is limited, and disturbance by humans, pets, and nuisance wildlife deters this species from nesting. Any individuals observed are probably non-breeding adults, post-breeding wanderers, or migrating individuals that forage in the New York and New Jersey Harbor area, including Newark Bay (Bull 1974). Least terns may occasionally be found foraging in the Harbor from late April through early September (Bull 1974). Nesting occurs as early as May, and fledging occurs as late as August (Andrle and Carroll 1988).

Roseate Tern

5.446 Roseate terns are Federally listed as an endangered species; they are listed as endangered by both New York and New Jersey as well. Roseate terns generally prefer to nest along isolated sandy, rocky, or pebble beaches, or on split-off islets of barrier islands (Matthews and Moseley

1990). Roseate terns primarily nest in colonies with common terns (Bull 1974, Peterson, et al. 1985). Roseate terns tend to place their nests under some sort of cover such as vegetation or rocks, while common terns nest in open areas with less vegetation (Bull 1974, Hays 1984). Roseate terns were first observed nesting at Breezy Point in 1993. This colony and others along the south shore of Long Island represent the southernmost known nesting colonies of the northern U.S population of roseate terns.

5.447 Roseate terns reach sexual maturity at 3 or 4 years and breed once per year, producing an average of 1.5 young per brood (NYSDEC 1993j). Nests, concealed in vegetation or debris, consist of a scrape in the substrate lined with vegetation. Clutches average 1 to 3 eggs.

5.448 Roseate terns feed over open waters of channels and shoal areas, pursuing schools of small fish. Important prey species include American sand lance, Atlantic herring, blueback herring, juvenile mackerel, and bluefish (USACE-NYD 1999b).

5.449 A recovery plan for the northern population of roseate terns was published in 1989 (USFWS 1989). Declines of roseate tern populations are due to habitat loss as a result of vegetational changes, competition with gulls, coastal development, and predation (Buckley and Buckley 1981, Spendelow 1982, Safina 1985).

5.450 Roseate terns migrate in late August and September to South American overwintering areas, primarily eastern Brazil and western Colombia. During their overwintering period they may be trapped and hunted for food. Roseate terns return to the northeast in late April and early May, laying eggs between late May and early June.

Common Tern

5.451 The common tern is listed as a threatened species in New York State, where it is found along the coast. No common tern nesting sites are presently reported in the New York and New Jersey Harbor, although nesting has been reported just east of the project area (Andrle and Carroll 1988). The most recent recorded nesting was in 1995, at Breezy Point on Rockaway Beach (NYSDEC 1999). Nesting habitat includes ocean beaches, sparsely vegetated ridges and flats, vegetated areas adjacent to open land, piles of rubble or rock, and islands in the bays along the south shore of Long Island (Bull 1985, NYSDEC 1994a). Nests are usually established on the sand among scattered clumps of grass, and are often lined with shell fragments and pebbles. Where sand beaches are rare, eggs may be laid on gravel. In 1991, 51 colonies were documented on Long Island (NYSDEC 1994a).

5.452 Common terns are tenacious with respect to nesting site, and have strong group adherence. It can be expected that the same individuals nest in the same colony year after year. When the habitat becomes unstable, group adherence becomes stronger and the terns as a group search for a new colony site (NYSDEC 1994a).

5.453 Within the project area, suitable habitat for nesting is limited, and disturbance by humans, pets, and nuisance wildlife deters this species from nesting. Any individuals observed are

probably non-breeding adults, post-breeding wanderers, or migrating individuals. Transients are most abundant in spring and fall (Bull 1985).

Black Skimmer

5.454 Black skimmers are listed as endangered in New Jersey and as a species of special concern in New York (NYSDEC 1993k). A species of special concern is any native species for which a welfare concern or risk of endangerment has been documented (21 NYSR 25).

5.455 Black skimmers breed locally along the Atlantic coast from Massachusetts (Plymouth), New York (Long Island), and New Jersey south to southern Florida (American Ornithologists' Union, 1983). Wintering occurs on shallow bays and estuaries in the southern U.S. to central Argentina. Presently, black skimmers breed in three counties in New York: Nassau, Suffolk, and Queens (NYSDEC 1993k). In 1989, the largest colonies were recorded at Cedar Beach (212 adults) and at the west end of Jones Beach (680 adults). At Breezy Point, Queens County, 12 breeding adults were reported in 1989 and 86 in 1990.

5.456 Black skimmers nest on coastal beaches, sandbars, islands, bays, inlets, pebbly sand flats, and spoil banks. They prefer open sandy areas with little vegetation (NYSDEC 1993k). In New York, nesting areas are open, sandy, high-beach areas on the Long Island shore.

5.457 The nest consists of a scrape in the sand on open beach above the high tide line (Harrison 1975). The single clutch contains 4-5 eggs. Migration begins in September as soon as the young are able to fly (NYSDEC 1993k).

5.458 Black skimmers have been negatively affected by loss of habitat as a result of intrusion of humans into beach areas (Safina 1981, NYSDEC 1993k). Development near beach areas and increased recreational use reduces the amount of available breeding habitat (Bent 1963).

Yellow-crowned Night Heron

5.459 The yellow-crowned night heron is listed as an endangered species in New Jersey, and is protected but is not listed in New York. The bird was first reported nesting on Long Island in 1938 (Bull 1974), and was regarded as a rare to casual visitor to the New York City area (Peterson 1988b). Although no yellow-crowned night heron nests have been confirmed on any of the islands of the Harbor Herons Complex, some evidence exists that the species nests on several islands in the Harbor (Kerlinger 1999).

5.460 Yellow-crowned night herons usually nest in low coastal shrublands and on dredge spoil islands, as well as in dry woodlands near swamps, rivers, and harbors (Bull 1974). The nest consists of a platform of sticks set 5 to 12 ft above ground in shrubs, or 15 to 60 ft above ground in mature forest habitats (Bull 1974). The birds are restricted to coastal habitats, with the highest densities occurring in areas with extensive salt marshes (Peterson 1988b).

5.461 Yellow-crowned night herons forage for crustaceans, particularly fiddler crabs (Kushland

1978). They are found foraging in the low marsh, along the edges of ditches and creeks.

Piping Plover

5.462 The piping plover is listed as a Federally threatened species and as endangered by the states of New York and New Jersey. Small shorebirds, they have been found to breed along the Atlantic coast from Newfoundland to South Carolina. No piping plover nesting sites have been reported in the New York and New Jersey Harbor, although nesting has been reported just east of the project area (Andrle and Carroll 1988). Thirty-three pairs of piping plovers have been reported at the Breezy Point component of the Gateway National Recreation Area and five beach-nesting colonies have been reported at Sandy Hook (USACE-NYD 1999d).

5.463 Piping plovers nest above the high-tide mark on beaches, sandflats, gently sloping foredunes, and washover fans. Typically, a single brood is fledged per season, but breeding pairs may re-nest if broods or nests are lost. The piping plover feeds on adjacent intertidal areas such as the lower beach face, moist washover fans, mudflats, and along debris lines.

Peregrine Falcon

5.464 The peregrine falcon is listed as endangered in the states of New York and New Jersey. Due to reproductive failures caused by the broad-spectrum pesticide DDT, peregrine falcons experienced a population decline from the 1940s to the 1960s (Andrle and Carroll 1988). Federally listed as endangered in 1970, peregrines have since been de-listed (64 FR 46542). In 1970, peregrine falcons were considered extirpated from the eastern United States. Introduction began in 1974, and 12 peregrine pairs are now nesting successfully on bridges, buildings, and nest towers in the New York and New Jersey Harbor area. USFWS reports that the peregrine falcon is nesting on Harbor bridges, including the Goethals Bridge, the General Pulaski Skyway over the Hackensack River, the Bayonne Bridge over the Kill Van Kull, the Outer Bridge, and the Verrazano Narrows Bridge (USFWS 1997). The New York Bight also provides important migratory and wintering habitat for peregrine falcons that nest in Canada.

5.465 Peregrine falcons hunt from perches offering good views of foraging areas, taking prey from over land or water. In the project area, where few natural hunting perches occur, they hunt from high structures, including building ledges, bridges, cranes, cables, and towers. Their prey includes shorebirds, waterfowl, and passerines (Staples 1998). They may travel up to 18 miles in search of prey and seek feeding opportunities in marshes and riparian areas where prey species concentrate. Due to their position in the food chain, peregrine falcons are sensitive to the effects of bioaccumulating environmental contaminants such as dioxins and PCBs.

Northern Harrier

5.466 The northern harrier or marsh hawk is listed as an endangered species in New Jersey and as threatened in New York. The most common nesting and foraging sites are cattail marshes, grassy meadows, and cultivated fields, with occasional nesting in upland fields (Bull 1985, NYSDEC 1994b). Nests, ranging from flimsy to well made, are constructed of sticks, straw, and

grasses by the male each year and are placed on the ground, or, in wet areas, 1-2 feet above the ground.

5.467 During migration, the northern harrier is seen hunting alone or in small groups over cultivated fields in farming areas, as well as over marshes and meadows (Bull 1985). Wintering areas include the lower Hudson River Valley, Long Island, Staten Island, the Finger Lakes region (NYSDEC 1994b), and coastal marshes of New Jersey.

5.468 Loss of habitat is the most critical issue facing northern harriers in the New York and New Jersey Harbor area. Currently, populations and habitat areas are on the decline. Populations are found in the same areas as historical records indicate, but their numbers have decreased (NYSDEC 1994b).

American Bittern

5.469 The American bittern (*Botaurus lentiginosus*) is listed as endangered in New Jersey and as a species of special concern in New York (NYSDEC 19931). The American bittern has been observed on Long Island (Bull 1985), and is considered a possible breeder in the study area (Eaton 1988). Wintering grounds occur along southern coastal plains where temperatures remain above freezing and waters remain open (NYSDEC 19931).

5.470 American bittern breed in fresh, salt or brackish marshes, beaver ponds, kettle-hole bogs and shrub swamps among tall emergent vegetation such as cattail, rushes, and sedge (NYSDEC 1993). They arrive at breeding areas between 5 and 15 April in southeastern New York (Eaton 1910). The nest is a platform constructed of reeds, sedges, cattail, or other available vegetation, lined with fine grasses (Gibbs and Melvin 1992b). It is usually found on the ground or on a tussock surrounded by water, with a dense overhead cover of vegetation. Females lay and incubate 4-5 eggs (Eaton 1988).

Black-crowned Night Heron

5.471 The black-crowned night heron is listed as a threatened species in New Jersey. It was first confirmed breeding on Shooters Island in 1974 (HHR 1990) and on Pralls Island in 1981. Generally breeding in mixed colonies, black-crowned night herons may place their nests up to 60 ft above the ground in the middle and upper layers of tall trees (Bull 1974; Andrle and Carroll 1988). Constructed of reeds and branches, nests may be found in dense thickets of sumac and wild cherry (Andrle and Carroll 1988).

5.472 The black-crowned night heron takes a variety of prey, both invertebrate and vertebrate (Kushlan 1978). Killifish, eel, herring, and sunfish are primary fish species taken in the New York City region (Allen 1938 cited in Palmer 1962). Similar to the snowy egret in feeding behavior (Kushlan 1976), black-crowned night herons normally forage after sunset and may therefore avoid competition (Willand 1977).

5.473 Black-crowned night herons may travel some distance to find suitable foraging habitat,

depending on tide levels, prey availability, and competition from other species. Custer and Osborn (1978) reported mean flight distances of black-crowned night herons from the nesting colony to foraging areas of 1.2 miles at low tide and 2.8 miles at high tide. The maximum flight distance recorded was 4.5 miles.

Osprey

5.474 The osprey is listed as a threatened species in New Jersey and as a special-concern species in New York. Due to the indirect effects of chemicals such as DDT, dieldrin, and chlordane, drastic population declines occurred during the 1960s (Clark 1995). Adults commonly experienced reproductive failure after eating contaminated fish. Populations have appeared to recover from pesticide contamination, increasing substantially over the last 10 years (Spitzer et al. 1978)

5.475 Osprey may be found along rivers, lakes, and coasts. Nests are typically built over or adjacent to water, and on trees, towers, or or poles (Poole 1989, Clark and Jenkins 1993). Clutch size averages 3-4 eggs, and both parents participate in brooding. The male supplies his mate with food from the courtship through the brooding stage (Ehrlich et al. 1988).

5.476 Osprey generally forage in an area 1 to 3 miles from the nest, but range farther if necessary. Osprey feed on a variety of fish species, depending on availability. Menhaden and white perch are among their preferred prey species (Steidl et al. 1991).

Short-eared Owl

5.477 Once common in the northeast, short-eared owl nesting and wintering populations have declined severely in recent years (Sutton 1995). The species is listed as endangered in both New Jersey and New York.

5.478 Short-eared owls are ground nesters; they congregate and roost communally in the winter in a variety of habitats, including abandoned dumps, old fields, small evergreen groves, bayberry thickets, and dunes (Clark 1975; Bosakowski 1986). Females lay 4-7 eggs, depending on the food supply and prey density (Korpimaki and Norrdahl 1991).

5.479 Short-eared owls select high marsh, where saltmeadow cordgrass abounds, for hunting and roosting. Areas dominated by saltmarsh cordgrass are less preferred (Sutton 1995). This species of owl feeds predominantly on microtine rodents such as the meadow vole (Melvin et al. 1989). Rodent populations may play a role in attracting wintering owls to an area.

Barred Owl

5.480 The barred owl (*Strix varia*)is listed as a threatened species in New Jersey. Barred owls tend to remain in localized areas, moving about most often in late fall and winter. It is at this time that largest concentrations may be found (Bull 1974). Once abundant on Staten Island, the barred owl is now more numerous on the mainland.

5.481 Barred owls nest in tree cavities, in old hawk or squirrel nests, in areas bordering streams and marshes, and in open woody areas (Peterson 1988c). Barred owls produce only one brood each year. Clutches of 2 to 4 eggs are typically laid from March through May. Eggs are incubated from 28 to 33 days, and the nestling period lasts from 28 to 35 days (DeGraaf and Rudis 1986).

5.482 Barred owls are typically nocturnal hunters, but will hunt during daylight hours when a brood is present (DeGraaf and Rudis 1986). Major food items include mice and other small mammals, frogs, birds, insects, and crayfish.

Reptiles

5.483 Threatened or endangered reptiles that may occur in the project area include four species of sea turtles: the Kemp's ridley, the green (*Chelonia mydas*), the leatherback (*Dermochelys coriacea*), and the loggerhead. [The first three are listed as endangered, Federal list and both the New York and New Jersey lists; the loggerhead is listed as threatened, Federal and New York lists, and as endangered on the New Jersey list.] Within the past three decades the regular occurrence of these four species in northeastern U.S. waters during the warmer months has been documented (Bleakney 1965, Brongersma 1972, Lazell 1980, Shoop 1980, Morreale and Standora 1994). These findings, however, were not completely accepted by the scientific community. It was argued that the northeast was an unsuitable environment for Kemp's ridley turtles (Hendrickson 1980) and, by implication, for other species. This argument was supported by the fact that many of the turtles in both recent and historical accounts had been found dead or moribund from apparent hypothermia in early winter (Murphy 1916, Latham 1969, Meylan and Sadove 1986, Morreale, et al. 1992). Other researchers surmised that young sea turtles are swept occasionally into inshore waters of the northeast by anomalous currents, eddies, and meanders of the Gulf Stream, whereupon they may sometimes find their way back to southern waters (Carr 1980: 1986, Meylan 1986, Ogren 1989, Collard and Ogren 1990).

5.484 Current hypotheses identify some New England, New York, and New Jersey waters as critical habitat for loggerhead, Kemp's ridley, and leatherback turtles during warmer months (Lazell 1980, Shoop and Kenney 1992, Morreale and Burke 1997). Extensive long-term studies in the New York and New Jersey Harbor have substantiated this through detailed examination of demographics, feeding ecology, and behavior of the sea turtles that appear in northern coastal waters (Morreale and Standora 1998). With the exception of a few leatherbacks, the turtles in nearshore waters are small juveniles. The loggerhead is the most abundant, followed by the Kemp's ridley. These two species, along with a few green turtles, move into harbors and estuarine waters, while the leatherback turtles remain along the coast and are rarely seen in embayments.

5.485 The young turtles appear each year in early summer and remain for up to several months. Loggerheads and Kemp's ridleys feed heavily on a diet composed mainly of crabs and, to a lesser extent, mollusks (Burke 1990, Morreale and Standora 1994), while green turtles feed mainly on algae (Burke et al. 1992). The leatherbacks feed primarily on jellyfish in the open

waters along the coastline and offshore. The abundant resources in the nearshore environment result in extremely high measured growth of the juveniles before they slow down their activity in the fall. As temperatures decline, turtles begin to move toward open ocean waters. The general trend for the southward-migrating turtles is to leave the New York Bight in October, passing the Virginia border by the first week of November in their migration southward.

5.486 There has been some evidence of sea turtle occurrence in the New York and New Jersey Harbor and surrounding waters. It has been difficult, however, to verify their presence. No studies are being conducted, and the fishing industry is not of the sort that normally captures turtles as by-catch. Some dead individuals wash up on shore along Staten Island, Coney Island, and Rockaway each summer. These carcasses are often of large turtles, much larger than the expected size of the juveniles that normally would be anticipated in nearshore waters.

5.487 Additional data are available from several relatively recent Harbor sampling studies where sea turtles might have been expected to be encountered. USFWS used a variety of gill nets, fyke nets, and otter trawls to extensively sample Upper New York Bay (USFWS Planning and Aid Report 1985; 1986). No turtles were encountered. Other studies in both Upper and Lower New York Bays revealed no sea turtles after extensive sampling and monitoring (Woodhead et al. 1987).

5.488 Consultations regarding the impacts of the identified alternatives on listed species will be coordinated with the appropriate state and Federal agencies.

Fish

Shortnose Sturgeon (Acipenser brevirostrum)

5.489 The shortnose sturgeon was among the original species listed (in 1967) by the Federal government as endangered (USFWS 1997). It is still listed Federally, and listed as endangered in New Jersey and New York as well. The shortnose sturgeon ranges from the St. John River, New Brunswick, to the St. Johns River, Florida (Grunchy and Parker 1980). In the Hudson River, the species regularly occurs from Manhattan upriver to the Federal Dam at Troy, New York. Some adults may leave the Hudson River over the summer and move into the project area, but most remain in the Hudson River. They migrate upriver in the fall to overwinter around Kingston (Dovel 1992).

5.490 Shortnose sturgeon spawn between February and May. In the Hudson River, shortnose sturgeon move upstream as far as the reach between River Miles 124 (Coeymans) and 153 (Troy) to spawn. The demersal eggs become strongly adhesive after about 20 minutes, becoming attached to rocks, weeds, and other submerged objects (Gilbert 1989). Shortnose sturgeon grow rapidly at first, slowing by the third year. Average adult length is 33-in (Greeley 1937). Males tend to grow slightly faster than females. Sexual maturity is not reached until 8-10 years of age. The maximum reported age of shortnose sturgeon in the Hudson river is 37 years.

5.491 The diet of the shortnose sturgeon includes insects, crustaceans, mollusks, annelids,

polychaete worms, and small benthic fishes (Dadswell 1984, USFWS 1997).

Invertebrates

Northeastern Beach Tiger Beetle (Cicindela d. dorsalis)

5.492 The Federally listed (threatened) northeastern beach tiger beetle is listed as endangered in New Jersey. The last sighting occurred in the Sandy Hook quadrangle, although the date of the sighting was not recorded (NJDEP 1999a). In 1995, new and second-year larvae were transplanted to the Sandy Hook component of the Gateway National Recreation Area in New Jersey (USACE-NYD 1999b).

5.493 The tiger beetle requires an undisturbed sand habitat during the larval phase of its development, which lasts two years. One of the primary causes of its decline is trampling by foot traffic and off-road vehicles. Adults emerge from sand burrows to mate and lay eggs during midsummer months, coinciding with peak foot and off-road vehicle traffic along beaches. Northeastern beach tiger beetles prey on amphipods, flies, and other arthropods, and are scavengers on dead fish and crustaceans.

Plants

5.494 There are 126 plant species listed as threatened or endangered by either the Federal government or by the governments of New York or New Jersey. Many of these species were last found during the latter part of the nineteenth century or the early part of the twentieth century. Of the 126 species listed, the following species have been identified by New York and New Jersey Natural Heritage database searches as likely to occur in the project area based on their habitat requirements or date and location of sighting.

Small Whorled Pogonia (Isotria medeoloides)

5.495 The small whorled pogonia was listed (Federally) as an endangered species in 1982. It has since been reduced to threatened status. Only one individual has been recorded in New York State in the last 50 years. A member of the orchid family, the plant is found in a variety of habitats, including deciduous or mixed coniferous/deciduous woodlands in dry to swampy situations (USFWS 1997). It is often associated with limestone, but is sometimes found in acidic soils. These plants are noted for long periods of dormancy, and appear above ground only irregularly. Colonies often fluctuate in apparent size from year to year, and the species may not be evident for years at a time (Mitchell and Sheviak 1983).

Seabeach Amaranth (Amaranthus pumilus)

5.496 The seabeach amaranth is also a threatened plant species (Federal list), mostly found in tidal areas or wetlands, although sometimes in non-wetland areas. It is an annual forb, native to the northeast (USFWS 1988). In the New York and New Jersey port area, populations of seabeach amaranth have been recorded along a stretch of barrier beach at Arverne, on the

Rockaway Peninsula, east of Breezy Point. Nearby populations occur along the south shore of Long Island, and historically along New Jersey beaches, although the last documented occurrence of seabeach amaranth along the New Jersey coastline was in 1913 (USACE-NYD 1999d).

5.497 Due to its high dispersal and colonization ability, seabeach amaranth thrives in newly disturbed habitats. It needs extensive areas of barrier islands, beaches, and inlets functioning in a relatively natural and dynamic manner, allowing the plant to move to suitable habitats as they become available. Germination takes place from April to July, and flowering occurs from July through the fall. Seed production starts in the summer, peaks in September, and continues until the death of the plant in the fall (USFWS 1997).

5.498 Shoreline stabilization efforts appear to be the primary reason for the extirpation of many populations of seabeach amaranth. Hard shoreline structures are particularly destructive. Even soft shoreline stabilization techniques such as sand fencing and planting of dune grasses may threaten existing populations.

Saltmarsh Bulrush (*Scirpus maritimus*)

5.499 The saltmarsh bulrush is an endangered species in both New York and New Jersey. A perennial, and member of the sedge family, it is found in coastal marshes (either brackish or saline), often near the upper edge of salt marshes. It was last identified in New Jersey in 1971. The saltmarsh bulrush has scaly brown flower clusters, and, since it spreads by rhizomes, it is usually found in clusters (Brown 1979).

Seabeach Knotweed (*Polygonum glaucum*)

5.500 Seabeach knotweed is listed as an endangered species in New Jersey. Last identified in 1993, it is found mostly in non-wetlands, but has also been identified in wetland areas. The seabeach knotweed is an annual forb, native to the northeast (USFWS 1988).

Red Goosefoot (*Chenopodium rubrum*)

5.501 The red goosefoot is a freshwater plant listed as endangered in New Jersey. It is almost always found in wetland areas. The red goosefoot is an annual forb, native to the northeast (USFWS 1988).

Coast Flatsedge (*Cyperus polystachyos*)

5.502 The coast flatsedge is a listed as an endangered species in New Jersey. It has been noted to occur within the Raritan Bay–Sandy Hook Bay Habitat Complex (USFWS 1999). An annual, it belongs to the sedge family and may be found in wet soil, mostly near coastal areas (Gleason and Cronquist 1991).

Ecological Resources of the Selected Alternative

5.503 The following ecological resources were used to characterize the habitats of the Recommended Plan navigation pathways: (1) aquatic habitats, (2) wetlands, (3) EFH, (4) significant habitats, (5) aquatic species, (6) threatened and endangered species, and (7) unique species. The habitat resources of the selected pathway, which includes the Ambrose, Anchorage, Kill Van Kull, Arthur Kill, Newark Bay, Port Jersey, and Bay Ridge Channels that are described in Section 2 (see "Channel Deepening Plans"), will be described in this section.

Aquatic Habitats

5.504 Aquatic habitats of the Recommended Plan pathways include both marine and estuarine habitats, and vary in depth from shallow intertidal areas to deep-water channels. The aquatic habitats are described by channel below:

Ambrose Channel

5.505 The Ambrose Channel and vicinity is characterized by marine, deep-water channel habitat.

Anchorage Channel

5.506 The Anchorage Channel and vicinity is characterized by estuarine habitat in the Upper New York Harbor reach. The currently maintained navigation channel consists of deep-water channel habitat.

Kill Van Kull Channel

5.507 The Kill Van Kull Channel and vicinity is characterized by estuarine and deep-water channel habitat along the currently maintained navigation pathway. Shallow-water habitats, including intertidal mudflats with *Spartina* fringe, low and high salt marsh areas, and gravel/sand beaches, occur along the Staten Island and New Jersey shorelines.

Arthur Kill Channel to Howland Hook

5.508 The Arthur Kill Channel to Howland Hook and vicinity is characterized by estuarine and deep-water channel habitat along the currently maintained navigation pathway. Shallow-water habitats, including intertidal shore zones, littoral and sublittoral zones, wetlands, intertidal mudflats, low (naturally occurring and planted) salt marshes, high salt marshes, gravel/sand beaches, and tidal creeks (Old Place Creek and Morses Creek) occur along the Staten Island and New Jersey shorelines.

Newark Bay Channel, South Elizabeth Channel, and Elizabeth Channel

5.509 The Newark Bay Channel to the Elizabeth Port Authority Marine Terminal and vicinity is characterized by estuarine and deep-channel habitats along the currently maintained navigation pathway. Extensive shoal areas occur in the vicinity. Other shallow-water habitats include littoral and sublittoral zones, intertidal mudflats, and sand beaches. Extensive unvegetated mudflats are located south of the South Elizabeth Channel, west of the Newark Bay Channel, and north of the Arthur Kill Channel.

Port Jersey Channel

5.510 The Port Jersey Channel and vicinity is characterized by estuarine and deep-water channel habitat along the currently maintained navigation pathway. Extensive shoal areas occur in the Jersey Flats. Other shallow-water habitats include intertidal mudflats, gravel/sand beaches, and low salt marsh areas.

Bay Ridge Channel

5.511 The Bay Ridge Channel and vicinity is characterized by estuarine and deep-water channel habitat along the currently maintained navigation pathway.

Wetlands

5.512 Intertidal wetlands that are part of the ecological resources of the selected alternative are identified by channel below:

Ambrose Channel

5.513 No intertidal wetlands are associated with the Ambrose Channel.

Anchorage Channel

5.514 No intertidal wetlands are associated with the Anchorage Channel.

Kill Van Kull Channel

5.515 Intertidal mudflats with *Spartina* fringe and low and high salt marsh areas are associated with the Kill Van Kull Channel.

Arthur Kill Channel to Howland Hook

5.516 Large, vegetated intertidal wetlands are located in the Arthur Kill corridor on the Staten Island and New Jersey shores. Large complexes of intertidal wetlands are also located along the

Arthur Kill in the vicinity of the project area, east of Howland Hook at Port Ivory (Arlington Marsh), and near the Goethals Bridge bordering Old Place Creek. In addition, two significant freshwater marshes are located on Staten Island: Mariners Marsh near Port Ivory and Goethals Bridge Pond near Old Place Creek.

Newark Bay Channel

5.517 Intertidal mudflats and a significant *Spartina* and reed grass wetland are associated with the Newark Bay Channel.

Port Jersey Channel

5.518 Intertidal mudflats and low salt marsh areas are associated with the Port Jersey Channel.

Bay Ridge Channel

5.519 No intertidal wetlands are associated with the Bay Ridge Channel.

Essential Fish Habitat

5.520 Essential fish habitat (EFH) has been designated in the selected alternative project area for several species and life stages, and is identified by channel below:

Ambrose Channel

5.521 EFH has been designated for the following species in the vicinity of the Ambrose Channel: red hake (eggs, larvae, juveniles, and adults); winter flounder (eggs, larvae, juveniles, and adults); windowpane flounder (eggs, larvae, juveniles, and adults); Atlantic herring (larvae, juveniles, and adults); bluefish (eggs, larvae, juveniles, and adults); butterfish (juveniles and adults); Atlantic mackerel (juveniles and adults); summer flounder (larvae, juveniles, and adults); scup (eggs, larvae, juveniles, and adults); black sea bass (juveniles and adults); king mackerel (*Scomberomorus cavalla*) (eggs, larvae, juveniles, and adults); Spanish mackerel *(S. maculatus)* (eggs, larvae, juveniles, and adults); cobia (*Rachycentron canadus*) (eggs, larvae, juveniles, and adults); sand tiger shark (*Odontaspis taurus*) (larvae); dusky shark (*Carcharhinus obscurus*) (larvae and juveniles); and sandbar shark (*C. plumbeus*) (larvae, juveniles, and adults).

Anchorage Channel

5.522 EFH has been designated for the following species in the vicinity of the Anchorage Channel: red hake (eggs, larvae, and juveniles); winter flounder (eggs, larvae, juveniles, and adults); windowpane flounder (eggs, larvae, juveniles, and adults); Atlantic herring (larvae, juveniles, and adults); bluefish (juveniles and adults); butterfish (larvae, juveniles, and adults); summer flounder (larvae, juveniles, and adults); scup (eggs, larvae, juveniles, and adults); black sea bass (juveniles and adults); king mackerel (eggs, larvae, juveniles, and adults); Spanish

mackerel (eggs, larvae, juveniles, and adults); cobia (eggs, larvae, juveniles, and adults); sand tiger shark (larvae); dusky shark (larvae and juveniles); and sandbar shark (larvae and adults).

Kill Van Kull Channel

5.523 EFH has been designated for the following species in the vicinity of the Kill Van Kull Channel: red hake (eggs, larvae, and juveniles); winter flounder (eggs, larvae, juveniles, and adults); windowpane flounder (eggs, larvae, juveniles, and adults); Atlantic herring (larvae, juveniles, and adults); bluefish (juveniles and adults); butterfish (larvae, juveniles, and adults); summer flounder (larvae, juveniles, and adults); scup (eggs, larvae, juveniles, and adults); black sea bass (juveniles and adults); king mackerel (eggs, larvae, juveniles, and adults); Spanish mackerel (eggs, larvae, juveniles, and adults); cobia (eggs, larvae, juveniles, and adults); sand tiger shark (larvae); dusky shark (larvae and juveniles); and sandbar shark (larvae and adults).

Arthur Kill to Howland Hook Channel

5.524 EFH has been designated for the following species in the vicinity of the Arthur Kill Channel to Howland Hook: red hake (eggs, larvae, and juveniles); winter flounder (eggs, larvae, juveniles, and adults); windowpane flounder (eggs, larvae, juveniles, and adults); Atlantic herring (larvae, juveniles, and adults); bluefish (juveniles and adults); butterfish (larvae, juveniles, and adults); summer flounder (larvae, juveniles, and adults); scup (eggs, larvae, juveniles, and adults); king mackerel (eggs, larvae, juveniles, and adults); Spanish mackerel (eggs, larvae, juveniles, and adults); cobia (eggs, larvae, juveniles, and adults); and sandbar shark (larvae and adults).

Newark Bay Channel

5.525 EFH has been designated for the following species in the vicinity of the Newark Bay Channel to the Elizabeth Port Authority Marine Terminal: red hake (eggs, larvae, juveniles, and adults); winter flounder (eggs, larvae, juveniles, and adults); windowpane flounder (eggs, larvae, juveniles, and adults); Atlantic herring (larvae, juveniles, and adults); bluefish (eggs, larvae, juveniles, and adults); butterfish (larvae, juveniles, and adults); summer flounder (larvae, juveniles, and adults); scup (eggs, larvae, juveniles, and adults); black sea bass (juveniles and adults); king mackerel (eggs, larvae, juveniles, and adults); Spanish mackerel (eggs, larvae, juveniles, and adults); cobia (eggs, larvae, juveniles, and adults); sand tiger shark (larvae); dusky shark (larvae and juveniles); and sandbar shark (larvae, juveniles, and adults).

Port Jersey Channel

5.526 EFH has been designated for the following species in the vicinity of the Port Jersey Channel: red hake (eggs, larvae, juveniles, and adults); winter flounder (eggs, larvae, juveniles, and adults); windowpane flounder (eggs, larvae, juveniles, and adults); Atlantic herring (larvae, juveniles, and adults); bluefish (eggs, larvae, juveniles, and adults); butterfish (larvae, juveniles, and adults); summer flounder (larvae, juveniles, and adults); scup (eggs, larvae, juveniles, and

adults); black sea bass (juveniles and adults); king mackerel (eggs, larvae, juveniles, and adults); Spanish mackerel (eggs, larvae, juveniles, and adults); cobia (eggs, larvae, juveniles, and adults); sand tiger shark (larvae); dusky shark (larvae and juveniles); and sandbar shark (larvae, juveniles, and adults).

Bay Ridge Channel

5.527 EFH has been designated for the following species in the vicinity of the Bay Ridge Channel: red hake (eggs, larvae, and juveniles); winter flounder (eggs, larvae, juveniles, and adults); windowpane flounder (eggs, larvae, juveniles, and adults); Atlantic herring (larvae, juveniles, and adults); bluefish (juveniles and adults); butterfish (larvae, juveniles, and adults); summer flounder (larvae, juveniles, and adults); scup (eggs, larvae, juveniles, and adults); black sea bass (juveniles and adults); king mackerel (eggs, larvae, juveniles, and adults); Spanish mackerel (eggs, larvae, juveniles, and adults); cobia (eggs, larvae, juveniles, and adults); sand tiger shark (larvae); dusky shark (larvae and juveniles); and sandbar shark (larvae and adults).

Significant Habitats

5.528 Significant habitats have been designated by USFWS (1997) in the New York Bight watershed. They are described by channel below:

Ambrose Channel

5.529 Swinburne and Hoffman Islands, located in the Lower New York Bay, are part of the Harbor Herons Complex that is designated as significant habitat and may be affected by dredging operations in the Ambrose Channel.

Anchorage Channel

5.530 No significant habitat is located in the vicinity of the Anchorage Channel.

Kill Van Kull Channel

5.531 Both Shooters Island, located at the junction of the Kill Van Kull and Arthur Kill, and the tidal and freshwater wetlands located in the northwest quadrant of Staten Island are part of the Harbor Herons Complex, designated as significant habitat by USFWS (1997), that may be affected by dredging the Kill Van Kull Channel.

Arthur Kill Channel to Howland Hook

5.532 Shooters Island, located at the junction of the Kill Van Kull and Arthur Kill, is part of the Harbor Herons Complex, designated as significant habitat by USFWS (1997), that may be affected by dredging operations in the vicinity of the island.

Newark Bay Channel

5.533 No significant habitat is located in the vicinity of the Newark Bay Channel.

Port Jersey Channel

5.534 No significant habitat is located in the vicinity of the Port Jersey Channel.

Bay Ridge Channel

5.535 No significant habitat is located in the vicinity of the Bay Ridge Channel.

Finfish and Shellfish

5.536 Site-specific sampling was carried out from October 1998 through September 1999 for the purpose of collecting information on the seasonal use and distribution of resident and migrant fish and shellfish species in the selected alternative navigation channels. Finfish species distribution within the estuary was generally similar between sampling areas (see Section 5.4, "Aquatic Species"), although CPUE was highest for several species in Newark Bay during October, December, February, and March. Bay anchovy, white perch, striped bass, and winter flounder were among those species collected in large numbers. Most of these fish were collected during only one trawl sample. Bay anchovy and white perch exhibit a tight schooling behavior, which often results in large individual catches. Relatively large catches of winter flounder in Newark Bay may also reflect winter flounder movement to spawning areas in Newark Bay. CPUE during December was also relatively high at Arthur Kill/Kill Van Kull Stations compared to other stations in the project area. See Appendix B-1.2 for the CPUE of finfish collected among sample areas in the selected alternative navigation channels.

5.537 The distribution of shellfish species within the estuary was generally similar between sampling areas, with the dwarf surfclam the most prevalent species throughout the selected alternative navigation channels. Gammarid amphipods, tellinids, and slipper shells were also widespread throughout the selected alternative channels. Blue crabs were the most prevalent crab species. Tables in Appendix B-1.2 list the seasonal CPUE of shellfish using two sampling techniques (crab dredge and otter trawl) for the sampling stations in the selected alternative navigation channels.

Benthos

5.538 Polychaete worms, namely *Scoloplos benedicti* and *Scoloplos* sp., are the most abundant taxa throughout the selected alternative navigation pathways. Two bivalve mollusks, the dwarf surfclam and the softshell clam, are also abundant in the Newark Bay, Arthur Kill, Kill Van Kull, and Ambrose Channels. Other abundant species include tubificid worms in the Anchorage and Bay Ridge Channels, and the amphipod, *Ampelisca abdita*, in the Ambrose Channel.

Threatened and Endangered Species

5.539 With the possible exception of the shortnose sturgeon, threatened and endangered species in the Harbor do not reside in the channels that have been selected for deepening. The shortnose sturgeon has shown a preference for deep-channel areas and has been documented in the Harbor. Its preference, however, for less saline waters typically keeps the species further up the Hudson River.

5.540 It is possible that some threatened or endangered marine mammals, including the fin whale and humpback whale, may on rare occasions be found in the channels. These species are migratory and rare in the study area. Their presence in the area would be only temporary.

5.541 The peregrine falcon, listed as endangered in both New York and New Jersey, may feed near the channels. Nesting peregrine falcons have been sighted at the Verrazano Narrows, Goethals, and Bayonne Bridges. The bird, therefore, may be feeding in the vicinity of the Ambrose, Howland Hook, or Arthur Kill Channels.

Unique Species

5.542 For the purposes of this study, the term "unique species" refers to a species that occurs in only one of the seven channel areas to be deepened. This determination was made solely by examination of the results of sampling data that were obtained on a monthly basis from October 1998 through July 1999. Unique species are listed by channel below.

Ambrose Channel

5.543 The short-finned squid was the only project-area species found to be unique in the Ambrose Channel.

Anchorage Channel

5.544 No unique species were recorded in the Anchorage Channel.

Kill Van Kull Channel

5.545 The following species were found to be unique to the Kill Van Kull Channel: American eel, hickory shad, northern searobin (*Prionotus carolinus*), and wentletrap (*Epitonium* sp.).

Arthur Kill to Howland Hook

5.546 No unique species were recorded in the Arthur Kill Channel to Howland Hook.

Newark Bay Channel

5.547 The following species were found to be unique to the Newark Bay Channel: Acadian hermit crab, bubble shell (*Retusa* sp.), convex slipper snail, gizzard shad, and thick-lipped drill.

Port Jersey Channel

5.548 The following species were found to be unique to the Port Jersey Channel: American sand lance, lined seahorse (*Hippocampus erectus*), naked goby (*Gobiosoma bosc*), fourspot flounder (*Paralichthys oblongus*), and pollock (*Pollachius virens*).

Bay Ridge Channel

5.549 Only the striped cusk-eel (*Ophidion marginatum*) was found to be unique to the Bay Ridge Channel.

5.5 Affected Environment – Landside Elements

5.550 This section describes the upland (landside) terminal sites at which productivity improvements or conversion of non-container uses to container facilities will be implemented. These improvements will occur to accommodate an anticipated increase in goods entering the port by the year 2040. This expansion in port commerce is expected to occur regardless of whether the proposed channel improvements are implemented. Environmental conditions at each of the four sites are described below.

Howland Hook Marine Terminal – Existing Conditions

5.551 The Howland Hook project site is illustrated in Figure 5.4-1. The project site and study area is situated in the Howland Hook section of Staten Island, New York, which is co-terminous with Richmond County. The project site includes the Howland Hook Marine Terminal.

5.552 The Howland Hook project study area encompasses a zone extending approximately one-quarter of a mile around the perimeter of the project site limits, including waterfront areas along the Kill Van Kull and the Arthur Kill, surrounding commercial facilities, vacant industrial facilities, transportation corridors and facilities, and portions of Arlington Marsh and Mariners Marsh. The project study area is bounded by the Kill Van Kull to the north, the terminus of Omaha Street and Mariners Marsh to the east, a railway associated with Arlington Yards and Old Place Creek to the south, and the Arthur Kill to the west. Figure 5.5-1 depicts both the project site and study area.

Port Newark/Elizabeth Port Authority Marine Terminal – Existing Conditions

5.553 The Port Newark Terminal and Elizabeth Port Authority Marine Terminal project site

(Figure 5.4-2) is situated in the City of Newark (Essex County) and City of Elizabeth (Union County), New Jersey. The project site includes the Elizabeth Port Authority Marine Terminal and a portion of the Port Newark Marine Terminal. Most of the project site serves as container terminal area. The remaining areas are dedicated to other port-related terminal activities.

5.554 The Port Newark/Elizabeth Port Authority Marine Terminal project study area encompasses a zone extending approximately one-quarter mile around the perimeter of the project site limits, including the industrial waterfront along Newark Bay and surrounding commercial/industrial facilities, and transportation corridors and facilities. In addition, a section of the Arthur Kill's Elizabethport Reach, situated southwest of the project site, has been included in the project study area. The Elizabethport section located within the study area includes industrial, commercial, residential and open space/recreation uses. The study area is bounded by the I-78/New Jersey Turnpike Extension to the north, Newark Bay to the east and south, Elizabethport to the southwest, and the New Jersey Turnpike and Newark International Airport to the west. The Kill Van Kull is situated south-southeast of the study area and both the Elizabeth Channel and the Port Newark Channel are included within the study area. Figure 5.5-2 depicts both the project site and study area.

Port Jersey/MOTBY – Existing Conditions

5.555 The Port Jersey/MOTBY site is illustrated in Figures 5.5-3 and 5.5-3a. The project site is situated in the Cities of Bayonne and Jersey City (Hudson County), New Jersey. The 310-acre project site includes the western portion of the Military Ocean Terminal Bayonne (MOTBY), the 100-acre Port Jersey Marine Terminal, including the Global Marine Terminal, and the area occupied by Northeastern Auto Marine Terminal, Inc. (NEAT).

5.556 The Port Jersey/MOTBY project study area encompasses a zone extending approximately one-quarter mile around the perimeter of the project site limits, including the industrial waterfront along the Hudson River as well as surrounding commercial and industrial facilities. The project study area is bounded by Caven Point and the Claremont Channel to the north; Upper New York Bay to the east; South Channel and the predominantly industrial Constable Hook section of Bayonne to the south; and transportation corridors and commercial and industrial properties to the west. The Port Jersey Channel and the Greenville Channel are included within the project study area (Figure 5.5-4).

South Brooklyn Marine Terminal (Sunset Park)

5.557 The 100-acre South Brooklyn Marine Terminal project site is situated entirely within the Sunset Park section of Brooklyn, New York (Figure 5.5-5). The site currently functions as a cocoa bean break-bulk facility and a vehicle storage area.

5.558 The South Brooklyn project study area encompasses a zone extending approximately one-quarter mile around the perimeter of the project site limits, including the waterfront area along Gowanus Bay, surrounding commercial/industrial facilities, and surrounding residential

areas (generally east of the project site), as well as transportation corridors. The project study area is bounded by Gowanus Bay to the north, 4th Avenue to the east, 53rd Street (just south of Bush Terminal) to the south, and Gowanus Bay and New York Harbor to the west. The Gowanus Expressway extends north/south through the eastern portion of the study area. Figure 5.5-5 depicts both the project site and study area.

5.6 Cultural Resources

5.559 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 study. Statutes and regulations governing the identification, protection, and preservation of these resources include the National Historic Preservation Act of 1966 (NHPA), as amended through 1992; the National Environmental Policy Act of 1969; Executive Order 11593; the regulations implementing Section 106 of the NHPA (36 CFR § 800, Protection of Historic Properties); the Abandoned Shipwreck Act of 1987; and USACE regulations regarding Identification and Administration of Cultural Resources. Significant cultural resources include any material remains of human activity eligible for inclusion on the National Register of Historic Places (NRHP).

5.560 The APE associated with the study area is defined as locations within and adjacent to the Ambrose, Anchorage, Port Jersey, Kill Van Kull, Newark Bay, Elizabeth, South Elizabeth, Bay Ridge and Arthur Kill (to Howland Hook) Channels. In locations where blasting will be undertaken the APE will also encompass onshore and nearshore areas within zones expected to experience any force from the blast. Previous blasting near historic structures has been limited to 0.5 in/sec PPV. These areas will be delineated as project plans develop and blasting locations are defined.

5.561 Major portions of the project's APE and the New York and New Jersey Harbor area as a whole have been subject to numerous cultural resources surveys and studies directed at particular project locations within the Harbor. Many of these previous studies were conducted for USACE as part of the Collection and Removal of Drift project, individual channel navigation projects, beach erosion control projects, or the Dredged Material Management Plan (DMMP). Studies have also been undertaken for other agencies; these are on file with the New York and New Jersey State Historic Preservation Offices (SHPO) or the New York City Landmarks Preservation Commission. A bibliography of cultural resources reports for the Harbor area is provided at the end of this report. Because of overlap of this study's project area with project areas investigated during earlier work, previous reports and Section 106 coordination undertaken for USACE's other Harbor projects have proven to be an adequate basis for this study's cultural resources evaluation. These previous projects are discussed below (see "Prior Surveys").

Archaeological Resources

5.562 Archaeological resources within the APE associated with the proposed project are likely to be limited to prehistoric remains, since the area has historically been inundated (see

"Shipwrecks and Abandoned Vessels" below). Because much of the Harbor area was dry land at the end of the last ice age and now-inundated areas may have been inhabited by Native American populations, prehistoric resources may be present (see "Cultural Resources Investigations," below). Due, however, to the fact that the project area is now submerged, it is unlikely that traditional archaeological sites will be found. On the other hand, recent analysis has enabled archaeologists to identify previously dry areas that are sensitive for prehistoric remains. Prehistoric archaeological sites are generally encountered near key physiographic resources such as freshwater and ecologically rich habitats. The preservation of continental shelf sites was affected by many factors associated with a rising sea level, but it appears that a number of artifacts may have survived this inundation. These artifacts may signify the location of prehistoric archaeological sites.

5.563 If any actual prehistoric resources are identified off shore they would almost certainly be eligible for listing on the NRHP under Criterion D of 36 CFR § 60, due to their contribution to the study of the life and culture of indigenous peoples before the advent of written records. The documentation of the presence of such sites and their spatial distribution relative to landforms and resource bases would be important to the interpretation of prehistoric regional settlement patterns, demography, and ecology. These sites may contain information on prehistoric environmental adaptations and subsistence strategies for environments not represented by terrestrial sites (e.g., Paleoindian coastal adaptations).

Historic Structures/Districts

5.564 Numerous properties of national, state and local significance are found in the New York and New Jersey Harbor and vicinity. The Harbor area includes two National Monuments (NM): the Statue of Liberty NM, and the Castle Clinton NM at the Battery on the southern tip of Manhattan. National Historic Landmarks (NHLs) in the Harbor vicinity include the Governor's Island Historic District, the Brooklyn Bridge, the Holland Tunnel, the Brooklyn Heights Historic District, and the Sailors Snug Harbor Historic District on Staten Island. None of these NHLs is within the APE.

5.565 Properties in the Harbor vicinity listed on the NRHP include the Central Railroad Terminal in Liberty State Park, Jersey City, New Jersey; and City Pier A at the Battery in Lower Manhattan. In Brooklyn, structures at Fort Hamilton, under the Verazzano Narrows Bridge, are listed, as is the U.S. Army Military Ocean Terminal further north along the shoreline. Fort Wadsworth, opposite Fort Hamilton at the Narrows, is also listed. In Bayonne, the ELCO Historic District at Port Johnson is on the NRHP. The Goethals Bridge and the Staten Island Railroad Vertical Lift Bridge over the Arthur Kill are both NRHP structures. This is not a complete list of NRHP properties in the vicinity of the Harbor shoreline. Other structures and districts may be listed on state and local registers.

5.566 Also of note are properties near the shoreline that, through various cultural resources surveys, have been determined to be eligible for listing on the NRHP. Such properties include portions of Atlantic Basin, Erie Basin, and Bush Terminal in Brooklyn. Two shoreline structures

were recently determined eligible for NRHP listing through USACE's Collection and Removal of Drift project. The first of these is a wooden Howe truss transfer bridge, one of two extant examples of such bridge design in New York (and possibly in the nation), found along the Kill Van Kull on Staten Island. The second is a pier associated with the Guggenheim American Smelting and Refining Company plant, on the Arthur Kill in New Jersey.

Landscapes and Viewsheds

5.567 The term "cultural landscape" is defined as a "geographic area, including both cultural and natural resources and the wildlife and domestic animals therein, associated with a historic event, activity, or person, or exhibiting other cultural or aesthetic values." According to guidelines established by the National Park Service, cultural landscapes fall into four non-mutually-exclusive categories: historic sites, historic designed landscapes, historic vernacular landscapes, and ethnographic landscapes (Birnbaum 1995, 1996). The historic vernacular landscape is the only type applicable to the present proposed undertaking. It is defined as:

> "a landscape that evolved through use by the people whose activities or occupancy shaped that landscape. Through social or cultural attitudes of an individual, family, or a community, the landscape reflects the physical, biological, and cultural character of those everyday lives. Function plays a significant role in vernacular landscapes. They can be a single property such as a farm or a collection of properties such as a district of historic farms along a river valley. Examples include rural villages, industrial complexes, and agricultural landscapes (Birnbaum 1995)."

Although the term "cultural landscape" typically evokes agrarian vistas or meticulously engineered landscapes (McClelland et al. n.d., Melnick 1984, Seifert 1995), the inclusion of the term "industrial complexes" in the definition cited above indicates that the term can be applied to areas that border the New York and New Jersey Harbor. Given the extent and nature of the Harbor project, however, such landscapes and viewsheds would not fall within the APE of this undertaking.

Shipwrecks and Abandoned Vessels

5.568 Abandoned vessels and structures such as piers and wharves have been evaluated along most of the Harbor shoreline as part of the USACE Collection and Removal of Drift project. Numerous significant resources were identified. In most cases the resources were documented to the standards of the Historic American Engineering Record (HAER) prior to removal as the project proceeded. Abandoned vessels were determined to be eligible for the NRHP during three recent surveys along the New York and New Jersey reaches of the Arthur Kill and the New York reach of the Kill Van Kull. Surveys along the Bayonne reach have determined that the Port Johnson Sailing Vessels and Pier No. 2 are NRHP-eligible. The vessels identified along the Kill Van Kull and Arthur Kill are scheduled for further work as the Removal of Drift project proceeds.

5.569 Due to the nature of the Harbor Navigation Project, impact upon shipwrecks—namely, submerged or buried vessels that have foundered, or that have become stranded or wrecked—has not been considered. Most work for the proposed deepening of the Harbor will take place in existing navigation channels that have been subject to maintenance dredging for many years. These channels represent an already disturbed environment. Any historic resources that may have existed in these channels would have been significantly disturbed, if not completely destroyed, by dredging activities. It is unlikely that intact historic resources eligible for NRHP listing would be found in existing channels. In certain locations, where excavation beyond previously disturbed areas will be required to widen channels, additional cultural resources studies will be necessary.

5.570 In general, the potential for shipwrecks in the Harbor has been substantial (Engebretsen 1982, Ferguson 1986). Commercial shipping has been carried on here since the early 1600s and the volume of shipping from that time to the present has remained high. By the second half of the nineteenth century, New York was handling two-thirds of the nation's foreign commerce, and was the third largest port in the world. Lower New York Bay would have been the site of most shipwrecks occurring in the Greater New York Harbor area, since it is relatively unprotected, and experiences the full force of gales.

5.571 In connection with the USACE Coney Island Beach Erosion Control Project, remote-sensing surveys were undertaken in six locations near the Ambrose Channel. While several hundred anomalies were identified, only 35 were determined to be possible cultural resources, such as shipwrecks. A diving inspection was made of nine of those possible resources but no shipwrecks were encountered (Nowak and Riess 1989; Gardner and Riess 1990; Riess 1993, 1994).

5.572 Two long linear remote-sensing surveys were undertaken in the Lower Bay and into the Bight running from Morgan, New Jersey, to Edgemere, New York (Miller and James 1992a; 1992b). One survey crossed the Ambrose Channel in Lower New York Bay. Hundreds of anomalies were encountered throughout the area of these surveys, and numerous targets were determined to be potentially significant. It was recommended that potentially significant targets be avoided or that they be made subject to further investigation. An anomaly identified as a potential wreck has been found near the Ambrose Channel.

Cultural Resources Investigations

Prior Surveys

5.573 The New York and New Jersey Harbor area has been the subject of numerous cultural resources surveys that have been directed at particular project locations within the Harbor. Many of these previous studies were conducted for USACE as part of the Collection and Removal of Drift project, individual channel navigation projects, beach erosion control projects, or the DMMP. Due to significant project area overlap with the Harbor Navigation Project, these previous surveys have been used for cultural resources identification and impact assessment as

well as for Section 106 coordination with the New York and New Jersey State Historic Preservation Offices (SHPOs) and the New York City Landmarks Preservation Commission.

5.574 In a geomorphological and archaeological study conducted for the DMMP, borings were analyzed from the Hudson River, Constable Hook/Port Jersey, Newark Bay, Ward's Point, Bowery Bay, Red Hook/Bay Ridge, and two zones in Lower Bay (LaPorta, et al. 1999). The LaPorta study provided the direction for the Geoarchaeology Research Associates (GRA) study described below (see "Surveys for this Project" below).

5.575 The LaPorta study determined that the DMMP project locations with low sensitivity are the center channel of the Hudson River and the previously dredged navigation channels at Constable Hook/Port Jersey and Newark Bay. No further work is required for these locations. Areas within Newark Bay determined to be moderately sensitive are those that have not been previously dredged. Moderate sensitivity has also been applied to an area in the southeast corner of Zone 1 (in Raritan Bay) and to all of Zones 2 (in Raritan Bay) and 3 (in the Bight). Areas considered moderately sensitive will become subject to additional studies in the form of corings and core analysis. Additional vibracores, for example, are recommended for Red Hook/Bay Ridge, which was evaluated at moderate to low sensitivity. Highly sensitive areas, such as those at Ward's Point (at the southern end of Staten Island) and a swath of Zone 1 (in Raritan Bay), will be studied further through remote sensing, vibracores, and sediment testing. Both the New York and New Jersey SHPOs have reviewed and accepted the DMMP report by La Porta.

5.576 A number of studies have been conducted on the Arthur Kill. The results of the most recent, Wagner and Siegel in 1996 and Panamerican Consultants, Inc. (PCI), in 1999, are applicable to the Harbor Navigation project. These two studies were based on previous surveys and recommendations (Raber Associates 1996a, 1996b, 1996c). Wagner and Siegel conducted a geomorphological assessment of the Arthur Kill Marine Terminal Channel and determined that one area just northeast of Shooters Island was sensitive for paleoenvironmental data. This area was examined in greater detail through a series of borings in the autumn of 1999. The resulting report will be available in early 2000.

5.577 The PCI study area, which included both the New York and New Jersey banks of the Arthur Kill, was conducted concurrently with a survey of the Staten Island shore of the Kill Van Kull. The survey entailed an examination of over 100 individual vessels, 14 vessel clusters, and several shoreline structures to determine their NRHP eligibility and to provide recommendations for further study, if required. The results of the survey indicate that 44 derelict vessels and one structure along the Arthur Kill require further work to mitigate the adverse impact of their removal as part of the Collection and Removal of Drift project (Panamerican Consultants, Inc. 1999). A Programmatic Agreement (PA) has been signed with the New York and New Jersey SHPOs.

5.578 Two cultural resources surveys of the derelict vessels surrounding Shooters Island were undertaken as part of the Collection and Removal of Drift project (Brouwer 1983, 1985). Although most of the vessels were wooden and badly deteriorated, the surveys indicated that the

vessel complex as a whole was potentially significant because it represented late nineteenth and early twentieth century maritime technology. USACE staff coordinated with the New York and New Jersey SHPOs to develop an appropriate mitigation plan for the Shooters Island Graveyard, which was subsequently included in a PA for this study. After consultation with the Historic American Building Survey/Historic American Engineering Record (HABS/HAER) as to the particulars of the mitigation plan, USACE undertook archival recording of selected vessels in the ship graveyard (Kardas and Larrabee 1985). This recording was completed and formally accepted by the HABS/HAER office on 4 December 1985.

5.579 The PA for Shooters Island required that USACE would try to find a suitable curating institution willing to acquire the A-frame from the walking-beam engine of the *Jane Moseley*, one of the vessels in the ship graveyard. The South Street Seaport Museum indicated interest in acquiring the A-frame. However, since that time, the A-frame has deteriorated so significantly that preservation is no longer possible. A revised PA was therefore signed, stipulating that USACE will conduct additional research and develop a model for an appropriate institution or produce a brochure for public distribution. These actions will occur once funding is allocated for this reach in the Collection and Removal of Drift project.

5.580 As mentioned above, PCI conducted a survey of the Kill Van Kull on the New York side at the same time as the Arthur Kill survey was conducted. PCI's work indicated that 28 vessels and one structure in the Kill Van Kull on the New York side are NRHP-eligible. As with the Arthur Kill vessels, further study is required (Panamerican Consultants, Inc. 1999). The New Jersey side of the Kill Van Kull was investigated under the Bayonne Reach portion of the Collection and Removal of Drift project. The ELCO Historic District is an NRHP-listed property. At Port Johnson, Pier No. 2 (Atlas Yacht Club Pier), the Port Johnson Historic Sailing Vessels (a cluster of eight historic ships) and a number of other vessels were determined to be NRHP-eligible. These resources will be subject to further study. Section 106 coordination in connection with the deepening of the Kill Van Kull Channel to 45 feet established that no NRHP properties would be impacted by the project, provided that protective measures were employed during the blasting process.

5.581 The Brooklyn shoreline in the Bay Ridge/Red Hook area was investigated for the Brooklyn Reaches I and II portion of the Collection and Removal of Drift project (Raber Associates 1984, 1985). Significant resources along this reach are Pier 41, the Columbia Street Pier, the Warehouse Pier in Erie Basin, the 29th Street Pier, Bush Terminal Pier 7, and Pier 1 at the Brooklyn Military Ocean Terminal. Most of these structures were recorded to HAER standards and removed.

5.582 Port Jersey was the subject of a cultural resources study in connection with proposed channel deepening (Henn 1985). The study concluded that there was little potential for historic resources within the Port Jersey Channel as a whole, although the Jersey Flats (at the mouth of the channel) and the shallows at the channel's western end were declared sensitive for submerged prehistoric resources.

5.583 A cultural resources study was undertaken for PANYNJ prior to construction of the Newark Bay Confined Disposal Facility (NBCDF) near the mouth of the Port Newark Channel, in Newark Bay (Hartgen Archaeological Associates, Inc. 1996). It was determined by this study that no historic resources were present in the study area and that the location was not sensitive for submerged prehistoric resources. Recent work by LaPorta, et al., and GRA has indicated that while the Port Newark Channel lacks sensitivity, the shallows within Newark Bay hold some potential (LaPorta et al. 1999, Geoarchaeology Research Associates 1999).

5.584 The results of these previous studies are being integrated into the Section 106 coordination for the Harbor Navigation Project; other studies will be programmed as necessary. The need for and scope of these additional studies has been stipulated in a PA developed for this study This is discussed in greater detail in Section 6.6.

Surveys for this Project

5.585 As discussed above, cultural resources reports and Section 106 coordination conducted for other Harbor studies have provided significant and relevant data for the overall Harbor study. A cultural resources survey has also been conducted specifically for the Harbor Navigation project: a geomorphological and archaeological study of the channels under consideration for deepening, conducted by GRA, as subconsultants to PCI. The objective of this study was to assess the potential for prehistoric resources within these Upper and Lower New York Bay channels and vicinity by evaluating pertinent geophysical and paleoenvironmental data. GRA staff monitored the excavation of borings and selected certain samples to undergo analysis for pollen and foraminifera. [Carbon-14 analysis was added where appropriate.] The data were used to reconstruct the former shorelines and surrounding environment (i.e., marine, estuarine, terrestrial) in the immediate vicinity of the project impact areas. The key trend examined was the variation in shoreline margin as a function of variation in sea level. Results were presented as a series of maps (Geoarchaeological Consultants, Inc. 1999).

5.586 The results of GRA's study indicate that the Port Jersey, Claremont, and the Anchorage Channels have a moderate to high potential for cultural resources. It was recommended that several additional borings be taken and analyzed at each location. Further borings are also recommended along the channel margins of Newark Bay, where the potential for cultural resources is considered moderate. Areas estimated to have low cultural-resources potential are the Port Newark Channel, Port Newark Point, the Elizabeth Channel, and Buttermilk Channel. No further cultural resources work is recommended for these areas. Since data recovered from the borings along the Ambrose Channel were insufficient to characterize cultural-resources potential, further study is recommended there.

5.587 Since Bay Ridge was examined previously by LaPorta, et al., for the DMMP, it was not included within the GRA study. Because this channel had been assessed at moderate to low sensitivity it was recommended that additional samples be excavated and analyzed.

5.588 Since the South Elizabeth Channel was not under consideration as part of this study when

the cultural resources work was contracted, no data were recovered from it. A cultural resources study will be undertaken for this area.

5.589 In a survey of upland port facilities conducted as part of this study by PANYNJ, a number of significant cultural resources were identified (Killam Associates 1998). The New York City Department of Economic Development prepared an Environmental Screening Technical Memorandum for its "Strategic Plan for the Redevelopment of the Port of New York," which included an assessment of cultural resources in the vicinity of the Red Hook, Sunset Park, and Howland Hook port facilities (Edwards and Kelcey Engineers, Inc. 1999). Numerous resources were identified. Coordination of the upland studies will be undertaken by the appropriate SHPO as the project proceeds.

5.590 Placement sites for dredged material will be addressed under the DMMP. Cultural resources issues related to such sites are being coordinated through that project as it proceeds. If other placement areas are proposed specifically for the Harbor Navigation Project they may require a cultural resources evaluation.

5.7 Socioeconomic Resources

5.591 This section provides a description of New York and New Jersey Harbor socioeconomic resources, with emphasis on those resources potentially affected by the proposed navigation improvements to the Harbor. This discussion includes a description of the flow of goods through the Harbor and the origins and destinations of goods traffic. Population, income, and employment resources of the region are also described.

5.592 The geographic scope of the socioeconomic resources evaluation extends beyond the New York–New Jersey metropolitan area to include the Harbor's economic hinterland, which extends into the continent's interior. The Harbor's hinterland encompasses both the domestic origins and destinations of waterborne commodities that pass through the Harbor. These interior origins and destinations are linked to the Harbor through the existing intermodal network, which includes rail, truck, air, and water (barges).

5.593 The discussion of population, income, and employment focuses on the Harbor's primary hinterland, which extends roughly north, west, and south 260 miles from the Harbor, and which includes portions of 14 states. The core of the Harbor's primary hinterland is the 31-county metropolitan region, the destination or point of origin of 70% of the volume of containerized shipping passing through the Harbor. The primary hinterland as a whole serves as destination or point of origin of approximately 82% of the volume of containerized cargo passing through the Harbor.

5.594 The 31-county metropolitan region includes 14 counties in southern New York State (five in New York City, two on Long Island, and seven mid-Hudson), 14 counties in northern New Jersey; and three counties in southwestern Connecticut.

5.595 Within a 260-mile radius of the Harbor are the District of Columbia and all or part of 13 states, including: New York, New Jersey, Massachusetts, Rhode Island, New Hampshire, Vermont, Connecticut, Maine, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia. The latter two states are not included in this socioeconomic profile, because their portions falling within the 260-mile radius are negligible.

Shipping

5.596 The shipping of goods through New York and New Jersey Harbor may be categorized as containerized shipping, liquid bulk shipping, and general cargo. Containerized shipping will be positively impacted by the proposed navigation improvements, far more than either liquid bulk shipping or general cargo. The volume of containerized traffic in the Harbor is expected to increase from 4.2 million TEUs in 2010 to more than 19 million TEUs in 2060. This increase in TEU volume will be accompanied by shifts in the allocation of TEUs among international trading partners. The most significant shifts in TEU allocation are expected to be the decline in the proportion of New York and New Jersey Harbor traffic with northern Europe (from 27.3% in 2010 to 12.9% in 2060) and the increase in the proportion with Middle Eastern and Indian Sub-continent countries (from 11.9% in 2010 to 22.3% in 2060). It should be noted that the shift in allocation among international trading partners is expected to occur regardless of New York and New Jersey Harbor navigation improvements.

5.597 Liquid bulk shipping is a major component of shipping in the Harbor. New York and New Jersey Harbor is in fact the largest petroleum port by volume in the U.S. (1998 throughput of crude petroleum and petroleum products: over 30 billion gallons). The positive impact of the proposed navigation improvements on liquid bulk shipping through the Harbor is, however, expected to be limited. This is so for the following reasons: (1) most oil facilities are located in an area (along the Arthur Kill) not currently considered for channel deepening, and (2) most petroleum entering the Harbor is refined product, carried on mid- to small-size vessels.

5.598 General cargo operations are carried on at numerous facilities throughout the Harbor, and the volume of depth-limited general cargo shipping in the port is very small relative to the volume of depth-limited containerized and liquid bulk shipping. General cargo trade includes scrap metal, vehicles, wastepaper, bananas, lumber, coffee, cocoa, sugar, and numerous other commodities. General cargo shipping is not expected to increase greatly, if at all, as a result of navigation improvements to the Harbor.

Population

5.599 The table below shows projected population levels for the metropolitan region and its primary hinterland. As of 1998, the Harbor's primary hinterland contained approximately 22% of the population of the continental United States. Population in the primary hinterland is expected to grow much more slowly than the national average.

Estimated Population of Project Areas and Continental US			
Year	31-County Area*	260-Mile Radius	Continental U.S.
1998	20,363,000	59,040,000	268,836,000
2015	22,164,000	65,038,000	310,857,000
% change 1998-2015	9%	10%	16%
2045	25,394,000	76,488,000	378,986,000
% change 1998-2045	25%	30%	41%

Sources: Transportation Models and Data Initiative Technical Memorandum No. 8.9 Population Forecasting and Analysis NYMTC; U.S. Department of Commerce, Bureau of Economic Analysis (BEA)
*Estimated by applying the percentage growth from BEA projections (2015-2045) for the NY-NJ-CT CMSA to the NYMTC 2015 population estimate

Income

5.600 The table below shows projected per capita and total personal income levels for the Harbor's evaluation areas. Per capita income in the 31-county metropolitan region and the 260-mile radius exceeds the national average by 32 and 15%, respectively. Estimates of 1998 total personal income show that approximately 25% of the nation's total personal income is generated within the 260-mile radius. Total personal income is expected to grow by a smaller percentage in the 31-county metropolitan region than in the 260-mile radius.

Estimated Per Capita & Total Income ($mil) of Hinterlands				
Income Category	Year	31-County Area*	260-Mile Radius	Continental U.S.
PerCapita Income	1998	22,888	20,030	17,344
	2015	26,476	23,490	20,504
	% change (1998-2015)	16%	17%	18%
	2045	33,420	29,623	26,144
	% change (1998-2045)	46%	48%	51%
Total Income	1998	466,073	1,182,557	4,662,575
	2015	586,814	1,527,764	6,373,873
	% change (1998-2045)	26%	29%	37%
	2045	848,671	2,265,805	9,908,041
	% change (1998-2045)	82%	92%	113%

Source: U.S. Department of Commerce, Bureau of Economic Analysis.
*Regional income projections were not available from NYMTC, therefore, BEA estimates for the NY-NJ-CT CMSA are presented for the 31-county metropolitan area.

Employment

5.601 Table 5.7-1 presents estimated employment by sector for the Harbor's evaluation areas for the years 1998, 2015, and 2045. For the 1998-2045 period, all-industry employment growth rates throughout the Harbor's primary hinterland are expected to be slower than projected national growth rates. This is consistent with the expected slower growth in total population for this region relative to the nation. The 1998-2045 sectoral employment forecasts suggest that the hinterland, like the nation as a whole, will continue its current transition from a manufacturing to a service economy. Throughout the Harbor's pruimary hinterland, manufacturing employment is expected to decline, while employment in the construction and services sectors is expected to grow significantly.

Environmental Justice Issues

5.602 Executive Order 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. Consistent with this mandate, an evaluation of the population in the vicinity of the New York and New Jersey Harbor was conducted to determine the potential for the project to adversely affect minority and low-income populations. The environmental impacts of the proposed project are presented in detail in Section 6. The environmental justice issues presented here should be considered in light of the impacts discussed in Section 6.

Environmental Justice Issues Associated with Dredging Activities

5.603 Since all dredging activities will take place in existing navigation channels, no primary direct impacts related to environmental justice issues will occur in landside residential areas. In order to identify landside areas that may experience secondary direct project impacts, such as odor or noise, a one-mile "buffer area" was delineated around all channel-deepening areas with the use of Geographic Information System (GIS) software. Census tracts with any portion of their area falling within this buffer were then evaluated for minority and low-income populations. The buffer area consists of sections of Union, Essex, and Hudson Counties in New Jersey, and sections of Richmond and Kings Counties in New York. Data are presented for the median household income by race for 128 census tracts, with a total population of 354,875 (see Table 5.7-2).

Race

5.604 The 1990 U.S. Census of Population and Housing describes the racial composition of the buffer area as 71% white, 13% African American, 25% Hispanic, and 11% other classifications. [Persons of Hispanic origin can be of any race.] Asian and Native American populations comprise 5 and 0% of the buffer area, respectively (see Table 5.7-3).

5.605 Within the buffer area, 16 census tracts have African American populations of 25 to 50%

of the total population, and seven census tracts have African American populations between 50 and 75% of the total population. Fourteen of the tracts in the 25 to 75% range are located in northern Staten Island (see Figure 5.7-1). Thirteen census tracts have Hispanic populations of 25 to 50%, while sixteen tracts are in the 50 to 75% range. Tracts with high Hispanic populations are found in two locations: adjacent to the Arthur Kill in Elizabeth, New Jersey, and adjacent to the Bay Ridge Channel in the Red Hook and Sunset Park neighborhoods of Brooklyn (see Figure 5.7-2).

5.606 Asian populations within the New York sections of the buffer area range from 0 to 29% of the total population. Most census tracts, however, are less than 10% Asian. Within the New Jersey section, the Asian population ranges from 0 to 9%. The most sizable concentration of other minority classifications is found in Union County, with an 18% share of the total population.

Income

5.607 Significant variation in median household income is seen throughout the buffer area, with an income range of $4,999 to $87,674. Census tracts with median household income values less than 50% of the overall median household value of the county in which they are located are classified as "low-income." The greatest concentration of low-income populations is found in Union County, New Jersey, where 32% of the buffer area population resides in census tracts meeting this threshold. Overall, 7% of the total buffer area population lives in low-income census tracts.

5.608 Based on 1990 U.S. Census data, there exist several concentrations of minority and/or low-income populations within the buffer area. However, these concentrations do not comprise a significant portion of the overall population within the buffer area, and therefore, minority populations are not disproportionately represented in the area of potential impact.

5.8 Recreation

Marinas & Boating

5.609 In addition to the commercial boating traffic in the New York and New Jersey Harbor, there is also a great deal of recreational boating. Marinas, capable of accommodating various sizes of vessels, are found throughout the Harbor in the study area. A listing of Harbor area marinas is presented in Table 5.8-1. A general description of the major facilities is presented below:

5.610 In the southern portion of the study area, Sandy Hook Bay, the Atlantic Highlands Municipal Harbor has 430 berths, transient slips, moorings, and marine fuel stations. Also in the Sandy Hook area is Bahrs Landing and Marina, the Atlantic Highlands Yacht Club, and the Sandy Hook Marina. In Raritan Bay, the Leonardo State Marina contains some slips for transients, but no anchorages (Northern Waterway Guide 1999). At the mouth of the Raritan

River is the Perth Amboy Yacht Club. North of this is a municipal marina known as the Armory.

Boat launching facilities in the Sandy Hook/Raritan Bay region of the study area include:

Wagner's Twin Towers Marina, in Keyport on Matawan Creek
A public boat ramp in Rumson, on the Navesink River
Chris's River Plaza Marina in Red Bank on the Navesink River
The Atlantic Highlands Municipal Marina in Atlantic Highlands on Sandy Hook Bay
Brooks Marina in Sea Bright on the Navesink River
Surfside Marina in Sea Bright on the Shrewsbury River
Blue Water Marina at the Channel Club, in Monmouth Beach on the Shrewsbury River
The Armory, in Perth Amboy on the Raritan River
Launch ramp in the southernmost part of the Arthur Kill River, near Perth Amboy

[Above information from New Jersey Boat Ramps 1999, Northern Waterway Guide 1999]

5.611 In Upper New York Bay, Liberty Harbor Marina and the Marina at Battery Park provide ferry service to the Statue of Liberty. South Street Seaport Piers 15 and 16, located at the mouth of the East River, have transient slips for tourists. Both South Street Seaport and Battery Park offer a 40-minute Lunch Boat Cruise to the Statue of Liberty and back. In addition, South Street Seaport offers a daily 90-minute New York Harbor Cruise.

5.612 Two boat launches give boaters access to the New York and New Jersey Harbor from Manhattan Island. The 79th Street Boat Basin is a residential marina that has become the unofficial New York area headquarters of the Hudson River Waterway Association. Another, the Downtown Boathouse, is located near Greenwich Village (Hudson River Watertrail Guide 1999).

5.613 Several marinas are found in Lower New York Bay. Marinas are scattered along the eastern shore of Staten Island, on Rockaway Point, and along the southern shore of Brooklyn up to the Verrazano Narrows Bridge. Several are found in Great Kills Harbor, Staten Island. In addition to the Richmond County Yacht Club and the Great Kills Yacht Club, Mansion Marina (210 berths, some for transients), and Great Kills Park Marina (350 berths, some for transients) may be found here (Northern Waterway Guide 1999).

5.614 Several marinas may be found on the Brooklyn side of Lower New York Bay. Located furthest south on Gravesend Bay, the Surfside Marina has 25 slips, a boatlift, and facilities for outside winter storage. Further north on Gravesend Bay are the Excelsior Yacht Club and the Marine Basin Marina, the latter of which has 400 slips, winter storage, and full fueling facilities (Citeno 1999).

Fishing

5.615 Ten locations within the study area have been designated by New Jersey as specific sport

and commercial fishing grounds. They all fall within the Lower New York Bay/Raritan Bay area. The entrance to Lower New York Bay is the border of the recreational fishing areas for whiting, red hake, striped bass, black sea bass, weakfish, bluefish, summer flounder, and tautog (NJDEP 1982).

5.616 Along the eastern shore of Staten Island, between the Verrazano Narrows Bridge and Great Kills Harbor, stormwater outfalls and a bulkhead wall perpendicular to the shoreline are popular sites for recreational fishing.

5.617 Within the Gateway National Recreation Area fishing areas have been allocated in Lower New York Bay and Raritan Bay, where waters are calm. At the Sandy Hook unit, a fishing beach is found just north of the ranger station, although surf fishing is permitted at any unguarded beach.

5.618 On the Arthur Kill, fishing access is commonly gained through abandoned buildings and breaks in fences. Recreational fishermen frequent Ward's Point, Seguine Point, and Crookes Point on the east shoreline of Staten Island. Red Hook reach, south of Staten Island, is also a popular recreational fishing area.

5.619 A number of charter companies fish in the New York and New Jersey Harbor.

Parks

5.620 Several parks may be found along the New York and New Jersey Harbor shoreline. These parks provide recreational facilities such as paved pathways, swimming beaches, fishing areas, and nature trails. Harbor-area parks are listed in Table 5.8-2. A general description is presented below:

5.621 The Gateway National Recreation Area is the largest park in the Harbor area. Other nearby parks are: Sandy Hook, New Jersey; Breezy Point (on the Rockaway peninsula), New York; and Great Kills Park (Staten Island), New York. Sandy Hook offers swimming beaches with lifeguards, hiking trails, picnic areas, birding, and windsurfing. Great Kills Park (which includes Hoffman and Swinburne Islands) features beaches, a paved pathway, and nature trails through tidal wetlands. Recreational activities at Breezy Point include Fort Tilden and Jacob Riis Park, which offers swimming and surf fishing.

5.622 Wolfe's Pond Park, located on the southeastern end of Staten Island, is popular for its paved pathways and guarded beaches. Several other parks are also located on Staten Island, including: Staten Island Botanical Gardens, Conference House Park, Kill Van Kull Park, and Faber Pool Park. Many smaller parks are also found along the shore of Staten Island. Along the New Jersey shore of the Arthur Kill are Sadowski Park and Cliff Road Park.

5.623 Several parks may be found in the Newark Bay area within the confines of the study area. Stephen R. Gregg Hudson County Park and City Park are both located in Bayonne on the eastern

side of Newark Bay. The approximately 98-acre Hudson County Park is the largest park facility within the city limits. Veterans Memorial Park and the Bayonne High School facilities are located south of Hudson County Park. The 20-acre City Park is bordered by Newark Bay to the west. All these parks offer waterfront walkways and access to the Newark Bay waterfront. The City of Bayonne Comprehensive Master Plan includes the concept of linking these park areas by means of a waterfront pathway network (USACE 1997b).

5.624 Elizabeth Memorial Park is located at the corner of Front street and Elizabeth Avenue in Elizabeth, New Jersey.

5.625 Lincoln Park is located in Jersey City, New Jersey, on the shores of the Hackensack River. The 1,212-acre Liberty State Park, also located within Jersey City limits, borders Upper New York Bay.

5.626 Ellis Island and Liberty Island are two park areas run by the National Park Service. Both are located in Upper New York Bay, and are prime tourist attractions. Ellis Island, also known as the Gateway to America, is a 28-acre island with more than 30 buildings used from 1892 though 1954 to process immigrants entering the United States. The immigration center, in the northern part of the park, now serves as a museum. Liberty Island is the site of the 300-ft high Statue of Liberty national monument. Both parks may be reached by ferry from either Liberty State Park (New Jersey) or lower Manhattan.

5.627 Battery Park, on the southern tip of Manhattan Island, includes 25 memorials, free tours, a playground, and the Battery Park Esplanade, popular with runners.

5.628 Riverbank State Park lies along the Hudson River on the west shoreline of Manhattan Island. It is a multi-level landscaped recreational facility situated on a half-mile-long terrace above the Hudson. The park offers views of the George Washington Bridge, the New Jersey shoreline, and the Hudson River (NYS Parks 1999).

5.629 Empire-Fulton Ferry State Park is a nine-acre waterfront park along the East River in Brooklyn, located between the Manhattan and Brooklyn Bridges.

Water Access

5.630 In addition to parkland in and near the study area, the New York and New Jersey Harbor offers many beach areas. The Point Comfort beach area, located in Keansburg, New Jersey, includes an amusement park/waterpark with a walkway along the beach, and a baywalk park where water sports equipment may be rented. The south shore of Sandy Hook Bay features maintained beaches.

5.631 The recently renovated South Beach, located on Staten Island just south of the Verrazano Narrows Bridge, offers views of the bridge and Lower New York Bay. Other beaches on the eastern shore of Staten Island include Midland Beach, New Dorp Beach, Oakwood Beach,

Annandale Beach, and Huguenot Beach.

5.632 The beach at Coney Island, on the south shore of Long Island, features an amusement park, a boardwalk, and swimming beaches.

INDEX

A

Affected environment, landside elements
Howland Hook Marine Terminal 112
Port Jersey/MOTBY 113
Port Newark/Elizabeth Port Authority Marine Terminal 113
South Brooklyn Marine Terminal 113
Air quality 21–27
amphibians 90, 91, 94
Aquatic species in study area 58–84
benthos 74–79
commercially and recreationally important 68–74
finfish 58–63
marine mammals 79–84
shellfish 63–68

B

benthos 65, 74, 75, 77, 78
birds 45, 52, 53, 54, 55, 84, 86, 87, 88, 89, 94, 101
bivalves 63, 64, 74, 76, 85

C

CARP 34
cephalopods 65
clams 45, 56, 63, 66, 67, 71, 72
Climate 18
Coastal Zone Management (CZM) Act 42
Contaminant Assessment and Reduction Program (CARP) 34
crabs 42, 45, 56, 59, 60, 67, 68, 72, 73, 83, 85, 92, 98, 102, 110
Cultural resources 114–21
archaeological resources 115
historic structures/districts 115
investigations 117–21
present 120–21
prior 117–20
landscapes and viewsheds 116
shipwrecks and abandoned vessels 116–17
CZM 40, 42

D

dioxin 33, 39
DMMP 33, 34, 114, 117, 118, 120

E

Ecological resources of selected alternative 112
aquatic habitats 105–6
benthos 111
commercially and recreationally important species 111
Essential Fish Habitat 107–9
finfish and shellfish 110–11
significant habitat 109–10
threatened and endangered species 111
unique species 111–12
wetlands 106–7
EFH 56, 57, 58, 64, 72, 73, 107, 108, 109
Essential Fish Habitat (EFH) 56
estuary 1, 9, 21, 40, 57, 58, 59, 62, 67, 68, 76, 77, 82, 84

F

fish 2, 7, 35, 37, 41, 43, 44, 45, 46, 53, 55, 56, 57, 58, 59, 60, 61, 62, 63, 67, 69, 70, 74, 80, 81, 83, 84, 85, 86, 87, 88, 89, 94, 96, 100, 103, 107, 110, 126
fishing 15, 35, 40, 42, 46, 70, 102, 126

G

Geology 21–27
regional 21–23
site 23–27
Ambrose channel 24
Anchorage channel 24
Arthur Kill 25
Arthur Kill - Elizabethport Reach 26
Arthur Kill - Gulfport Reach 26
Bay Ridge Channel 26
Elizabeth Port Authority Marine Terminal 25
Kill Van Kull 24
Newark Bay South and Middle Reaches 25
Newark Bay to Elizabeth Port Authority Marine Terminal 25
Port Jersey Channel 27
Stapleton Anchorage 27
Groundwater 29–31

H

habitat 1, 5, 7, 40, 41, 42, 44, 45, 46, 50, 51, 52, 53, 55, 56, 57, 58, 60, 74, 84, 85, 86, 89, 90, 91, 92, 93, 94, 96, 97, 98, 99, 100, 102, 103, 104, 105, 106, 107, 109, 110
Habitats 58
aquatic 40–43
Critical or Significant 53–58
uplands 51–53
wetlands 43–51

Harbor Estuary Program (HEP) 34
HARS 33, 34
Hazardous, Toxic and Radioactive Waste (HTRW) 40
Hydrology and tidal hydraulics 31–33

I

invertebrates 45, 57, 59, 60, 63, 74, 84, 87, 89, 94

M

mammals 51, 52, 79, 88, 89, 94, 101, 111
mussels 45, 56, 64, 66, 70, 83

N

Navigation 16–18
NJDEP 5, 19, 20, 34, 35, 37, 49, 94, 103, 126
NYSDEC 8, 19, 20, 34, 35, 41, 43, 44, 45, 47, 51, 91, 92, 93, 94, 95, 96, 97, 98, 99

P

PAHs 33, 39
PCBs 39
pesticides 33, 39
phytoplankton 7, 40
plants 5, 17, 32, 39, 44, 45, 48, 53, 63, 67, 92, 94, 104
polychaetes 75, 76, 77, 79
Polychlorinated biphenyls (PCBs) 33
Polycyclic aromatic hydrocarbons (PAHs) 33

R

Recreation 124–29
- fishing 126
- marinas and boating 124–26
- parks 126–27
- water access 127

reptiles 90, 91, 94

S

SAV 64, 67, 71, 72
shellfish 2, 42, 56, 63, 66, 67, 110
shrimp 45, 64, 67, 69, 74, 76, 80, 85, 87
Sideslopes, channel 28
Socioeconomic resources 121–24
- employment 123
- environmental justice issues 123–24
- income 122
- population 122
- shipping 121

Soils 28
Study area, description of 1–16
- aesthetics 15–16
- Arthur Kill 4
- demographics 10
- East River 9
- employment 10
- Harlem River 9
- Hudson River 8
- income 11
- Kill Van Kull 5
- land use 11
- Lower New York Bay 6
- Newark Bay 2
- noise 12–14
- Raritan Bay 6
- Sandy Hook Bay 7
- Upper New York Bay 7

submerged aquatic vegetation 40, 64

T

Temperature, water 38–40
Terrestrial species in study area 84–94
- amphibians and reptiles 90–93
- avifauna 84–89
- mammals 93–94

Threatened and endangered species 94–105
- birds 95–103
  - American bittern 99
  - barred owl 101
  - black skimmer 97
  - black-crowned night heron 100
  - common tern 97
  - least tern 95
  - northern harrier 99
  - osprey 100
  - peregrine falcon 98
  - pied-billed grebe 95
  - piping plover 98
  - roseate tern 96
  - short-eared owl 101
  - yellow-crowned night heron 98
- fish 103
  - shortnose sturgeon 103
- invertebrates 103
  - northeastern beach tiger beetle 103
- plants 103–5
  - coast flatsedge 105
  - red goosefoot 105
  - seabeach amaranth 104
  - seabeach knotweed 105
  - small whorled pogonia 104
- reptiles 105
  - turtles, sea 101

U

Utilities, buried 18

V

volatile organic compounds 20, 39

W

Water quality 35

wetlands 8, 11, 15, 28, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 55, 84, 85, 87, 89, 90, 94, 104, 105, 106, 107, 110, 126

TABLE 5.1-1
Population and Age Distribution in the Study Area Counties

Area	Total Population				Age Distribution, 1990	
	1980	1990	1998*	2005*	Percent Younger than 25	Percent Older than 65
New Jersey						
Bergen County	845,385	825,380	858,529		29.3	16.3
Essex County	851,304	778,206	750,273		35.2	12.7
Hudson County	556,972	553,099	557,159		33.3	12.7
Middlesex County	595,893	671,780	716,176		33.5	11.8
Monmouth county	503,173	553,124	603,434		33.4	12.7
Union County	504,094	493,819	500,608		31.5	15
New York						
Bronx County	1,168,972	1,203,789		1,213,270	39.2	11.6
Queens County	1,892,325	1,951,598		1,933,829	31.1	14.7
Kings County	2,231,028	2,300,664		2,242,890	37.1	12.4
Richmond County	352,029	378,977		465,818	35.4	11.2
New York County	1,428,285	1,487,536		1,456,292	26.8	13.3
Westchester County	866,599	874,866		864,314	31.4	14.4

*Estimated Projection
1980, 1990 and age distribution data – U.S. Bureau of the Census. County & City Data Book: 1994. Washington, DC 1994.
2005 Projections for New York – Batutis, Michael J. Jr. and Robert Scardamalia 1985. Official Population Projection for NYS Counties 1980-2010.
1998 estimate – http://wnjpin.state.nj.us/OneStopCareerCenter/LaborMarketInformation

5-23

TABLE 5.1-2 (Page 1 of 2)
Employment and Annual Wages in Bergen, Essex, Hudson, Middlesex, Monmouth and Union Counties, 1995.

Industry	Bergen County		Essex County		Hudson County		Middlesex County		Monmouth County		Union County	
	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)
Total	424.1	14,647,928	333.6	11,443,359	215.4	6,850,789	333.7	11,285,568	187.4	5,372,860	211.3	7,230,188
Agricultural	2.2	57,016	0.296	15,876	.180	4,402	1.4	29,737	1.7	38,560	0.537	15,796
Mining	0.056	1563	0	0	0.024	1,147	.340	15,311	0.059	2,322	0.028	1,728
Construction	16.4	585,270	8.6	349,585	5.1	179,903	10.5	382,671	11.1	399,246	10.3	410,474
Manufacturing	76.8	3,115,153	47.7	1,863,145	33.4	1,070,590	65.8	2,749,760	19.6	795,028	54.3	2,365,611
Transportation	26.2	989,616	42.9	1,639,306	30.9	980,206	27.8	1,041,619	12.2	564,214	18.9	710,157
Wholesale Trade	63.3	2,761,873	25.2	1,014,969	37.3	1,032,335	43.3	1,880,921	11	440,862	23.8	1,073,772
Retail Trade	79.0	1,653,149	41.9	713,575	34.9	606,942	59.2	1,065,626	49.3	749,432	29.6	520,835
Finance, Insurance, Real Estate	25.4	1,098,738	40.4	1,821,626	24.6	1,407,177	25.2	1,153,456	12.1	444,193	11.9	397,094
Services	134.3	475,803	126.1	4,020,116	58.7	1,566,145	100.2	2,964,303	70.4	1,934,643	61.8	1,733,471
Unclassified	0.347	9,747	0	0	0.161	1,942	0.128	2,164	0.184	4,360	0.066	1,250

Source: http://fisher.lib.virginia.edu/cgi-local/cbpbin/go.cgi

TABLE 5.1-2 (Page 2 of 2)
Employment and Annual Wages in Bronx, Kings, New York, Queens, Richmond, and Westchester Counties, 1995.

Industry	Bronx County		Kings County		New York County		Queens County		Richmond County		Westchester County	
	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)	Employees (1000)	Annual Wages (1000)
Total	196.7	5935515	403.6	10365671	1819.3	92201108	421.6	11919091	77.8	1895412	376.9	12804154
Agricultural	.2	4185	.4	9948	1.7	46254	.4	9704	.4	7210	2.5	75256
Mining	0	0	0	0	.6	55848	0	0	0	0	0	0
Construction	8.2	276783	16.4	526304	24.3	1188992	29.5	1182967	4.8	156999	17.1	715723
Manufacturing	15.7	421342	49.7	1099683	158.4	7719982	51.7	1437669	2.6	81501	50.9	2772770
Transportation	10.3	374956	24.6	867581	102.0	5107241	67.9	2569344	6.9	227846	20.3	854344
Wholesale Trade	12.6	418923	27.8	788547	128.2	6545749	29.7	1002908	2	52442	34.1	1641750
Retail Trade	27	403932	57.7	898285	194.4	4288495	68.2	1099205	17.3	214675	64.6	1170319
Finance, Insurance, Real Estate	11.2	271869	27.7	976541	419.6	35300760	26.1	867166	3.6	104875	32.3	1336509
Services	111.3	3760592	198.9	5180209	788.7	31920180	147.7	3744436	40.1	1017728	153.6	4154701
Unclassified	0	0	0	0	1.4	27607	0	0	0	0	0	0

Source: http://fisher.lib.virginia.edu/cgi-local/cbpbin/go.cgi

5-135

TABLE 5.1-3
Income for Counties in New York and New Jersey that fall within the study area.

Area	Per Capita Income		Median Household Income**		Percent Of Families Below Poverty Line 1989**
	1990*	1996***	1989	1995	
New Jersey					
Bergen County	32,230	41,555	49,249	55,340	3.9
Essex County	24,523	31,900	34,518	36,365	14.3
Hudson County	24,896	24,456	30,917	32,152	14.8
Middlesex County	27,391	29,720	45,623	50,019	5.1
Monmouth County	18,463	32,438	45,912	53,199	5.0
Union County	26,248	33,462	41,791	46,161	7.2
New York					
Bronx County	15,579	18,766	21,944	22,225	28.7
Kings County	16,803	22,459	25,684	24,034	22.7
New York County	38,794	64,411	32,262	34,405	20.5
Queens County	20,705	26,220	34,186	34,115	10.9
Richmond County	23,447	28,375	43,861	48,489	7.8
Westchester County	33,330	43,921	48,405	53,043	6.8

*Per Capita Income from – U.S. Bureau of the Census. County & City Data Book: 1994. Washington, DC 1994.
** www.census.gov
*** www.bea.doc.gov

Table 5.2-1 Navigation Channels in the New York and New Jersey Harbor			
Waterway	**Authorized Depth**	**Authorized Width (ft)**	**Presently Maintained Dimensions**
Ambrose Channel	45 ft MLW	2,000	Authorized width is maintained. Depths are greater than authorized 45 ft MLW in many areas due to sand mining by commercial interests.
Anchorage Channel	45 ft MLW	2,000	Same as authorized. Little maintenance is required.
Kill Van Kull and Newark Bay	45 ft MLW (47 ft MLW in rock)	500 to 2,200	Authorized width is maintained. Interim depth of 40 ft MLW is maintained pending construction of the 45-ft depth.
Arthur Kill to Gulfport	40 ft MLW	500 to 800	Authorized widths are maintained. The previously authorized depth of 35 ft MLW is maintained at the present time, pending reauthorization of a 40-ft MLW interim depth. A GRR is underway for the 45-ft channel.
Port Jersey Channel	41 ft MLW	370 to 600	Authorized width is maintained. A 35 ft/38 ft depth is privately maintained. Construction of a deeper Federal channel will federalize maintenance requirements.
Bay Ridge- Red Hook Channels	40 ft MLW	1,200 to 1,750	Same as authorized.
Buttermilk Channel	35 ft MLW in the western half, 40 ft MLW in the eastern (or Brooklyn) half	1,000	Same as authorized.

TABLE 5.4-1 (page 1 of 3) Special Water Areas As Defined Under The New Jersey Coastal Zone Management Program		
NJAC Part	**Habitat Area**	**Definition**
7:7E-3.2	Shellfish habitat	Shellfish habitat is defined as an estuarine bay or river bottom which has a history of production for hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), eastern oysters (*Crassostrea virginica*), bay scallops (*Argopecten irradians*), or blue mussels (*Mytilus edulis*). A shellfish habitat area is defined as an area which meets one or more of the following criteria: • the area has a current shellfish density equal to or greater than 0.20 shellfish per square foot; • the area has a history of natural shellfish production according to data available to the New Jersey Bureau of Shellfisheries, or is depicted as having high or moderate commercial value in the Distribution of Shellfish Resources in Relation to the New Jersey Intracoastal Waterway (USDOI 1963), "Inventory of New Jersey's Estuarine Shellfish Resources" (NJDEP 1983-present); and/or the "inventory of Delaware Bays Estuarine Shellfish Resources" (NJDEP 1993); • the area is designated by the State of New Jersey as a shellfish culture area as authorized by NJSA 50:1 et seq.; or • the area is designated as productive at NJAC 7:25-24, Leasing of Atlatnic and Delaware Bay Bottom for Aquaculture.
7:7E-3.3	Surf clam areas	"Surf clam areas" are waters within the territorial seas of the State of New Jersey which can be demonstrated to support significant commercially harvestable quantities of surf clams *(Spisula solidissima)*, or areas important for recruitment of surf clam stocks. This includes areas where fishing is prohibited for research sanctuary or conservation purposes by NJAC 7:25-12.1(d)4.

TABLE 5.4-1 (page 2 of 3)
Special Water Areas As Defined Under The New Jersey Coastal Zone Management Program

NJAC Part	Habitat Area	Definition
7:7E-3.4	Prime fishing areas	Prime fishing areas include tidal water areas and water edge areas which have a demonstrable history of supporting a significant local quantity of recreational or commercial fishing activity. The area includes all coastal jetties and groins and public fishing piers or docks. Prime fishing areas also include all red line delineated features within the State of New Jersey's three-mile territorial sea illustrated in: B.L. Freeman and L.A. Walford (1974) Angler's Guide to the United States Atlantic Coast Fish; Fishing Grounds and Fishing Facilities, Section III and IV or as indicated on New Jersey's Specific Sport and Commercial Fishing Grounds Chart contained in New Jersey's Recreational and Commercial Ocean Fishing Grounds (Long and Figley 1984); recently developed artificial reefs off the New Jersey coast as identified in Figley (1989) "A Guide to Fishing and Diving New Jersey's Artificial Reefs", and The Fishing Grounds of Raritan, Sandy Hook and Delaware Bays as determined in Figley and McCloy (1988) "New Jersey's Recreational and Commercial Fishing Grounds of Raritan Bay, Sandy Hook Bay and Delaware Bay and The Shellfish Resources of Raritan Bay and Sandy Hook Bay."
7:7E-3.5	Finfish migratory pathways	Finfish migratory pathways are waterways (rivers, streams, creeks, bays and inlets) which can be determined to serve as passageways for diadromous fish to or from seasonal spawning areas, including juvenile anadromous fish which migrate in autumn and those listed by H.E. Zich (1977) New Jersey Anadromous Fish Inventory" NJDEP Miscellaneous Report No. 41, and including those portions of the Hudson and Delaware rivers within the coastal zone boundary. Species associated with migratory pathways include: alwife or river herrings, blueback herring, American shad, striped bass, Atlantic sturgeon, shortnose sturgeon and American eel.
7:7E-3.6	Submerged vegetation habitat	A submerged vegetation special area consists of water areas supporting or documented as previously supporting rooted, submerged vascular plants such as widgeon grass (*Ruppia maritima*), sago pondweed (*Potamogeton pectinatus*), horned pondweed (*Zannichellia palustris*) and eelgrass (*Zostera marina*). Detailed maps of the distribution of submerged vegetation habitat are provided in New Jersey Subnerged Aquatic Vegetation Distribution Atlas (Final report), February 1980 and also on "Eelgrass Inventory" maps prepared by the Division of Fish and Wildlife, Burea of Shellfisheries, 1983.

5-139

TABLE 5.4-1 (page 3 of 3) Special Water Areas As Defined Under The New Jersey Coastal Zone Management Program		
NJAC Part	**Habitat Area**	**Definition**
7:7E-3.7	Navigation channels	Navigation channels include water areas in tidal rivers and bays presently maintained by DEP or the Army Corps of Engineers and marked by US Coast Guard with buoys or stakes, as shown on NOAA/National Ocean Survey Charts. Navigation channels also include channels marked with buoys, dolphins, and stakes, and maintained by the State of New Jersey, access channels and anchorages. Navigation channels include all areas between the top of the channel slopes on either side.
7:7E-3.9	Inlets	"Inlets" are natural channels through barrier islands allowing movement of fresh and salt water between the ocean and the back bay system. Inlets naturally have delta fans of sediment seaward and landward, deposited by the ebb and flow of the tide.
7:7E-3.10	Marina moorings	Marina moorings are areas of water that provide mooring, docking and boat maneuvering room as well as access to land and navigational channels for five or more recreational boats.
7:7E-3.11	Ports	Ports are water areas having, or lying immediately adjacent to, concentrations of shoreside marine terminals and transfer facilities for the movement of waterborne cargo (including fluids), and including facilities for loading, unloading and temporary storage. Port locations in New Jersey include, among others, Newarl, Elizabeth, Bayonne, Jersey City, Weehawken, Hoboken, Woodbridge, Perth Amboy, Camden, Gloucester City, Paulsboro and Salem.
7:7E-3.12	Submerged infrastructure routes	A "submerged infrastructure route" is the corridor in which a pipe or cable runs on or below a submerged land surface.
7:7E-3.13	Shipwrecks and artificial reefs	A "shipwrecks and artificial reefs" special area includes all permanently submerged or abandoned remains of vessels which serve as a special marine habitat or are fragile historic and cultural resources. This policy applies to tidal and ocean waters of the State of New Jersey three mile territorial sea, but outside of navigation channels.

TABLE 5.4-2
Summary of Federally Managed Species with EFH Designations in the Hudson-Raritan Estuary and Sandy Hook Bay

Species	Life Stage				
	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Red hake (*Urophycis tenuis*)		M,S	M,S	M,S	
Winter flounder (*Pleuronectes americanus*)	M,S	M,S	M,S	M,S	M,S
Windowpane flounder (*Scopthalmus aquosus*)	M,S	M,S	M,S	M,S	M,S
Atlantic sea herring (*Clupea harengus*)		M,S	M,S	M,S	
Bluefish (*Pomatomus saltatrix*)			M,S	M,S	
Long finned squid (*Loligo pealei*)	n/a	n/a			
Short finned squid (*Illex illecebrosus*)	n/a	n/a			
Butterfish (*Peprilus triacanthus*)		M	M,S	M,S	
Atlantic mackerel (*Scomber scombrus*)			S	S	
Summer flounder (*Paralicthys dentatus*)		F,M,S	M,S	M,S	
Scup (*Stenotomus chrysops*)	S	S	S	S	
Black sea bass (*Centropristus striata*)			M,S	M,S	
Surf clam (*Spisula solidissima*)	n/a	n/a			
Ocean quahog (*Artica islandica*)	n/a	n/a			
Spiny dogfish (*Squalus acanthias*)	n/a	n/a			
King mackerel (*Scomberomorus cavalla*)	X	X	X	X	
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X	
Cobia (*Rachycentron canadum*)	X	X	X	X	

S = Includes the seawater salinity zone (salinity ∃ 25.0 ‰)
M = Includes mixing water / brackish salinity zone (0.5‰ < salinity < 25.0‰)
F = Includes tidal freshwater salinity zone (0.0‰ # salinity ∃ 0.5‰)

n/a = No EFH designated for this lifestage (squids, surf clam, ocean quahog). With regard to the squids, the surf clam, and the ocean quahog, juvenile corresponds to pre-recruits, and adult corresponds to recruits in these species' life histories.

Source: NMFS (1999)

TABLE 5.4-3
Summarized Locations of EFH within the Project Area
Life Stage and EFH Location (10' x 10' latitude and longitude square)

	Eggs							Larvae						
Species	42	56	57	58	72	73	74	42	56	57	58	72	73	74
Red hake		X	X	X			X	X	X	X	X	X	X	X
Winter flounder	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Windowpane flounder	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Atlantic herring								X	X	X		X	X	
Bluefish							X							X
Butterfish								X	X	X	X	X	X	
Atlantic mackerel														
Summer flounder								X	X	X	X	X	X	
Scup	X	X	X	X	X			X	X	X	X	X		
Black sea bass	n/a													
King mackerel	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spanish mackerel	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cobia	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sand tiger shark								X		X	X			X
Dusky shark										X	X		X	X
Sandbar shark								X	X	X	X	X	X	X

TABLE 5.4-4 (page 1 of 5)

Summary of General Habitat Parameters for those Species and Life Stages for which EFH has been Designated in the Project Area

Species	Life Stage / Stage of Maturity	EFH General Habitat Parameters				
		Water Temp (°F)	Salinity (‰)	Water Depth (m)	Seasonal Occurrence	Comments
Red hake	Larvae	< 66	> 0.5	<200	May – December	Surface waters
	Juveniles	< 61	31 – 33	<100	October – June	Bottom habitats with shell fragment, including areas abundant in live scallops
	Adults	< 54	33 – 34	10 – 130	October – June	Bottom habitats in depressions with sand and mud substrate
Winter flounder	Eggs	< 50	10 – 30	<5	November – April	Bottoms habitats of sand, muddy sand, mud and gravel substrate
	Larvae	< 59	4 – 30	<6	November – May	Pelagic and bottom waters
	Young-of-the-Year	< 82	5 – 33	0.1 - 10		Bottoms habitats of mud or fine grained sand
	Juveniles	< 77	10 – 30	1 – 50	January – December	Bottoms habitats of mud or fine grained sand

5-143

TABLE 5.4-4 (page 2 of 5)

Summary of General Habitat Parameters for those Species and Life Stages for which EFH has been Designated in the Project Area

Species	Life Stage / Stage of Maturity	EFH General Habitat Parameters				
		Water Temp (°F)	Salinity (‰)	Water Depth (m)	Seasonal Occurrence	Comments
Winter flounder (cont.)	Adults	< 77	15 – 33	1 – 100	January – December	Bottom habitats of mud, sand, and gravel
	Spawning Adults	< 59	5.5 – 36	<6	October – April	Bottoms habitats of sand, muddy sand, mud and gravel substrate
Windowpane flounder	Eggs	< 68	0.5 – 25	<70	February – November	Surface waters
	Larvae	< 68	0.5 – 25	<70	February – November	Pelagic waters
	Juveniles	< 77	5.5 – 36	1 – 100	January – December	Bottom habitats with a substrate of mud or fine-grained sand
	Adults	< 80	5.5 – 36	1 – 75	January – December	Bottom habitats with a substrate of mud or fine-grained sand
	Spawning Adults	< 70	5.5 – 36	1 – 75	February – November	Bottom habitats with a substrate of mud or fine-grained sand

TABLE 5.4-4 (page 3 of 5)

Summary of General Habitat Parameters for those Species and Life Stages for which EFH has been Designated in the Project Area

Species	Life Stage / Stage of Maturity	EFH General Habitat Parameters				
		Water Temp (°F)	Salinity (‰)	Water Depth (m)	Seasonal Occurrence	Comments
Atlantic Herring	Larvae	< 61	~32	50 – 90	March – May	Pelagic waters
	Juveniles	< 50	26 – 32	15 - 135	January – May	Pelagic water and bottom habitats
	Adults	< 50	>28	20 - 130	January – May	Pelagic water and bottom habitats
Bluefish	Juveniles				April – October	Occur within estuarine and marine salinities
	Adults		>25		April – October	Occur within estuarine and marine salinities
Butterfish	Larvae	48 - 66	0.5 – 25	10 – 1829	Common in August	Pelagic shelf waters and estuarine and marine inshore waters
	Juveniles	37 - 82	0.5 – 25	10 – 360	March – November, offshore in winter	Over sandy and muddy bottoms during day, upper water column at night
	Adults	37 - 82	0.5 – 25	10 – 360	March – November offshore in winter	Pelagic waters over sandy, sandy-silt, and muddy substrates
Atlantic mackerel	Juveniles	39 - 72	∃ 25	Shore – 320	April – December	Depth and water temperature ranges vary seasonally
	Adults	39 - 61	∃ 25	Shore – 380	April – June, September – December	Depth and water temperature ranges vary seasonally

5-145

TABLE 5.4-4 (page 4 of 5)

Summary of General Habitat Parameters for those Species and Life Stages for which EFH has been Designated in the Project Area

Species	Life Stage / Stage of Maturity	EFH General Habitat Parameters				
		Water Temp (°F)	Salinity (‰)	Water Depth (m)	Seasonal Occurrence	Comments
Summer flounder	Larvae		0 > 25	9 – 70	September – February November – May	Pelagic waters, most abundant inshore (12-50 miles from shore)
	Juveniles	> 37	10 – 30		March – December	Demersal inshore and offshore waters over sand and mud substrate
	Adults		10 – 30	Shallow estuaries during warmer months; outer continental shelf during colder months (150 m)	March – December	Demersal inshore and offshore waters over sand and mud substrate; depths vary seasonally
Scup	Eggs	55 - 73	>15		May – August	
	Larvae	55 - 73	>15		May – September	

TABLE 5.4-4 (page 5 of 5)

Summary of General Habitat Parameters for those Species and Life Stages for which EFH has been Designated in the Project Area

Species	Life Stage / Stage of Maturity	EFH General Habitat Parameters				
		Water Temp (°F)	Salinity (‰)	Water Depth (m)	Seasonal Occurrence	Comments
Scup (cont.)	Juveniles	> 45	>15		May – October	Demersal waters sand, mud, mussel and eelgrass bed bottoms
	Adults		∃ 25		May – October	Adults winter offshore November – April
Black sea bass	Juveniles	> 43	> 18			Demersal waters over rough bottom, shellfish and eelgrass beds, and man-made structures in sandy-shelly areas; winter offshore from New Jersey and south
	Adults	43 - 82	0.5 – 25 ∃ 25		May – October	Demersal waters over structured habitats, sand and shell bottoms preferred; winter offshore south of New York (Nov – Apr)

Seasonal occurrence / abundance based on EFH descriptions in species' FMP and/or the ELMR temporal distribution and relative abundance database for the Hudson River/Raritan Bay estuary.

ELMR relative abundance rankings: Common – species is frequently encountered but not in large numbers; does not imply a uniform distribution over a specific salinity zone.
Abundant – species is often encountered in substantial numbers relative to other species with similar life modes.

Bluefish Distribution of juveniles by temperature, salinity, and depth over the continental shelf is undescribed.
Bluefish Adults are highly migratory and distribution varies seasonally and according to the size of the individuals comprising the schools.

5-147

TABLE 5.4-5 (page 1 of 4) Habitat Preferences of Macroinvertebrates Collected in New York and New Jersey Harbor Complex			
Common Name	**Scientific Name**	**Depth preference**	**Substrate preference**
Bivalves			
Blue mussel	*Mytilus edulis*	intertidal	rocks, pilings, etc.
Atlantic ribbed mussel	*Geukensia demissa*	intertidal	mud, peat, pilings
Atlantic jackknife	*Ensis directus*	intertidal	sand
Donax	*Donax fossor*	intertidal	sand
Green jackknife	*Solen viridis*	lower intertidal	sand and mud
False angel wing	*Petricola pholadiformis*	lower intertidal	heavy mud, clay or peat
Disk dosinia	*Dosinia discus*	lower intertidal	sandy mud
Baltic macoma	*Macoma balthica*	intertidal – 33ft	mud, muddy sand, or gravel
Northern quahog	*Mercenaria mercenaria*	intertidal – 49ft	sand or mud
Northern dwarf cockle	*Cerastoderma pinnulatum*	intertidal – 98ft	sand or sandy mud
American oyster	*Crassostrea virginica*	intertidal – 131ft	hard or soft bottom
Soft shell clam	*Mya arenaria*	intertidal – 240ft	sand or mud
Bay scallop	*Argopecten irradians*	1 – 59ft	muddy sand
Northern dwarf tellin	*Tellinia agilis*	2 – 151ft	sandy mud
Dwarf surf clam	*Mulinia lateralis*	2 – 181ft	sand or mud
Atlantic razor clam	*Siliqua costata*	low tide	sand or mud
Common jingle shell	*Anomia simplex*	low tide – 30ft	hard objects, rocks, pilings
Atlantic surf clam[1]	*Spisula solidissima*	low tide – 138ft	Sand, mud, or gravel
Glassy lyonsia	*Lyonsia hyalina*	low tide – 200ft	sand
Chestnut astarte	*Astarte castanea*	low tide – 597ft	Sand, mud, or gravel
Wavy astarte	*Astarte undata*	low tide – 627ft	Sand, mud, or gravel
File yoldia	*Yoldia limatula*	4 – 98ft	mud or muddy sand
Fragile spoon clam	*Periploma fragile*	6 – 1201ft	sand or mud
Lucine (crosshatched)	Lucinidae	7 – 299ft	sand
False quahog	*Pitar morrhuanus*	10 – 98ft	sand or mud
Atlantic nut clam	*Nucula proxima*	10 – 2500ft	sand or mud
Northern cardita	*Cyclocardia borealis*	15 – 751ft	sand, gravel or rubble

TABLE 5.4-5 (page 2 of 4) Habitat Preferences of Macroinvertebrates Collected in New York and New Jersey Harbor Complex			
Common Name	**Scientific Name**	**Depth preference**	**Substrate preference**
Bivalves (cont.)			
Crenella	*Crenella glandula*	16 – 361ft	mud
Comb yoldia	*Yoldia myalis*	20 – 299ft	sand or mud
Dolphin-toothed nut clam	*Nucula delphinodonta*	30 – 151ft	sand or mud
Ocean quahog	*Arctica islandica*	30 – 840ft	sand
Sea scallop[1]	*Placopecten magellanicus*	59 – 400ft	sand, gravel or rubble
Gastropods			
Common periwinkle	*Littorina littorea*	Intertidal	rocks, shells, sand
Hydrobia	*Hydrobia minuta*	Intertidal	marsh grass and mud
White slipper shell	*Crepidula plana*	Intertidal	rocks and other objects
Eastern mud whelk	*Ilyanassa obsoleta*	Intertidal	mud
Solitary paper shell	*Haminoea solitaria*	intertidal - low tide	sandy mud
Lobed moon shell	*Polinices duplicatus*	intertidal - low tide	sand or sandy mud
Channeled whelk	*Busycon canaliculatum*	intertidal - low tide	sand or mud
Common slipper shell	*Crepidula fornicata*	intertidal – 49ft	rocks and other objects
New England dog whelk	*Ilyanassa trivittatus*	intertidal – 299ft	sand or muddy sand
Northern moon snail	*Lunatia heros*	intertidal – 1201ft	sand
Barrel bubble	*Retusa sp.*	intertidal – 6001ft	sand or mud
Thick-lipped drill	*Eupleura caudata*	low tide	oyster beds
Convex slipper shell	*Crepidula convexa*	low tide	rocks and other objects
Three-toothed odostome	*Odostomia trifida*	low tide	rocks and other objects
Knobbed whelk	*Busycon carica*	low tide – 15ft	sand
Turbonille	*Turbonilla stricta*	low tide – 600ft	rubble
Wentletrap	*Epitonium sp.*	low tide – 600ft	sand or rubble
North Atlantic top shell	*Calliostoma occidentale*	low tide – 6001ft	sand or rubble

TABLE 5.4-5 (page 3 of 4) Habitat Preferences of Macroinvertebrates Collected in New York and New Jersey Harbor Complex			
Common Name	**Scientific Name**	**Depth preference**	**Substrate preference**
Nudibranch			
sea slug	*Corambella sp.*	Unavailable	unavailable
Cephalopods			
Long-fin squid[1]	*Loligo pealei*	near shore - continental shelf	
Short-fin squid[1]	*Illex illecebrosus*	near shore -open ocean	
Arthropods			
Green crab	*Carcinus maenus*	Intertidal	Sand, rock or mud
Scud	*Gammarus spp.*	intertidal – 98ft	Sand, rock or mud
Opossom shrimp	*Neomysis americana*	intertidal – 761ft	Seagrass
Harris mud crab	*Rhithropanopeus harrisii*	low tide	Mud
Flat-browed mud shrimp	*Upogebia affinis*	low tide	Sand and mud flats
Daggerblade grass shrimp	*Palaemonetes pugio*	low tide – 30ft	Macrophytes or other structures
Brackish grass shrimp	*Palaemonetes intermedius*	low tide – 30ft	
Common shore shrimp	*Palaemonetes vulgaris*	low tide – 46ft	Seagrass
Say's mud crab	*Neopanope texana*	low tide – 89ft	Mud, near oysters
Blue crab	*Callinectes sapidus*	low tide – 121ft	Sand, rock or mud
Lady crab	*Ovalipes ocellatus*	low tide – 131ft	Sand, rock or mud
Flat mud crab	*Eurypanopeus depressus*	low tide – 131ft	Mud, near oysters
Long-clawed hermit crab	*Pagurus longicarpus*	low tide – 148ft	Sand, rock or mud
Seven spine bay shrimp	*Crangon septemspinosa*	low tide – 299ft	Sand or eelgrass beds
Spider crab	*Libinia emarginata*	low tide – 410ft	Sand, rock or mud
Mantis shrimp	*Squilla empusa*	low tide – 499ft	Sand or mud
Acadian hermit crab	*Pagurus acadianus*	low tide – 1601ft	Rocks
Jonah crab	*Cancer borealis*	low tide – 2622ft	Rocks

TABLE 5.4-5 (page 4 of 4) Habitat Preferences of Macroinvertebrates Collected in New York and New Jersey Harbor Complex			
Common Name	**Scientific Name**	**Depth preference**	**Substrate preference**
Arthropods (cont.)			
Atlantic rock crab	*Cancer irroratus*	low tide – 2560ft	Sand, rock or gravel
Deep-sea red crab	*Geryon quinquedens*	131 – 7071ft	Silty clay, mud
Fiddler crab	*Uca* sp.	Lower intertidal zone	Sand and organic matter
American lobster	*Homarus americanus*	near shore – continental shelf	rocks or mud
Merostomatid			
Horseshoe crab	*Limulus polyphemus*	low tide- 76ft	sand or mud
Echinoderms			
Forbe's common sea star	*Asterias forbesi*	low tide – 161ft	sand, rock or gravel
Atlantic purple sea urchin	*Arbacia punctulata*	low tide – 751ft	rock and shell bottoms
sea urchin	*Strongylocentrotidae*	low tide – 3797ft	
Common sand dollar	*Echinarachnius parma*	low tide – 5292ft	sand
Sea cucumber	*Stereoderma unisemita*	102 – 131ft	
Ascidian			
Sea grape	*Molgula manhattensis*	low tide	rocks and other objects
[1] Essential Fish Habitat species			

TABLE 5.4-6 New York and New Jersey Harbor Sediment Type Recorded at Sampling Station			
SITE CODE	STATION NAME	REGION	SEDIMENT TYPE
SB-1	Gowanus Bay Interpier South	South Brooklyn	Smooth, Mud
SB-2	Gowanus Bay Interpier	South Brooklyn	Sand, Smooth, Mud
SB-3	Gowanus Bay Interpier North	South Brooklyn	Smooth, Mud
SB-4	Bay Ridge Channel	South Brooklyn	Smooth, Mud
PJ-1	Jersey Flats	Port Jersey	Mud, Shells, Clay, Sand, Rocks
PJ-2	Pierhead Channel	Port Jersey	Smooth, Mud, Sand, Rocks, Shells
PJ-3	Constable Hook	Port Jersey	Smooth, Mud
PJ-4	Port Jersey Channel	Port Jersey	Smooth, Mud, Clay
PJ-5	Global Marine Terminal	Port Jersey	Smooth, Mud
PJ-6	Claremont Terminal Channel	Port Jersey	Smooth, Mud
HW-1	Ambrose Channel North	Lower NY Bay	Hard Sand
HW-2	Ambrose Channel South	Upper NY Bay	Hard Sand, Mud
HW-3	Red Hook Channel	Upper NY Bay	Smooth, Mud, Sand, Shells
HW-4	Anchorage Channel North	Upper NY Bay	Smooth, Mud, Sand, Shells, Rocks
HW-5	Bergen Point East Reach/ Constable Hook Reach	Kill Van Kull	Sand, Shells
HW-6	North of Shooter Island Reach	Arthur Kill	Smooth
HW-7	Elizabeth Reach	Arthur Kill	Smooth, Mud, Sand, Rocks, Bricks
HW-8	Middle Reach	Newark Bay	Smooth, Mud, Clay
HW-9	Newark Bay South Reach	Newark Bay	Smooth, Red Clay
HW-10	Newark Bay/Port Elizabeth	Newark Bay	Smooth

Table 5.4-7 Marine Mammals Reported from Offshore Areas that Could Occur in the New York and New Jersey Harbor	
Common Name	**Scientific Name**
Cetaceans	
Northern Right whale*[1,4]	*Eubalaena glacialis*
Finback whale*[1,4]	*Balaenoptera physalus*
Minke whale[2]	*Balaenoptera acutorostrata*
Sei whale*[1]	*Balaenoptera borealis*
Blue whale*[1]	*Balaenoptera musculus*
Humpback whale*[1,4]	*Megaptera novaeangliae*
Sperm whale*[1]	*Physeter catodon*
Bottlenosed dolphin[3]	*Tursiops truncatus*
Common dolphin[3]	*Delphinus delphis*
Striped dolphin[2]	*Stenella coeruleoalba*
Harbor porpoise[3]	*Phocoena phocoena*
Atlantic white-sided dolphin[2]	*Lagenorhynchus acutus*
Pinnipeds	
Harbor seal[3]	*Phoca vitulina*
Grey seal[2]	*Halichoerus grypus*
Harp seal[2]	*Phoca groenlandica*
Ringed seal[2]	*Phoca hispida*
Hooded seal[2]	*Cystophora cristata*

*Federally listed threatened or endangered species.
[1]Harbor Estuary Program, 1999
[2]USFWS, 1997
[3]Kiviat and Hartwig, 1994
[4]NMFS, 1999

TABLE 5.4-8 (page 1 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Ducks, Ducklike and Miscellaneous Swimming Birds		
Red-throated Loon	*Gavia stellata*	New Jersey
Common Loon	*Gavia immer*	New York and New Jersey
Pied-billed Grebe	*Podilymbus podiceps*	New York and New Jersey
Horned Grebe	*Podiceps auritus*	New York and New Jersey
Red-necked Grebe	*Podiceps grisegena*	New Jersey
Eared Grebe	*Podiceps nigricollis*	New Jersey
Razorbill	*Alca torda*	New Jersey
Great Cormorant	*Phalacrocorax carbo*	New Jersey
Double-crested Cormorant	*Phalacrocorax auritus*	New York and New Jersey
Wood Stork	*Mycteria americana*	New Jersey
Fulvous Whistling-Duck	*Dendrocygna bicolor*	New Jersey
Tundra Swan	*Cygnus columbianus*	New Jersey
Mute Swan	*Cygnus olor*	New York and New Jersey
Whistling Swan	*Olor columbianus*	New Jersey
Greater White-fronted Goose	*Anser albifrons*	New Jersey
Greater Snow Goose	*Chen caerulescens*	New York and New Jersey
Brant	*Branta bernicla*	New York and New Jersey
Canada Goose	*Branta canadensis*	New York and New Jersey
Wood Duck	*Aix sponsa*	New York and New Jersey
Green-winged Teal	*Anas crecca*	New York and New Jersey
American Black Duck	*Anas rubripes*	New York and New Jersey
Mallard	*Anas platyrhynchos*	New York and New Jersey
Northern Pintail	*Anas acuta*	New York and New Jersey
Blue-winged Teal	*Anas discors*	New York and New Jersey
Cinnamon Teal	*Anas cyanoptera*	New Jersey
Northern Shoveler	*Anas clypeata*	New York and New Jersey
Gadwall	*Anas strepera*	New York and New Jersey
Eurasian Wigeon	*Anas penelope*	New Jersey
American Wigeon	*Anas americana*	New York and New Jersey
Canvasback	*Aythya valisineria*	New York and New Jersey
Redhead	*Aythya americana*	New York and New Jersey
Ring-necked Duck	*Aythya collaris*	New York and New Jersey
Greater Scaup	*Aythya marila*	New York and New Jersey
Lesser Scaup	*Aythya affinis*	New York and New Jersey
Common Eider	*Somateria mollissima*	New York and New Jersey
King Eider	*Somateria spectabilis*	New York and New Jersey
Harlequin Duck	*Histrionicus histrionicus*	New York and New Jersey
Oldsquaw	*Clangula hyemalis*	New Jersey
Black Scoter	*Melanitta nigra*	New Jersey

TABLE 5.4-8 (page 2 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Ducks, Ducklike and Miscellaneous Swimming Birds (cont.)		
Surf Scoter	*Melanitta perspicillata*	New Jersey
White-winged Scoter	*Melanitta fusca*	New Jersey
Common Goldeneye	*Bucephala clangula*	New Jersey
Bufflehead	*Bucephala albeola*	New York and New Jersey
Hooded Merganser	*Lophodytes cucullatus*	New York and New Jersey
Common Merganser	*Mergus merganser*	New York and New Jersey
Red-breasted Merganser	*Mergus serrator*	New York and New Jersey
Ruddy Duck	*Oxyura jamaicensis*	New York and New Jersey
Seabirds, Gulls, etc. (Aerialists)		
Sooty Shearwater	*Puffinus griseus*	New Jersey
Wilson's Storm-Petrel	*Oceanites oceanicus*	New Jersey
Northern Gannet	*Morus bassanus*	New Jersey
Pomarine Jaeger	*Stercorarius pomarinus*	New Jersey
Parasitic Jaeger	*Stercorarius parasiticus*	New Jersey
Laughing Gull	*Larus atricilla*	New York and New Jersey
Franklin's Gull	*Larus pipixcan*	New Jersey
Little Gull	*Larus minutus*	New Jersey
Common Black-headed Gull	*Larus ridibundus*	New Jersey
Bonaparte's Gull	*Larus philadelphia*	New York and New Jersey
Ring-billed Gull	*Larus delawarensis,*	New York and New Jersey
Herring Gull	*Larus argentatus*	New York and New Jersey
Thayer's Gull	*Larus thayeri*	New Jersey
Iceland Gull	*Larus glaucoides*	New Jersey
Lesser Black-backed Gull	*Larus fuscus*	New Jersey
Glaucous Gull	*Larus hyperboreus*	New Jersey
Great Black-backed Gull	*Larus marinus*	New York and New Jersey
Black-legged Kittiwake	*Rissa tridactyla*	New Jersey
Ivory Gull	*Pagophila eburnea*	New Jersey
Gull-billed Tern	*Sterna nilotica*	New York and New Jersey
Caspian Tern	*Sterna caspia*	New Jersey
Royal Tern	*Sterna maxima*	New Jersey
Roseate Tern	*Sterna dougallii*	New York and New Jersey
Common Tern	*Sterna hirundo*	New York and New Jersey
Arctic Tern	*Sterna paradisaea*	New Jersey
Forster's Tern	*Sterna forsteri*	New York and New Jersey
Arctic Tern	*Sterna paradisaea*	New Jersey
Least Tern	*Sterna antillarum*	New York and New Jersey
Bridled Tern	*Sterna anaethetus*	New York
Sooty Tern	*Sterna fuscata*	New Jersey
Black Tern	*Chlidonias niger*	New Jersey

TABLE 5.4-8 (page 3 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Seabirds, Gulls, etc. (Aerialists) (cont.)		
Black Skimmer	*Rynchops niger*	New York and New Jersey
Razorbill	*Alca torda*	New Jersey
Long-legged Wading Birds		
American Bittern	*Botaurus lentiginosus*	New York and New Jersey
Least Bittern	*Ixobrychus exilis*	New York and New Jersey
Great Blue Heron	*Ardea herodias*	New York and New Jersey
Great Egret	*Casmerodius albus*	New York and New Jersey
Snowy Egret	*Egretta thula*	New York and New Jersey
Louisiana Heron	*Hydranassa tricolor*	New Jersey
Little Blue Heron	*Egretta caerulea*	New York and New Jersey
Tricolored Heron	*Egretta tricolor*	New York and New Jersey
Cattle Egret	*Bubulcus ibis*	New York and New Jersey
Green-backed Heron	*Butorides striatus*	New York and New Jersey
Black-crowned Night-Heron	*Nycticorax nycticorax*	New York and New Jersey
Yellow-crowned Night-Heron	*Nyctanassa violacea*	New York and New Jersey
White Ibis	*Eudocimus albus*	New Jersey
Glossy Ibis	*Plegadis falcinellus*	New York and New Jersey
White-faced Ibis	*Plegadis chihi*	New York and New Jersey
Smaller Wading Birds		
Yellow Rail	*Coturnicops noveboracensis*	New Jersey
Black Rail	*Laterallus jamaicensis*	New Jersey
Clapper Rail	*Rallus longirostris*	New York and New Jersey
King Rail	*Rallus elegans*	New Jersey
Virginia Rail	*Rallus limicola*	New York and New Jersey
Sora	*Porzana carolina*	New York and New Jersey
Common Gallinule	*Gallinula chloropus*	New Jersey
Common Moorhen	*Gallinula chloropus*	New York and New Jersey
American Coot	*Fulica americana*	New York and New Jersey
Black-bellied Plover	*Pluvialis squatarola*	New York and New Jersey
American Golden-Plover	*Pluvialis dominica*	New Jersey
Semipalmated Plover	*Charadrius semipalmatus*	New York and New Jersey
Piping Plover	*Charadrius melodus*	New York and New Jersey
Killdeer	*Charadrius vociferus*	New York and New Jersey
American Oystercatcher	*Haematopus palliatus*	New York and New Jersey
Black-necked Stilt	*Himantopus mexicanus*	New Jersey
American Avocet	*Recurvirostra americana*	New Jersey
Greater Yellowlegs	*Tringa melanoleuca*	New York and New Jersey
Lesser Yellowlegs	*Tringa flavipes*	New York and New Jersey
Solitary Sandpiper	*Tringa solitaria*	New York and New Jersey

TABLE 5.4-8 (page 4 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Smaller Wading Birds (cont.)		
Willet	*Catoptrophorus semipalmatus*	New York and New Jersey
Purple sandpiper	*Calidris maritima*	New Jersey
Spotted Sandpiper	*Actitis macularia*	New York and New Jersey
Upland Sandpiper	*Bartramia longicauda*	New York and New Jersey
Whimbrel	*Numenius phaeopus,*	New York and New Jersey
Hudsonian Godwit	*Limosa haemastica*	New York and New Jersey
Marbled Godwit	*Limosa fedoa*	New York and New Jersey
Ruddy Turnstone	*Arenaria interpres*	New York and New Jersey
Red Knot	*Calidris canutus*	New York and New Jersey
Sanderling	*Calidris alba*	New York and New Jersey
Semi-palmated Sandpiper	*Calidris pusilla*	New York and New Jersey
Western Sandpiper	*Calidris mauri*	New Jersey
Least Sandpiper	*Calidris minutilla*	New Jersey
White-rumped Sandpiper	*Calidris fuscicollis*	New York and New Jersey
Baird's Sandpiper	*Calidris bairdii*	New York and New Jersey
Pectoral Sandpiper	*Calidris melanotos*	New York and New Jersey
Purple Sandpiper	*Calidris maritima*	New Jersey
Dunlin	*Calidris alpina*	New York and New Jersey
Curlew Sandpiper	*Calidris ferruginea*	New Jersey
Stilt Sandpiper	*Calidris himantopus*	New Jersey
Buff-breasted Sandpiper	*Tryngites subruficollis*	New Jersey
Ruff	*Philomachus pugnax*	New Jersey
Short-billed Dowitcher	*Limnodromus griseus*	New Jersey
Long-billed Dowitcher	*Limnodromus scolopaceus*	New Jersey
Common Snipe	*Gallinago gallinago*	New York and New Jersey
American Woodcock	*Scolopax minor*	New York and New Jersey
Wilson's Phalarope	*Phalaropus tricolor*	New York and New Jersey
Red-necked Phalarope	*Phalaropus lobatus*	New Jersey
Red Phalarope	*Phalaropus fulicaria*	New Jersey
Fowl-like Birds		
Ring-necked Pheasant	*Phasianus colchicus*	New York and New Jersey
Ruffed Grouse	*Bonasa umbellus*	New York and New Jersey
Northern Bobwhite	*Colinus virginianus*	New York and New Jersey
Birds of Prey		
American Swallow-tailed Kite	*Elanoides forficatus*	New Jersey
Northern Harrier	*Circus cyaneus*	New York and New Jersey
Sharp-shinned Hawk	*Accipiter striatus*	New York and New Jersey
Cooper's Hawk	*Accipiter cooperii*	New York and New Jersey
Northern Goshawk	*Accipiter gentilis*	New York and New Jersey

TABLE 5.4-8 (page 5 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Birds of Prey (cont.)		
Red-shouldered Hawk	*Buteo lineatus*	New York and New Jersey
Broad-winged Hawk	*Buteo platypterus*	New York and New Jersey
Red-tailed Hawk	*Buteo jamaicensis*	New York and New Jersey
Rough-legged Hawk	*Buteo lagopus*	New York and New Jersey
Black Vulture	*Coragyps atratus*	New Jersey
Turkey Vulture	*Cathartes aura*	New Jersey
Osprey	*Pandion haliaetus*	New York and New Jersey
Bald Eagle	*Haliaeetus leucocephalus*	New York and New Jersey
Golden Eagle	*Aquila chrysaetos*	New York and New Jersey
American Kestrel	*Falco sparverius*	New York and New Jersey
Merlin	*Falco columbarius*	New York and New Jersey
Peregrine Falcon	*Falco peregrinus*	New York and New Jersey
Gyrfalcon	*Falco rusticolus*	New Jersey
Barn Owl	*Tyto alba*	New York and New Jersey
Eastern Screech-Owl	*Otus asio*	New York and New Jersey
Great Horned Owl	*Bubo virginianus*	New York and New Jersey
Snowy Owl	*Nyctea scandiaca*	New York and New Jersey
Barred Owl	*Strix varia*	New York and New Jersey
Long-eared Owl	*Asio otus*	New York and New Jersey
Short-eared Owl	*Asio flammeus*	New York and New Jersey
Northern Saw-whet Owl	*Aegolius acadicus*	New York and New Jersey
Songbirds		
Rock Dove	*Columba livia*	New York and New Jersey
Mourning Dove	*Zenaida macroura*	New York and New Jersey
Monk Parakeet	*Myiopsitta monachus*	New York and New Jersey
Black-hooded Parakeet	*Nandayus nenday*	New York
Budgerigar	*Melopsittacus undulatus*	New Jersey
Black-billed Cuckoo	*Coccyzus erythropthalmus*	New York and New Jersey
Yellow-billed Cuckoo	*Coccyzus americanus*	New York and New Jersey
Common Nighthawk	*Chordeiles minor*	New York and New Jersey
Chuck-will's-widow	*Caprimulgus carolinensis*	New York and New Jersey
Whip-poor-will	*Caprimulgus vociferus*	New York and New Jersey
Chimney Swift	*Chaetura pelagica*	New York and New Jersey
Ruby-throated Hummingbird	*Archilocus colubris*	New York and New Jersey
Rufous Hummingbird	*Selasphorus rufus*	New Jersey
Belted Kingfisher	*Ceryle alcyon*	New York and New Jersey
Red-headed Woodpecker	*Melanerpes erythrocephalus*	New Jersey
Red-bellied Woodpecker	*Melanerpes carolinus*	New York and New Jersey
Yellow-bellied Sapsucker	*Sphyrapicus varius*	New York and New Jersey
Downy Woodpecker	*Picoides pubescens*	New York and New Jersey

TABLE 5.4-8 (page 6 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Songbirds (cont.)		
Hairy Woodpecker	*Picoides villosus*	New York and New Jersey
Northern Flicker	*Colaptes auratus*	New York and New Jersey
Pileated Woodpecker	*Dryocopus pileatus*	New York and New Jersey
Olive-sided Flycatcher	*Contopus borealis*	New York and New Jersey
Eastern Wood-Pewee	*Contopus virens*	New York and New Jersey
Yellow-bellied Flycatcher	*Empidonax flaviventris*	New York and New Jersey
Acadian Flycatcher	*Empidonax virescens*	New York and New Jersey
Alder Flycatcher	*Empidonax alnorum*	New York and New Jersey
Willow Flycatcher	*Empidonax traillii*	New York and New Jersey
Least Flycatcher	*Empidonax minimus*	New York and New Jersey
Eastern Phoebe	*Sayornis phoebe*	New York and New Jersey
Great Crested Flycatcher	*Myiarchus crinitus*	New York and New Jersey
Western Kingbird	*Tyrannus verticalis*	New Jersey
Eastern Kingbird	*Tyrannus tyrannus*	New York and New Jersey
Horned Lark	*Eremophila alpestris*	New York and New Jersey
Purple Martin	*Progne subis*	New York and New Jersey
Tree Swallow	*Tachycineta bicolor*	New York and New Jersey
Northern Rough-winged Swallow	*Stelgidopteryx erripennis*	New York and New Jersey
Bank Swallow	*Riparia riparia*	New York and New Jersey
Cliff Swallow	*Hirundo pyrrhonota*	New York and New Jersey
Barn Swallow	*Hirundo rustica*	New York and New Jersey
Blue Jay	*Cyanocitta cristata*	New York and New Jersey
American Crow	*Corvus brachyrhynchos*	New York and New Jersey
Fish Crow	*Corvus ossifragus*	New York and New Jersey
Black-capped Chickadee	*Parus atricapillus*	New York and New Jersey
Carolina Chickadee	*Parus atricapillus*	New Jersey
Boreal Chickadee	*Parus hudsonicus*	New Jersey
Tufted Titmouse	*Parus bicolor*	New York and New Jersey
Red-breasted Nuthatch	*Sitta canadensis*	New York and New Jersey
White-breasted Nuthatch	*Sitta carolinensis*	New York and New Jersey
Brown Creeper	*Certhia americana*	New York and New Jersey
Carolina Wren	*Thryothorus ludovicianus*	New York and New Jersey
House Wren	*Troglodytes aedon*	New York and New Jersey
Winter Wren	*Troglodytes troglodytes*	New Jersey
Sedge Wren	*Cistothorus platensis*	New Jersey
Marsh Wren	*Cistothorus palustris*	New York and New Jersey
Golden-crowned Kinglet	*Regulus satrapa*	New York and New Jersey
Ruby-crowned Kinglet	*Regulus calendula*	New Jersey
Blue-gray Gnatcatcher	*Polioptila caerulea*	New York and New Jersey

TABLE 5.4-8 (page 7 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Songbirds (cont.)		
Eastern Bluebird	*Sialia sialis*	New York and New Jersey
Veery	*Catharus fuscescens*	New York and New Jersey
Gray-cheeked Thrush	*Catharus minimus*	New Jersey
Swainson's Thrush	*Catharus guttatus*	New Jersey
Hermit Thrush	*Catharus guttatus*	New York and New Jersey
Wood Thrush	*Hylocichla mustelina*	New York and New Jersey
American Robin	*Turdus migratorius*	New York and New Jersey
Varied Thrush	*Ixoreus naevius*	New Jersey
Gray Catbird	*Dumetella carolinensis*	New York and New Jersey
Northern Mockingbird	*Mimus polyglottos*	New York and New Jersey
Sage Thrasher	*Oreoscoptes montanus*	New Jersey
Brown Thrasher	*Toxostoma rufum*	New York and New Jersey
Water Pipit	*Anthus spinoletta*	New Jersey
Cedar Waxwing	*Bombycilla cedrorum*	New York and New Jersey
Northern Shrike	*Lanius excubitor*	New Jersey
Loggerhead Shrike	*Lanius ludovicianus*	New Jersey
European Starling	*Sturnus vulgaris*	New York and New Jersey
White-eyed Vireo	*Vireo griseus*	New York and New Jersey
Solitary Vireo	*Vireo solitarius*	New York and New Jersey
Yellow-throated Vireo	*Vireo flavifrons*	New York and New Jersey
Warbling Vireo	*Vireo gilvus*	New York and New Jersey
Philadelphia vireo	*Vireo philadelphicus*	New Jersey
Red-eyed Vireo	*Vireo olivaceus*	New York and New Jersey
Blue-winged Warbler	*Vermivora pinus*	New York and New Jersey
Golden-winged Warbler	*Vermivora chrysoptera*	New York and New Jersey
Brewster's Warbler	*Vermivora pinus x V. chrysoptera*	New York
Tennessee Warbler	*Vermivora peregrina*	New Jersey
Orange-crowned Warbler	*Vermivora celata*	New Jersey
Nashville Warbler	*Vermivora ruficapilla*	New York and New Jersey
Connecticut warbler	*Oporornis agilis*	New York
Northern Parula	*Parula americana*	New York and New Jersey
Yellow Warbler	*Dendroica petechia*	New York and New Jersey
Chestnut-sided Warbler	*Dendroica pensylvanica*	New York and New Jersey
Magnolia Warbler	*Dendroica magnolia*	New York and New Jersey
Cape May Warbler	*Dendroica tigrina*	New Jersey
Black-throated Blue Warbler	*Dendroica caerulescens*	New York and New Jersey
Yellow-rumped Warbler	*Dendroica coronata*	New York and New Jersey
Townsend's Warbler	*Dendroica townsendi*	New Jersey
Black-throated Green Warbler	*Dendroica virens*	New Jersey

TABLE 5.4-8 (page 8 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Songbirds (cont.)		
Blackburnian Warbler	*Dendroica fusca*	New York and New Jersey
Yellow-throated Warbler	*Dendroica dominica*	New Jersey
Pine Warbler	*Dendroica pinus*	New Jersey
Prairie Warbler	*Dendroica discolor*	New York and New Jersey
Palm Warbler	*Dendroica palmarum*	New York and New Jersey
Bay-breasted Warbler	*Dendroica castanea*	New York and New Jersey
Blackpoll Warbler	*Dendroica striata*	New York and New Jersey
Cerulean Warbler	*Dendroica cerulea*	New Jersey
Black-and-white Warbler	*Mniotilta varia*	New York and New Jersey
American Redstart	*Setophaga ruticilla*	New York and New Jersey
Prothonotary Warbler	*Protonotaria citrea*	New York and New Jersey
Worm-eating Warbler	*Helmitheros vermivorus*	New York and New Jersey
Swainson's Warbler	*Limnothlypis swainsonii*	New Jersey
Ovenbird	*Seiurus aurocapillus*	New York and New Jersey
Northern Waterthrush	*Seiurus noveboracensis*	New York and New Jersey
Louisiana Waterthrush	*Seiurus motacilla*	New York and New Jersey
Kentucky Warbler	*Oporornis formosus*	New York and New Jersey
Connecticut Warbler	*Oporornis agilis*	New Jersey
Mourning Warbler	*Oporornis philadelphia*	New York and New Jersey
Common Yellowthroat	*Geothlypis trichas*	New York and New Jersey
Hooded Warbler	*Wilsonia citrina*	New York and New Jersey
Wilson's Warbler	*Wilsonia pusilla*	New Jersey
Canada Warbler	*Wilsonia canadensis*	New York and New Jersey
Yellow-breasted Chat	*Icteria virens*	New York and New Jersey
Summer Tanager	*Piranga rubra*	New Jersey
Scarlet Tanager	*Piranga olivacea*	New York and New Jersey
Western Tanager	*Piranga ludoviciana*	New Jersey
Northern Cardinal	*Cardinalis cardinalis*	New York and New Jersey
House Sparrow	*Passer domesticus*	New York
Dickcissel	*Spiza americana*	New Jersey
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	New York and New Jersey
Blue Grosbeak	*Guiraca caerulea*	New Jersey
Indigo Bunting	*Passerina cyanea*	New York and New Jersey
Rufous-sided Towhee	*Pipilo erythrophthalmus*	New York and New Jersey
American Tree Sparrow	*Spizella arborea*	New York and New Jersey
Chipping Sparrow	*Spizella passerina*	New Jersey
Clay-colored Sparrow	*Spizella pallida*	New Jersey
Field Sparrow	*Spizella pusilla*	New Jersey
Vesper Sparrow	*Pooecetes gramineus*	New York and New Jersey
Lark Sparrow	*Chondestes grammacus*	New Jersey

TABLE 5.4-8 (page 9 of 9) Bird Species Identified in the New York and New Jersey Harbor Area		
Common Name	**Species Name**	**Location**
Songbirds (cont.)		
Lark Bunting	*Calamospiza melanocorys*	New Jersey
Lapland Longspur	*Calcarius lapponicus*	New Jersey
Savannah Sparrow	*Passerculus sandwichensis*	New York and New Jersey
Grasshopper Sparrow	*Ammodramus savannarum*	New York and New Jersey
Henslow's Sparrow	*Ammodramus henslowii*	New Jersey
Sharp-tailed sparrow	*Ammospiza caudacuta*	New York and New Jersey
Le Conte's Sparrow	*Ammodramus leconteii*	New Jersey
Sharp-tailed Sparrow	*Ammodramus caudacutus*	New Jersey
Seaside Sparrow	*Ammodramus maritimus*	New York and New Jersey
Fox Sparrow	*Passerella iliaca*	New Jersey
Song Sparrow	*Melospiza melodia*	New York and New Jersey
Lincoln's Sparrow	*Melospiza lincolnii*	New Jersey
Swamp Sparrow	*Melospiza georgiana*	New York and New Jersey
White-throated Sparrow	*Zonotrichia albicollis*	New York and New Jersey
White-crowned Sparrow	*Zonotrichia leucophrys*	New York and New Jersey
Dark-eyed Junco	*Junco hyemalis*	New York and New Jersey
Snow Bunting	*Plectrophenax nivalis*	New Jersey
Bobolink	*Dolichonyx oryzivorus*	New York and New Jersey
Red-winged Blackbird	*Agelaius phoeniceus*	New York and New Jersey
Eastern Meadowlark	*Sturnella magna*	New York and New Jersey
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	New Jersey
Rusty Blackbird	*Euphagus carolinus*	New Jersey
Boat-tailed Grackle	*Quiscalus major*	New Jersey
Common Grackle	*Quiscalus quiscula*	New York and New Jersey
Brown-headed Cowbird	*Molothrus ater*	New York and New Jersey
Orchard Oriole	*Icterus spurius*	New Jersey
Northern Oriole	*Icterus galbula*	New York and New Jersey
Pine Grosbeak	*Pinicola enucleator*	New Jersey
Purple Finch	*Carpodacus purpureus*	New York and New Jersey
House Finch	*Carpodacus mexicanus*	New Jersey
Red Crossbill	*Loxia curvirostra*	New Jersey
White-winged Crossbill	*Loxia leucoptera*	New Jersey
Common Redpoll	*Carduelis flammea*	New York and New Jersey
Hoary Redpoll	*Carduelis hornemanni*	New Jersey
Pine Siskin	*Carduelis pinus*	New York and New Jersey
American Goldfinch	*Carduelis tristis*	New York and New Jersey
European Goldfinch	*Carduelis carduelis*	New Jersey
Evening Grosbeak	*Coccothraustes vespertinus*	New Jersey

*The above table is based on sightings of birds in the New York and New Jersey Harbor area. There is no distinction as to whether they are breeding, overwintering or visitors to the area.

TABLE 5.4-9 (page 1 of 2)
Amphibians and Reptiles found at selected locations in the New York and New Jersey Harbor Area

Species		Location													
Common Name	Scientific Name	SH	HM	LP	PA	SI	NS	GK	FB	RB	UC	KP	AP	PB	JB
Salamanders															
Marbled Salamander	*Ambystoma opacum*					E									
Spotted Salamander *	*Ambystoma maculatum*					E				I			P		
Red-spotted Newt	*Notophthalmus v. viridescens*					U				U				P	
Northern Dusky Salamander	*Desmognathus f. fuscus*					C									
Northern Slimy Salamander	*Plethodon glutinosus*														
Four-toed Salamander	*Hemidactylium scutatum*					E	P								
Redback Salamander *	*Plethodon cinereus*					C	P	P	I	I				P	
Northern Red Salamander *	*Pseudotriton r. ruber*					P									
Northern Two-lined Salamander *	*Eurycea bislineata*					C									
Frogs and Toads															
Eastern Spadefoot *	*Scaphiopus h. holbrookii*					R				I					
Eastern American Toad *	*Bufo a. americanus*						P							P	
Fowler's Toad *	*Bufo woodhousii fowlerii*			P		U	P	P	I	I	P		P		
Northern Cricket Frog	*Acris c. crepitans*		P												
Northern Grey Treefrog *	*Hyla versicolor*														
Northern Spring Peeper *	*Pseudacris c. crucifer*		P			C	P	P	I	I			P		
BullFrog *	*Rana catesbeiana*		P			U	P						P	P	
Green Frog *	*Rana clamitans melanota*		P			C	P	U		I				R	
Wood Frog *	*Rana sylvatica*					C									
Northern Leopard Frog	*Rana pipiens*					C									
Southern Leopard Frog *	*Rana u. utricularia*		P										P		
Pickerel Frog *	*Rana palustris*		P			C									
Turtles															
Common Snapping Turtle *	*Chelydra s. serpentina*	P			P	C	P	U	U	I		P	P	P	
Common Musk Turtle *	*Sternotherus odoratus*														
Eastern Mud Turtle *	*Kinosternon s. subrubrum*	P			P						P		P		
Spotted Turtle *	*Clemmys guttata*	P			P										

5-163

TABLE 5.4-9 (page 2 of 2)
Amphibians and Reptiles found at selected locations in the New York and New Jersey Harbor Area

Species		Location													
Common Name	Scientific Name	SH	HM	LP	PA	SI	NS	GK	FB	RB	UC	KP	AP	PB	JB
Wood Turtle	*Clemmys insculpta*	P			P										
Eastern Box Turtle *	*Terrapene c. carolina*	P			P	C		U	I	I			P	P	
Northern Diamondback Terrapin *	*Malaclemys t. terrapin*	P		P		U	P	P	P	P	P	P	P	P	
Red-eared Slider *	*Trachemys scripta elegans*	P													
Yellowbelly Slider *	*Trachemys s. scripta*														
Snakes															
Northern Water Snake *	*Nerodia s. sipedon*	P			P	C					P				
Northern Brown Snake *	*Storeria d. dekayi*	P			P	C		P	I	I		P		P	
Eastern Garter Snake *	*Thamnophis s. sirtalis*	P				C	P	P	P						
Eastern Ribbon Snake	*Thamnophis s. sauritus*	P				E									
Eastern Hognose Snake *	*Heterodon platirhinos*	E				E									
Northern Ringneck Snake *	*Diadophis punctatus edwardsii*	P				U									
Eastern Worm Snake	*Carphophis a. amoenus*	P				R									
Northern Black Racer *	*Coluber c. constrictor*	E			P	U			I	I					
Smooth Green Snake	*Opheodrys vernalis*	P													
Eastern Milk Snake *	*Lampropeltis t. triangulum*	P			P	U				I					
Lizards															
Northern Fence Lizard *	*Sceloporus undulatus hyacinthinus*						P								
Italian Wall Lizard *	*Podarcis sicula*														

Occurrence Codes:	Site Codes:	
P=Present	SH=Sandy Hook, NJ	FB=Floyd Bennett Field, Brooklyn
E=Extirpated	HM=Hackensack Meadows, NY	RB=Ruler's Bar Hassock, Queens/Brooklyn
C=Common	LP=Liberty State Park Natural Area	UC=Udall's Cove and Ravine, Queens
U=Uncommon	PA=Poillon Avenue Wetlands, Staten Island	KP=Kissena Park, Queens
R=Rare	SI=Staten Island	AP=Alley Pond Park, Queens
I=Introduced	NS=Northwestern Staten Island	PB=Pelham Bay Park, Bronx
* = Confirmed during NYSDEC Amphibian and Reptile Atlas Project (NYSDEC 1999)	GK=Great Kills, Staten Island	JB=Jamaica Bay

Source: Barclay and Squires (1991)

TABLE 5.4-10 Terrestrial Mammals likely to be found in the New York and New Jersey Harbor Study Area		
Common Name	**Scientific Name**	**Reference**
Masked shrew	*Sorex cinereus*	NJDEP, 1999
Northern short-tailed shrew	*Blarina brevicauda*	NJDEP, 1999
Field mouse	*Peromyscus polionotus*	The Harbor Herons Report
White-footed mouse	*Peromyscus leucopus*	USACE, 1997
House mouse	*Mus musculus*	USACE, 1997
Meadow vole	*Microtus pennsylvanicus*	The Harbor Herons Report
Muskrat	*Ondatra zibethica*	The Harbor Herons Report
Black rat	*Rattus rattus*	NJDEP, 1999
Norway rat	*Rattus norvegicus*	The Harbor Herons Report
Eastern mole	*Scalopus aquaticus*	The Harbor Herons Report
Raccoon	*Procyon lotor*	The Harbor Herons Report
Long-tailed weasel	*Mustela frenata*	NJDEP, 1999
Common mink	*Mustela vison*	NJDEP, 1999
Striped skunk	*Mephitis mephitis*	NJDEP, 1999
Virginia opossum	*Didelphis virginiana*	The Harbor Herons Report
Gray squirrel	*Sciurus carolinensis*	The Harbor Herons Report
Red squirrel	*Tamiasciurus hudsonicus*	NJDEP, 1999
Southern flying squirrel	*Glaucomys volans*	NJDEP, 1999
Red bat	*Lasiurus borealis*	The Harbor Herons Report
Hoary bat	*Lasiurus cinereus*	The Harbor Herons Report
Little brown bat	*Myotis lucifugus*	The Harbor Herons Report
Silver-haired bat	*Lasionycteris noctivagans*	NJDEP, 1999
Eastern cottontail	*Sylvilagus floridanus*	The Harbor Herons Report
Blacktail jackrabbit	*Lepus californicus*	NJDEP, 1999
Red fox	*Vulpes fulva*	Halleck Street
Gray fox	*Urocyon cinereoargenteus*	NJDEP, 1999
Woodchuck	*Marmota monax*	NJDEP, 1999
Common eastern chipmunk	*Tamias striatus*	NJDEP, 1999
Domestic dog	*Canis familiaris*	NJDEP, 1999
House cat	*Felis domesticus*	NJDEP, 1999
Whited-tailed deer	*Odocoileus virginianus*	USACE, 1997

TABLE 5.4-11 (page 1 of 8)
Endangered and Threatened Species Occurring within the New York and New Jersey Harbor Study Area.

Common Name	Scientific Name	Federal[1] Status	NYS[2] Status	Year Identified	NJ[3] Status	Year Identified
BIRDS						
Peregrine falcon	*Falco peregrinus*		E	1991	E	1994
Piping plover	*Charadrius melodus*	T	E	1995	E	1997
Bald Eagle	*Haliaeetus leucocephalus*	T	T		E	
Roseate tern	*Sterna dougallii dougallii*	E	E	1995	E	
Black skimmer	*Rynchops niger*		Protected	1995	E	1986
Least tern	*Sterna antillarum*		T	1995	E	1996
Common tern	*Sterna hirundo*		T	1995		
Short-eared owl	*Asio flammeus*		E	1995	E	
Black rail	*Laterallus jamaicensis*		E	1999	T	
Black tern	*Chlidonias niger*		E	1999		
King rail	*Rallus elegans*		T			
Least bittern	*Ixobrychus exilis*		T			
Red knot	*Calidris canutus*				T	
Black-crowned night heron	*Nycticorax nycticorax*				T	
Savannah sparrow	*Passerculus sandwichensis*				T	1940
Black-crowned night heron	*Nycticorax nycticorax*				T	
Yellow-crowned night heron	*Nyctanassa violacea*		Protected		E	1996
Osprey	*Pandion haliaetus*				T	1987
Pied-billed grebe	*Podilymbus podiceps*		T		E	1994
American bittern	*Botaurus lentiginosus*		Protected		E	
Grasshopper sparrow	*Ammodramus savannarum*				T	1971
Northern harrier	*Circus cyaneus*		T		E	1986
Sedge wren	*Cistothorus platensis*		T		E	1963
American coot	*Fulica americana*				D	1986
Cooper's hawk	*Accipiter cooperii*				T	1982
Red-shouldered hawk	*Buteo lineatus*				Breed, E Non-Brd, T	1996
Red-headed woodpecker	*Melanerpes erythrocephalus*				T	1985
Upland sandpiper	*Bartramia longiauda*		T		E	
Vesper sparrow	*Pooecetes gramineus*				E	

TABLE 5.4-11 (page 2 of 8)
Engdangered and Threatened Species Occurring within the New York and New Jersey Harbor Study Area

Common Name	*Scientific Name*	Federal[1] Status	NYS[2] Status	Year Identified	NJ[3] Status	Year Identified
BIRDS (cont.)						
Barred Owl	*Strix varia*				T	
Long-eared owl	*Asio otus*				T	
Bobolink	*Dolichonyx oryzivorus*				T	
Henslow's sparrow	*Ammodramus henslowii*		T		E	
Loggerhead shrike	*Lanius ludovicianus migrans*		E		E	
Northern goshawk	*Accipiter gentilis*				E	
REPTILES						
Kemp's ridley turtle	*Lepidochelys kempii*	E	E		E	
Green turtle	*Chelonia mydas*	E	E		E	
Leatherback turtle	*Dermochelys coriacea*	E	E		E	
Loggerhead turtle	*Caretta caretta*	T	T		E	
Bog turtle	*Clemmys muhlenbergii*	T	T		E	1966
Wood turtle	*Clemmys insculpta*				T	1992
Timber Rattlesnake	*Crotalus horridus horridus*		T		E	
Northern pine snake	*Pituophis melanoleucus*				T	
AMPHIBIANS						
Pine barrens treefrog	*Hyla andersonii*				E	
Blue-spotted salamander	*Ambystoma laterale*				E	
Longtail Salamander	*Eurycea longicauda longicauda*				T	
MAMMALS						
Indiana bat	*Myotis sodalis*	E	E		E	
Allegheny woodrat	*Neotoma magister*	E			E	1984
Eastern small-footed myotis	*Myotis leibii*				U	
Southern bog lemming	*Synaptomys cooperi*				U	
FISH						
Shortnose Sturgeon	*Acipenser brevirostrum*	E	E		E	

TABLE 5.4-11 (page 3 of 8)
Endangered and Threatened Species Occurring within the New York and New Jersey Harbor Study Area.

Common Name	Scientific Name	Federal[1] Status	NYS[2] Status	Year Identified	NJ[3] Status	Year Identified
INVERTEBRATES						
American burying beetle	*Nicrophorus americanus*	E			E	
Giant swallowtail	*Ppilio cresphonetes*				Rare	1937
Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*	T			E	
Henry's elfin	Incisalia henrici				Rare	1991
Dwarf wedgemussel	*Alasmidonta heterodon*				E	
PLANTS						
Small whorled Pogonia	*Isotria medeoloides*	T				
Swamp pink	*Helonias bullata*	T**			E	1892
Seabeach amaranth	*Amaranthus pumilus*	T				
Coastal flat sedge	*Cyperus polystachyos*				E	
Heartleaf plantain	*Plantago cordata*		T	1894		
Bluegrass	*Poa cuspidata*			1897		
Saltmarsh bulrush	*Scirpus maritimus*		E	1891	E	1971
Maple-leaved goosefoot	*Chenopodium simplex*				Rare	1916
Silver Plumegrass	*Erianthus alopecuroides*				Rare	1936
Featherfoil	*Hottonia inflata*				E	1898
Mudweed	*Limosella subulata*				E	1920
Torrey's Mountain Mint	*Pycnanthemum Torrei*				E	1916
Three Birds Orchid	*Triphora Trianthopohora*				E	1 980
Minute duckweed	*Lemna perpusilla*				E	1869
Barratt's sedge	*Carex barrattii*				LP	1916
Willdenow's sedge	*Carex willdenowii*				Rare	1919
Virginia bunchflower	*Melanthium Virginicum*				E	1889
Southern arrow head	*Sagittaria australis*				E	1918
Wild wormwood	*Artemisia campestris ssp caudata*				Rare	1980
Pear Hawthorn	*Crataegus calpodendron*				E	1900

TABLE 5.4-11 (page 4 of 8)
Endangered and Threatened Species Occurring within the New York and New Jersey Harbor Study Area

Common Name	Scientific Name	Federal[1] Status	NYS[2] Status	Year Identified	NJ[3] Status	Year Identified
PLANTS (cont.)						
Sea-beach knotweed	*Polygonum glaucum*				E	1993
Eaton's beggarstick	*Bidens eatonii*				E	1994
Beaked Sedge	*Carex rostrata*				Rare	1961
Carolina whitlow grass	*Draba reptans*				E	1888
Southern Rein orchid	*Plantanthera falva var flava*				E	1916
Sea-side arrow grass	*Triglochin maritimum*				E	1945
Narrow-leaved vervain	*Verbena simplex*				E	1950
Oceanorus	*Zigadenus leimanthoides*				E	1985
Cyperus-like sedge	*Carex pseudocyperus*				E	1894
Tuckerman's sedge	*Carex Tuckermanii*				E	18__
Canada hawkweed	*Hieracium kalmii*				E	1936
Larger Canadian St. John's-wort	*Hypericum jajus*				E	1897
Virginia false-gromwell	*Onosmodium virginianum*				E	1865
Sea-side plantain	*Plantago maritima*				Rare	1894
Smooth rattlesnake root	*Prenanthes racemosa*				E	1894
Shining willow	*Salix lucida*				Rare	1866
New England grape	*Vitis nova-angliae*				E	1958
Allegheny vine	*Adlumia fungosa*				Rare	1920
Round-leaved serviceberry	*Amelanchier sanguinea*				E	18__
Puttyroot	*Aplectrum hyemale*				E	1867
Side-oats gramma grass	*Bouteloua curteipendula*				E	1903
Leatherwood	*Dirca palustris*				Rare	1989
Meadow horsetail	*Equisetum pratense*				E	1880
Slender cottongrass	*Eriophorum gracile*				E	1878
Clammy everlasting	*Gnaphlium macounii*				E	1897
Barton's St. John's wort	*Hypericum adpressum*				E	1880
Pale duckweed	*Lemna valdiviana*				E	1864

TABLE 5.4-11 (page 5 of 8) Endangered and Threatened Species Occurring within the New York and New Jersey Harbor Study Area						
Common Name	**Scientific Name**	**Federal[1] Status**	**NYS[2] Status**	**Year Identified**	**NJ[3] Status**	**Year Identified**
PLANTS (cont.)						
Grooved yellow flax	*Linum sulcatum*				E	1864
Small yellow pond lilly	*Nuphar microphyllum*				E	1864
Autumn bluegrass	*Poa autumnalis*				E	1980
Stiff goldenrod	*Solidago rigida*				E	1915
Northern white cedar	*Thuja occidentalis*				E	1865
Foamflower	*Tiarella cordifolia*				E	1884
Canada violet	*Viola canadensis*				E	1860
Northern blue violet	*Viola septentrionalis*				E	1918
Koehn's tooth-cup	*Ammannia latifolia*				E	
Glade fern	*Athyrium pycnocarpon*				E	
Cloud sedge	*Carex haydenii*				E	
Redbud	*Cercis canadensis*				E	
Slender rock-brake	*Cryptogramma stelleri*				E	
Showy Lady's-slipper	*Cypripedium reginae*				E	
Hemicarpha	*Hemicarpha micrantha*				E	
Hairy woodrush	*Luzula acuminata*				E	
Winged monkey flower	*Mimulus alatus*				Rare	
Small yellow pond lily	*Nuphar microphyllum*				E	
Smooth rattlesnake root	*Prenanthes racemosa*				E	
Bog willow	*Salix pedicellaris*				E	
Torrey's bulrush	*Schoenoplectus torreyi*				E	
Whorled nut rush	*Scleria verticillata*				E	
Spreading globe flower	*Trollius laxus ssp laxus*				E	
Large-water plantain	*Alisma triviale*				E	
Erect bindweed	*Calystegia spithamaea*				E	
Long-awned smoke grass	*Muhlenbergia capillaris*				E	
Smooth beard tongue	*Penstemon laevigatus*				E	

TABLE 5.4-11 (page 6 of 8)
Endangered and Threatened Species Occurring within the New York and New Jersey Harbor Study Area

Common Name	Scientific Name	Federal[1] Status	NYS[2] Status	Year Identified	NJ[3] Status	Year Identified
PLANTS (cont.)						
Downy phlox	*Phlox pilosa*				E	
Large-fruited sanicle	*Sanicula trifoliata*				E	
Red goosefoot	*Chenopodium rubrum*				E	
Butterfly pea	*Clitoria mariana*				E	
Creeping snowberry	*Gaultheria hispidula*				E	
Twin-flower	*Linnea borealis*				E	
Bearsfoot	*Polymnia Uvedalia*				E	
Low rough aster	*Aster radula*				E	
Bur-marigold	*Bidens bidentoides*				E	
Louisiana sedge	*Carex Louisianica*				E	
Variable sedge	*Carex ploymorpha*				E	
Pear hawthorn	*Crataegus calpodendron*				E	
Floating pennywort	*Hydrocotyle ranunculoides*				E	
Pale vetchling peavine	*Lathyrus*				E	
Northern Blazing Star	*Liatris scariosa var*				E	
Nuttall's mudwort	*Micranthemum micranthemoides*				E	
Slender water-milfoil	*Myriophyllum tenellum*				E	
Whorled water-milfoil	*Myriophyllum verticillatum*				E	
Purple fringeless orchid	*Platanthera peramoena*				E	
Rhodora	*Rhododendron canadense*				E	
Small skullcap	*Scutellaria leonardii*				E	
Sea-beach pigweed	*Amaranthus pumilus*				E	
Pale Indian plantain	*Cacalia atriplicifolia*				E	
Pickering's reedgrass	*Calamagrostis pickeringii*				E	
Clustered sedge	*Carex cumulata*				E	
Spiny coontail	*Ceratophyllum echinatum*				E	
Fleshy hawthorne	*Crataegus succulenta*				E	

TABLE 5.4-11 (page 7 of 8) Endangered and Threatened Species Occurring within the New York and New Jersey Harbor Study Area						
Common Name	**Scientific Name**	**Federal[1] Status**	**NYS[2] Status**	**Year Identified**	**NJ[3] Status**	**Year Identified**
PLANTS (cont.)						
Coast flatsedge	*Cyperus polystachyos*				E	
Trailing Tick-trefoil	*Desmodium humifusum*				E	
Larger buttonweed	*Diodia virginiana*				E	
Pumpkin ash	*Fraxinus profunda*				E	
Sea-beach milkwort	*Glaux maritima*				E	
New Jersey Rush	*Juncus caesariensis*				E	
Sandplain Flax	*Linum intercursum*				E	
Greenish-flowered Wintergreen	*Pyrola chlorantha*				E	
Sea-side Crowfoot	*Ranunculus cymbalaria*					
Grass-like Beaked Rush	*Rhynchospora globularis*				E	
Knieskern's Beaked Rush	*Rhynchospora knieskenii*				E	
Pine Barren Bellwort	*Uvularia puerula var nitida*				E	
Bog Rosemary	*Andromeda glaucophylla*				E	
Long's bitter cress	*Cardamine longii*				E	
Brownish sedge	*Carex brunnescens*				E	
Dewey's sedge	*Carex deweyana*				E	
Dry-spiked sedge	Carex foenea				E	
Mud Sedge	*Carex limosa*				E	
Slender wheatgrass	*Elymus trachycaulus*				E	
Variegated Horsetal	*Equisetum variegatum*				E	
Creeping snowberry	*Gaultheria hispidula*				E	
Narrow-leaved gentian	*Gentiana linearis*				E	
Mountain Holly	*Ilex montana*				E	
Slender Pinweed	*Lechea tenuifolia*				E	
Fly Honeysuckle	*Lonicera canadensis*				E	
Basil bee-balm	*Monarda clinopodia*				E	
Northern Panic Grass	*Panicum boreale*				E	
Hooker's orchid	*Platanthera hookeri*				E	

TABLE 5.4-11 (page 8 of 8)
Endangered and Threatened Species Occurring within the New York and New Jersey Harbor Study Area

Common Name	Scientific Name	Federal[1] Status	NYS[2] Status	Year Identified	NJ[3] Status	Year Identified
PLANTS (cont.)						
Smooth Blackberry	*Rubus canadensis*				E	
Lace-lip Ladies' Tresses	*Spiranthes laciniata*				E	
Northern stitchwort	*Stellaria borealis*				E	
Rosy Twisted-stalk	*Streptopus roseus*				E	
Spreading Globe Flower	*Trollius laxus*				E	
Witch Hobble	*Viburnum alnifolium*				E	
Florida bogmat	*Wolffiella floridana*				E	
Northern yellow-eyed grass	*Xyris montana*				E	

* Probably extinct
** Presumed extirpated
LP = Indicates taxa listed by the Pinelands Commission as endangered or threatened within their legal jurisdiction.
E = endangered species
T = threatened species
D =declining species
[1] = U.S. Dept of the Interior – Fish and Wildlife Service
[2] = NYS Dept. of Environmental Conservation – Wildlife Resources Center – Natural Heritage Database
[3] = NJ Dept. of Environmental Protection – Division of Parks and Forestry –Natural Heritage Database

TABLE 5.7-1 Estimated Employment Characteristics of the Port Hinterlands Thousands of Jobs (% change since 1998)				
Employment	**Year**	**31-County Area**	**260-Mile Radius**	**Continental U.S.**
All-Industry Total	1998	10,690	33,382	151,944
	2015	12,469 (17%)	38,126 (14%)	180,751 (19%)
	2045	13,534* (27%)	42,330 (27%)	207,133 (36%)
Farm	1998	n.a.	236	3,017
	2015	n.a.	217 (-8%)	2,767 (-8%)
	2045	n.a.	188 (-20%)	2,401 (-20%)
Mining	1998	2	48	836
	2015	2 (-14%)	41 (-15%)	730 (-13%)
	2045	1.8 * (-23%)	36 (-25%)	632 (-24%)
Construction	1998	262	1,450	7,610
	2015	332 (27%)	1,645 (13%)	9,015 (18%)
	2045	358* (36%)	1,818 (25%)	10,338 (36%)
Manufacturing	1998	991	3,723	18,834
	2015	619 (-38%)	3,313 (-11%)	18,697 (-1%)
	2045	556* (-44%)	3,109 (-16%)	19,146 (2%)
Transportation, Communication, Utilities	1998	561	1,538	7,084
	2015	613 (9%)	1,682 (9%)	8,230 (16%)
	2045	641* (14%)	1,808 (18%)	9,268 (31%)
Wholesale & Retail Trade	1998	1,865	6,806	32,669
	2015	2,050 (10%)	7,645 (12%)	38,434 (18%)
	2045	2,180* (17%)	8,393 (23%)	43,752 (34%)
Financial, Insurance, & Real Estate	1998	888	2,941	11,065
	2015	1,051(18%)	3,286(12%)	13,042(18%)
	2045	1,129* (27%)	3,605(23%)	14,859(34%)
Services	1998	3,029	11,550	46,692
	2015	4,190 (38%)	14,804 (28%)	62,435 (34%)
	2045	4,820* (59%)	17,492 (51%)	76,313 (63%)

Sources: Transportation Models and Data Initiative Technical Memorandum No. 8.8 Employment Forecasting and Analysis NYMTC; U.S. Department of Commerce, Bureau of Economic Analysis
*Estimated by applying the percentage growth from BEA projections (2015-2045) for the NY-NJ-CT CMSA to the NYMTC 2015 population estimate.

TABLE 5.7-2 (page 1 of 6)
New York and New Jersey Buffer Area Population Breakdown by Income and Race

Tract	Median HH Inc.	Total Pop.	White Pop.	Percent White	African American Pop.	Percent African American Popk	Native American Pop.	Percent Native American	Asian Pop.	Percent Asian	Hispanic Pop.	Percent Hispanic	Other Pop.	Percent Other
Kings County, NY	*$25,684*													
2	$9,798	1,019	574	56%	83	8%	0	0%	53	5%	892	88%	309	30%
18	$5,360	5	5	100%	0	0%	0	0%	0	0%	0	0%	0	0%
20	$17,759	1,343	701	52%	162	12%	0	0%	28	2%	1,272	95%	452	34%
22	$26,300	3,523	1,557	44%	330	9%	28	1%	269	8%	2,151	61%	1,339	38%
30	$36,250	1,491	1,325	89%	12	1%	0	0%	139	9%	70	5%	15	1%
34	$40,000	2,598	2,469	95%	8	0%	0	0%	100	4%	112	4%	21	1%
36	$32,911	3,489	3,123	90%	37	1%	0	0%	168	5%	322	9%	161	5%
38	$41,351	1,448	1,448	100%	0	0%	0	0%	0	0%	21	1%	0	0%
40	$73,261	1,435	1,435	100%	0	0%	0	0%	0	0%	12	1%	0	0%
42	$43,036	914	872	95%	0	0%	8	1%	34	4%	30	3%	0	0%
46	$33,239	823	754	92%	0	0%	0	0%	69	8%	19	2%	0	0%
48	$87,674	303	303	100%	0	0%	0	0%	0	0%	6	2%	0	0%
50	$42,178	2,250	2,192	97%	7	0%	0	0%	0	0%	209	9%	51	2%
51	$32,250	1,729	1,142	66%	173	10%	0	0%	154	9%	520	30%	260	15%
5201	$18,750	1,902	1,902	100%	0	0%	0	0%	0	0%	92	5%	0	0%
5202	$42,299	2,603	2,547	98%	0	0%	0	0%	50	2%	100	4%	6	0%
54	$35,507	3,093	2,913	94%	33	1%	4	0%	110	4%	122	4%	33	1%
55	$4,999	221	122	55%	87	39%	0	0%	0	0%	12	5%	12	5%
5601	$37,065	2,423	2,280	94%	17	1%	36	1%	90	4%	117	5%	0	0%
5602	$35,024	1,448	1,415	98%	0	0%	0	0%	17	1%	77	5%	16	1%
57	$24,519	1,544	795	51%	145	9%	38	2%	0	0%	935	61%	566	37%
58	$29,239	2,953	2,734	93%	15	1%	0	0%	127	4%	215	7%	77	3%

TABLE 5.7-2 (page 2 of 6)
New York and New Jersey Buffer Area Population Breakdown by Income and Race

Tract	Median HH Inc.	Total Pop.	White Pop.	Percent White	African American Pop.	Percent African American	Native American Pop.	Percent Native American	Asian Pop.	Percent Asian	Hispanic Pop.	Percent Hispanic	Other Pop.	Percent Other
59	$14,940	1,157	480	41%	320	28%	10	1%	5	0%	716	62%	342	30%
60	$29,545	2,641	2,125	80%	0	0%	7	0%	460	17%	157	6%	49	2%
62	$24,704	2,539	2,302	91%	10	0%	0	0%	169	7%	227	9%	58	2%
63	$35,827	1,736	1,599	92%	33	2%	0	0%	46	3%	123	7%	58	3%
64	$30,559	3,141	2,900	92%	30	1%	9	0%	172	5%	154	5%	30	1%
65	$32,958	5,084	4,780	94%	92	2%	0	0%	52	1%	602	12%	160	3%
66	$32,161	3,440	3,041	88%	22	1%	8	0%	221	6%	253	7%	148	4%
68	$29,696	4,207	3,259	77%	16	0%	0	0%	788	19%	467	11%	144	3%
70	$29,317	2,482	1,921	77%	232	9%	0	0%	265	11%	567	23%	64	3%
72	$22,312	1,545	753	49%	132	9%	0	0%	397	26%	788	51%	263	17%
74	$24,859	4,897	1,743	36%	532	11%	0	0%	830	17%	3,215	66%	1,792	37%
76	$20,725	3,694	1,931	52%	172	5%	39	1%	421	11%	2,457	67%	1,131	31%
77	$31,283	3,532	3,062	87%	332	9%	0	0%	70	2%	671	19%	68	2%
78	$22,563	4,948	2,170	44%	568	11%	26	1%	337	7%	3,931	79%	1,847	37%
80	$21,174	3,657	1,838	50%	166	5%	0	0%	287	8%	2,607	71%	1,366	37%
82	$19,219	3,666	1,646	45%	353	10%	0	0%	152	4%	2,941	80%	1,515	41%
84	$20,606	2,573	1,325	51%	156	6%	0	0%	151	6%	1,786	69%	941	37%
85	$7,602	8,149	951	12%	5,596	69%	63	1%	0	0%	2,889	35%	1,539	19%
88	$22,344	2,775	1,401	50%	219	8%	0	0%	294	11%	1,600	58%	861	31%
96	$25,191	5,113	2,051	40%	380	7%	0	0%	383	7%	3,325	65%	2,299	45%
98	$22,281	4,996	2,333	47%	387	8%	19	0%	535	11%	3,492	70%	1,722	34%
101	$21,487	3,252	1,887	58%	186	6%	0	0%	180	6%	1,817	56%	999	31%
117	$30,108	2,299	1,311	57%	272	12%	30	1%	179	8%	1,084	47%	507	22%
121	$26,514	1,566	1,076	69%	80	5%	0	0%	48	3%	665	42%	362	23%

TABLE 5.7-2 (page 3 of 6)
New York and New Jersey Buffer Area Population Breakdown by Income and Race

Tract	Median HH Inc.	Total Pop.	White Pop.	Percent White	African American Pop.	Percent African American	Native American Pop.	Percent Native American	Asian Pop.	Percent Asian	Hispanic Pop.	Percent Hispanic	Other Pop.	Percent Other
123	$36,023	268	177	66%	13	5%	0	0%	0	0%	161	60%	78	29%
124	$24,432	1,537	1,054	69%	0	0%	0	0%	444	29%	220	14%	39	3%
130	$25,600	4,195	3,515	84%	48	1%	0	0%	487	12%	470	11%	145	3%
130	$25,600	4,195	3,515	84%	48	1%	0	0%	487	12%	470	11%	145	3%
141	$24,636	2,625	1,617	62%	241	9%	0	0%	156	6%	1,134	43%	611	23%
143	$23,906	3,154	1,692	54%	191	6%	9	0%	46	1%	1,812	57%	1,216	39%
145	$21,100	4,047	2,487	61%	385	10%	0	0%	154	4%	2,106	52%	1,021	25%
147	$27,070	1,991	1,154	58%	226	11%	0	0%	80	4%	910	46%	531	27%
162	$35,142	1,772	1,604	91%	16	1%	0	0%	131	7%	30	2%	21	1%
164	$30,743	2,189	1,060	48%	745	34%	0	0%	170	8%	521	24%	214	10%
175	$48,750	20	20	100%	0	0%	0	0%	0	0%	0	0%	0	0%
Total Population		151,788	100,536		13,496		401		11,078		53,257		26,277	
Richmond County, NY	***$43,861***													
3	$28,125	1,487	1,004	68%	279	19%	0	0%	150	10%	180	12%	54	4%
6	$26,023	1,615	1,473	91%	60	4%	0	0%	72	4%	80	5%	10	1%
7	$26,489	4,579	1,876	41%	1,950	43%	27	1%	215	5%	1,044	23%	511	11%
8	$32,195	3,261	3,126	96%	8	0%	0	0%	66	2%	193	6%	61	2%
9	$27,412	1,756	902	51%	614	35%	27	2%	69	4%	470	27%	144	8%
11	$34,289	3,081	1,480	48%	1,277	41%	23	1%	133	4%	627	20%	168	5%
15	$33,500	125	46	37%	79	63%	0	0%	0	0%	37	30%	0	0%
17	$44,519	1,157	678	59%	222	19%	5	0%	131	11%	179	15%	121	10%
18	$53,750	255	230	90%	15	6%	0	0%	0	0%	40	16%	10	4%
2001	$46,295	2,093	1,924	92%	49	2%	0	0%	114	5%	136	6%	6	0%

TABLE 5.7-2 (page 4 of 6)
New York and New Jersey Buffer Area Population Breakdown by Income and Race

Tract	Median HH Inc.	Total Pop.	White Pop.	Percent White	African American Pop.	Percent African American	Native American Pop.	Percent Native American	Asian Pop.	Percent Asian	Hispanic Pop.	Percent Hispanic	Other Pop.	Percent Other
21	$36,742	2,683	1,572	59%	668	25%	0	0%	171	6%	545	20%	272	10%
59	$47,731	2,489	2,397	96%	46	2%	0	0%	46	2%	12	0%	0	0%
65	$44,940	1,861	1,758	94%	52	3%	0	0%	43	2%	165	9%	8	0%
74	$26,689	2,866	2,615	91%	26	1%	19	1%	123	4%	448	16%	83	3%
75	$36,908	3,006	2,380	79%	269	9%	0	0%	124	4%	511	17%	233	8%
77	$33,250	1,082	432	40%	532	49%	0	0%	37	3%	158	15%	81	7%
81	$25,316	3,839	2,259	59%	1,149	30%	38	1%	165	4%	505	13%	228	6%
91	$39,653	1,116	1,106	99%	7	1%	0	0%	3	0%	84	8%	0	0%
91	$39,653	1,116	1,106	99%	7	1%	0	0%	3	0%	84	8%	0	0%
105	$42,684	3,956	2,908	74%	740	19%	14	0%	79	2%	459	12%	215	5%
11202	$42,074	4,889	4,352	89%	197	4%	0	0%	177	4%	515	11%	163	3%
125	$40,068	2,425	1,994	82%	334	14%	0	0%	56	2%	232	10%	41	2%
13301	$10,129	1,860	434	23%	1,200	65%	0	0%	74	4%	565	30%	152	8%
13302	$25,804	2,194	1,082	49%	721	33%	9	0%	88	4%	428	20%	294	13%
141	$41,042	1,730	1,536	89%	105	6%	12	1%	55	3%	176	10%	22	1%
201	$45,594	3,094	2,919	94%	45	1%	0	0%	5	0%	148	5%	125	4%
207	$31,701	3,557	1,768	50%	1,369	38%	61	2%	66	2%	599	17%	293	8%
213	$43,074	3,726	3,291	88%	232	6%	0	0%	49	1%	405	11%	154	4%
219	$35,781	682	494	72%	67	10%	0	0%	28	4%	113	17%	93	14%
223	$41,250	1,650	1,203	73%	344	21%	0	0%	85	5%	259	16%	18	1%
231	$34,750	2,255	1,725	76%	379	17%	0	0%	8	0%	458	20%	143	6%
239	$36,379	2,101	1,794	85%	246	12%	6	0%	37	2%	182	9%	18	1%
247	$35,337	2,028	1,581	78%	282	14%	7	0%	70	3%	140	7%	88	4%
29101	$46,128	13,485	12,391	92%	146	1%	22	0%	759	6%	951	7%	167	1%
31901	$16,414	2,812	681	24%	1,946	69%	4	0%	25	1%	614	22%	156	6%

TABLE 5.7-2 (page 5 of 6)
New York and New Jersey Buffer Area Population Breakdown by Income and Race

Tract	Median HH Inc.	Total Pop.	White Pop.	Percent White	African American Pop.	Percent African American	Native American Pop.	Percent Native American	Asian Pop.	Percent Asian	Hispanic Pop.	Percent Hispanic	Other Pop.	Percent Other
31902	$22,487	3,115	1,525	49%	1,210	39%	21	1%	86	3%	556	18%	273	9%
32399	$0	8	8	100%	0	0%	0	0%	0	0%	0	0%	0	0%
Total Population		98,556	72,965		17,157		295		3,680		12,496		4,459	
Union County, NJ	***$41,791***													
301	$33,654	166	149	90%	17	10%	0	0%	0	0%	6	4%	0	0%
30199	$0	316	216	68%	100	32%	0	0%	0	0%	69	22%	0	0%
302	$24,297	3,245	1,053	32%	1,200	37%	0	0%	16	0%	1,855	57%	976	30%
303	$27,128	3,234	2,301	71%	391	12%	3	0%	0	0%	1,299	40%	539	17%
304	$16,549	5,908	1,959	33%	2,592	44%	0	0%	0	0%	2,637	45%	1,357	23%
305	$29,783	4,122	2,962	72%	480	12%	0	0%	48	1%	2,316	56%	632	15%
306	$20,000	3,286	2,214	67%	724	22%	0	0%	99	3%	853	26%	249	8%
309	$30,583	4,829	3,970	82%	157	3%	0	0%	10	0%	2,072	43%	692	14%
310	$27,150	3,566	2,254	63%	608	17%	7	0%	4	0%	2,540	71%	693	19%
Total Population		28,672	17,078		6,269		10		177		13,647		5,138	
Essex County, NJ	***$34,518***													
98	$34,844	1,841	646	35%	1,187	64%	0	0%	0	0%	425	23%	8	0%
Total Population		1,841	646		1,187		0		0		425		8	

5-179

TABLE 5.7-2 (page 6 of 6)
New York and New Jersey Buffer Area Population Breakdown by Income and Race

Tract	Median HH Inc.	Total Pop.	White Pop.	Percent White	African American Pop.	Percent African American	Native American Pop.	Percent Native American	Asian Pop.	Percent Asian	Hispanic Pop.	Percent Hispanic	Other Pop.	Percent Other
Hudson County, NJ	***$30,917***													
61	$32,616	7,411	3,483	47%	2,543	34%	0	0%	661	9%	1,139	15%	724	10%
63	$25,625	4,709	2,420	51%	1,044	22%	10	0%	424	9%	1,484	32%	811	17%
101	$34,988	5,119	4,853	95%	133	3%	15	0%	77	2%	327	6%	41	1%
102	$37,061	3,090	3,005	97%	21	1%	4	0%	35	1%	177	6%	25	1%
103	$26,375	2,818	2,561	91%	163	6%	0	0%	58	2%	195	7%	36	1%
104	$32,500	4,138	3,668	89%	286	7%	10	0%	65	2%	263	6%	109	3%
10499	$0	42	29	69%	13	31%	0	0%	0	0%	0	0%	0	0%
105	$39,775	5,037	4,725	94%	148	3%	0	0%	115	2%	322	6%	49	1%
106	$23,923	6,039	5,668	94%	40	1%	0	0%	167	3%	609	10%	164	3%
107	$30,804	3,465	3,197	92%	124	4%	0	0%	64	2%	347	10%	80	2%
108	$35,424	3,321	3,092	93%	69	2%	0	0%	86	3%	390	12%	74	2%
10899	$0	34	34	100%	0	0%	0	0%	0	0%	0	0%	0	0%
109	$18,079	1,981	1,720	87%	164	8%	0	0%	0	0%	124	6%	97	5%
110	$32,417	2,216	1,553	70%	391	18%	0	0%	24	1%	664	30%	248	11%
111	$28,302	4,333	3,271	75%	543	13%	0	0%	138	3%	945	22%	381	9%
112	$36,896	6,232	6,028	97%	20	0%	17	0%	126	2%	351	6%	41	1%
113	$29,657	2,940	2,695	92%	161	5%	0	0%	24	1%	312	11%	60	2%
114	$39,306	3,279	3,128	95%	0	0%	15	0%	70	2%	299	9%	66	2%
115	$40,850	3,250	3,176	98%	5	0%	0	0%	21	1%	187	6%	48	1%
116	$26,331	4,110	3,335	81%	629	15%	0	0%	61	1%	292	7%	85	2%
Total Population		74,018	61,959		6,615		71		2,234		8,433		3,139	

TABLE 5.7-3
Summary of Buffer Area Population and Racial Breakdown

Section of Buffer Area	Total Pop.	White Pop.	Percent White	African American Pop.	Percent African American Popk	Native American Pop.	Percent Native American	Asian Pop.	Percent Asian	Hispanic Pop.	Percent Hispanic	Other Pop.	Percent Other
Total Population-Kings Co. Section	151,788	100,536	66%	13,496	9%	401	0%	11,078	7%	53,257	35%	26,277	17%
Total Population-Richmond Co. Section	98,556	72,965	74%	17,157	17%	295	0%	3,680	4%	12,496	13%	4,459	5%
Total Population-Union Co. Section	28,672	17,078	60%	6,269	22%	10	0%	177	1%	13,647	48%	5,138	18%
Total Population-Essex Co. Section	1,841	646	35%	1,187	64%	0	0%	0	0%	425	23%	8	0%
Total Population-Hudson Co. Section	74,018	61,959	84%	6,615	9%	71	0%	2,234	3%	8,433	11%	3,139	4%
Buffer Area Totals:	**354,875**	**253,184**	**71%**	**44,724**	**13%**	**777**	**0%**	**17,169**	**5%**	**88,258**	**25%**	**39,021**	**11%**

Source: U.S. Department of Commerce, Bureau of the Census, *Census of Population and Housing, 1990.*
Note: Persons of Hispanic origin can be of any race.

5-181

TABLE 5.8-1 Marinas in the New York and New Jersey Harbor	
AREA	**MARINA**
Sandy Hook Bay	Atlantic Highlands Municipal Harbor Bahrs Landing and Marina Atlantic Highlands Yacht Club Sandy Hook Marina
Raritan Bay	Leonardo State Marina Perth Amboy Yacht Blub The Armory
Staten Island	Mansion Marina Great Kills Park Marina Richmond County Yacht Club Marine Basin Marina
Upper New York Bay	Liberty Harbor Marina Marina at Batter Park South Street Seaport Pier 15 &16

TABLE 5.8-2 (page 1 of 2)
Park Areas bordering the New York and New Jersey Harbor

PARK	BEACH	POOL	PICNIC	FISHING	WINDSURFING	WATERFRONT WALKWAYS/VIEW	PAVED PATHWAY	ROLLER BLADING	WALKING TRAIL	NATURE TRAILS	HIKING	BIKING	BIRDING	TRACK	SKATING RINK	SITTING AREAS	PLAYGROUND	BASEBALL FIELD	DRIVING RANGE	BASKETBALL COURT	TENNIS COURTS	FOOTBALL/ SOCCER FIELD	AMUSEMENT/WATER PARK	NATIONAL MONUMENTS/ MEMORIALS
Gateway National Recreation Center -- Sandy Hook	X		X		X					X	X		X											
Great Kills Park	X						X			X														
Breezy Point	X			X																				X
Wolfe's Pond Park	X						X																	
Kill Van Kull Park																		X						
Faber Pool Park		X																						
Bayonne High School Facilities						X										X		X				X		
Hudson County Park						X			X					X		X						X		
City Park			X			X										X	X			X	X			

5-183

TABLE 5.8-2 (page 2 of 2)
Park Areas bordering the New York and New Jersey Harbor

PARK	BEACH	POOL	PICNIC	FISHING	WINDSURFING	WATERFRONT WALKWAYS/VIEW	PAVED PATHWAY	ROLLER BLADING	WALKING TRAIL	NATURE TRAILS	HIKING	BIKING	BIRDING	TRACK	SKATING RINK	SITTING AREAS	PLAYGROUND	BASEBALL FIELD	DRIVING RANGE	BASKETBALL COURT	TENNIS COURTS	FOOTBALL/ SOCCER FIELD	AMUSEMENT/WATER PARK	NATIONAL MONUMENTS/ MEMORIALS
Elizabeth Memorial Park						X																		
Lincoln Park						X													X		X			
Ellis Island																								X
Liberty Island																								X
Liberty State Park		X	X			X				X	X	X												
Battery Park						X											X							X
Riverbank State Park		X	X			X								X	X		X	X		X	X	X		
Empire-Fulton Ferry State Park			X			X																		
Point Comfort						X																	X	
Coney Island	X					X																	X	

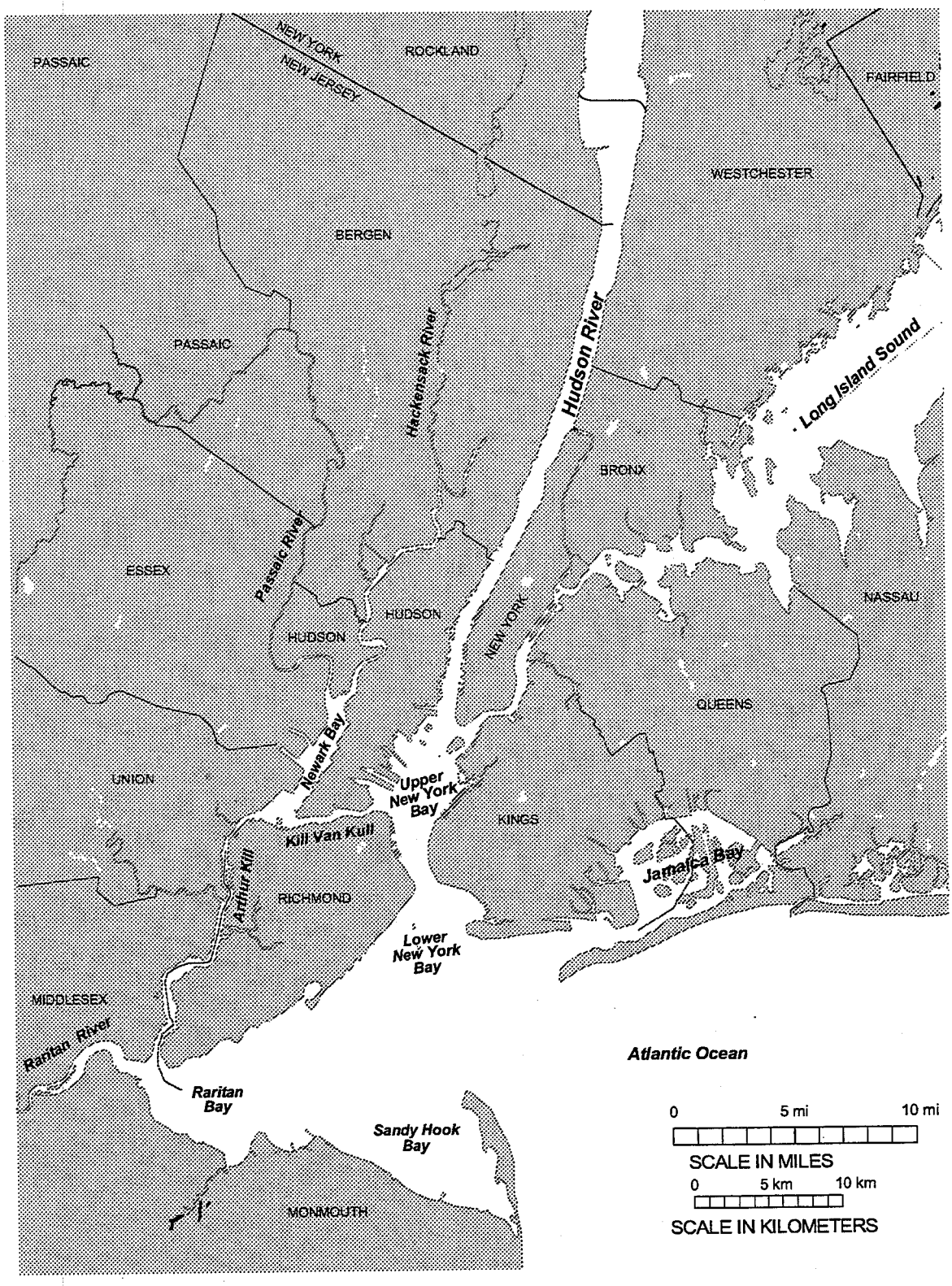


Figure 5.1-1 New York and New Jersey Harbor Portion of the Hudson-Raritan Estuary

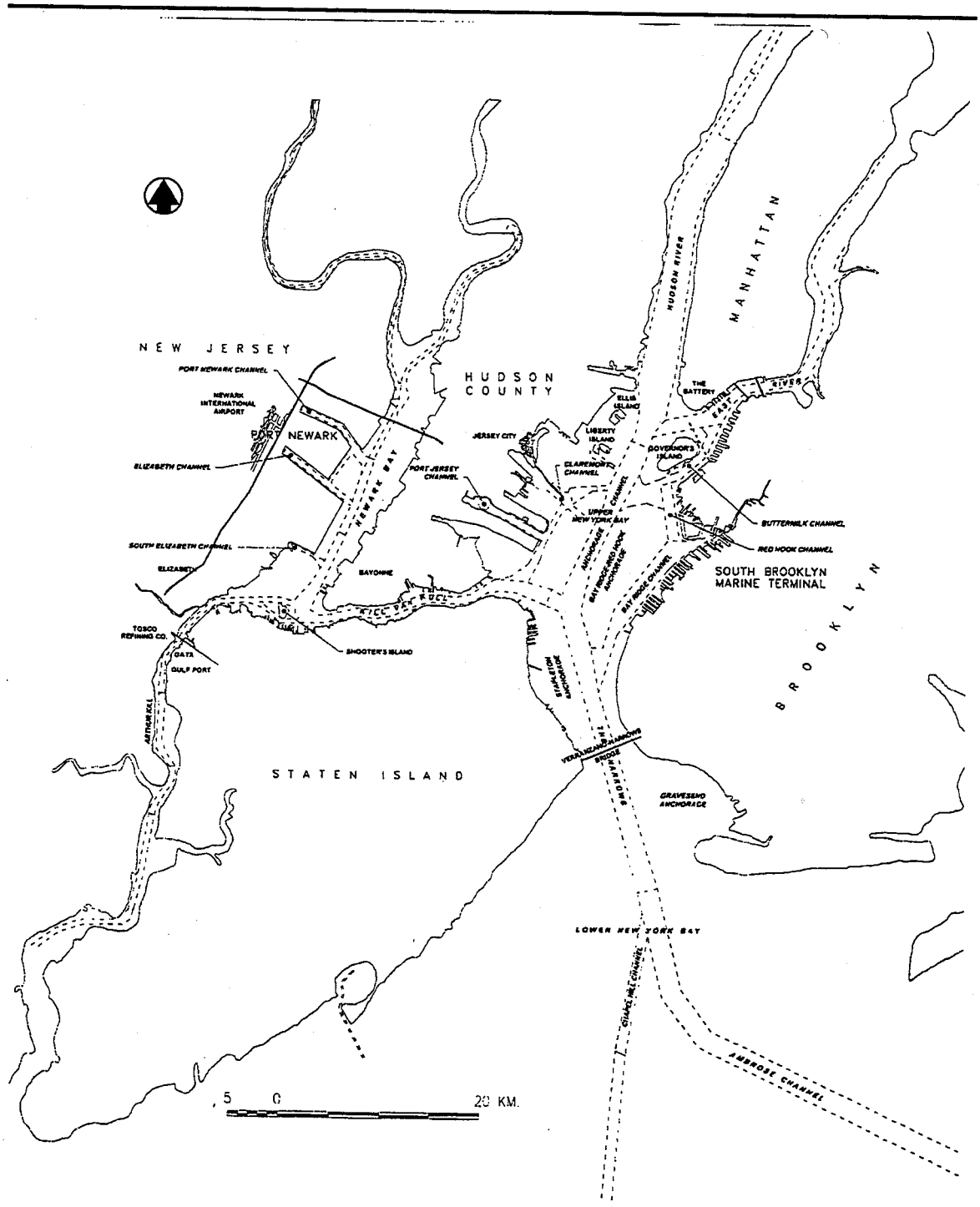


Figure 5.2-1 Location of New York & New Jersey Harbor Channels and Anchorages

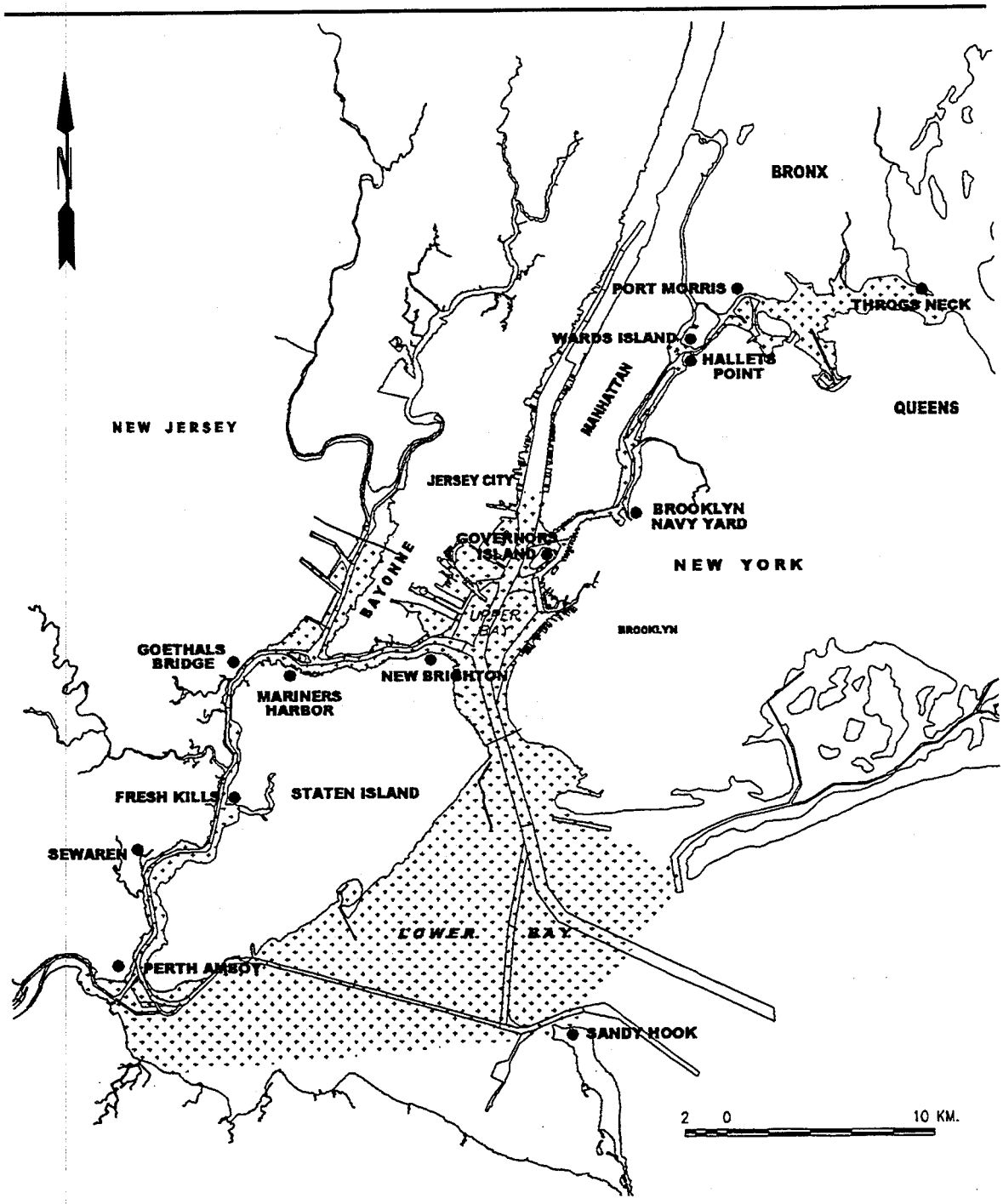


Figure 5.2-2 Vessel Traffic Management System – Remote Stations

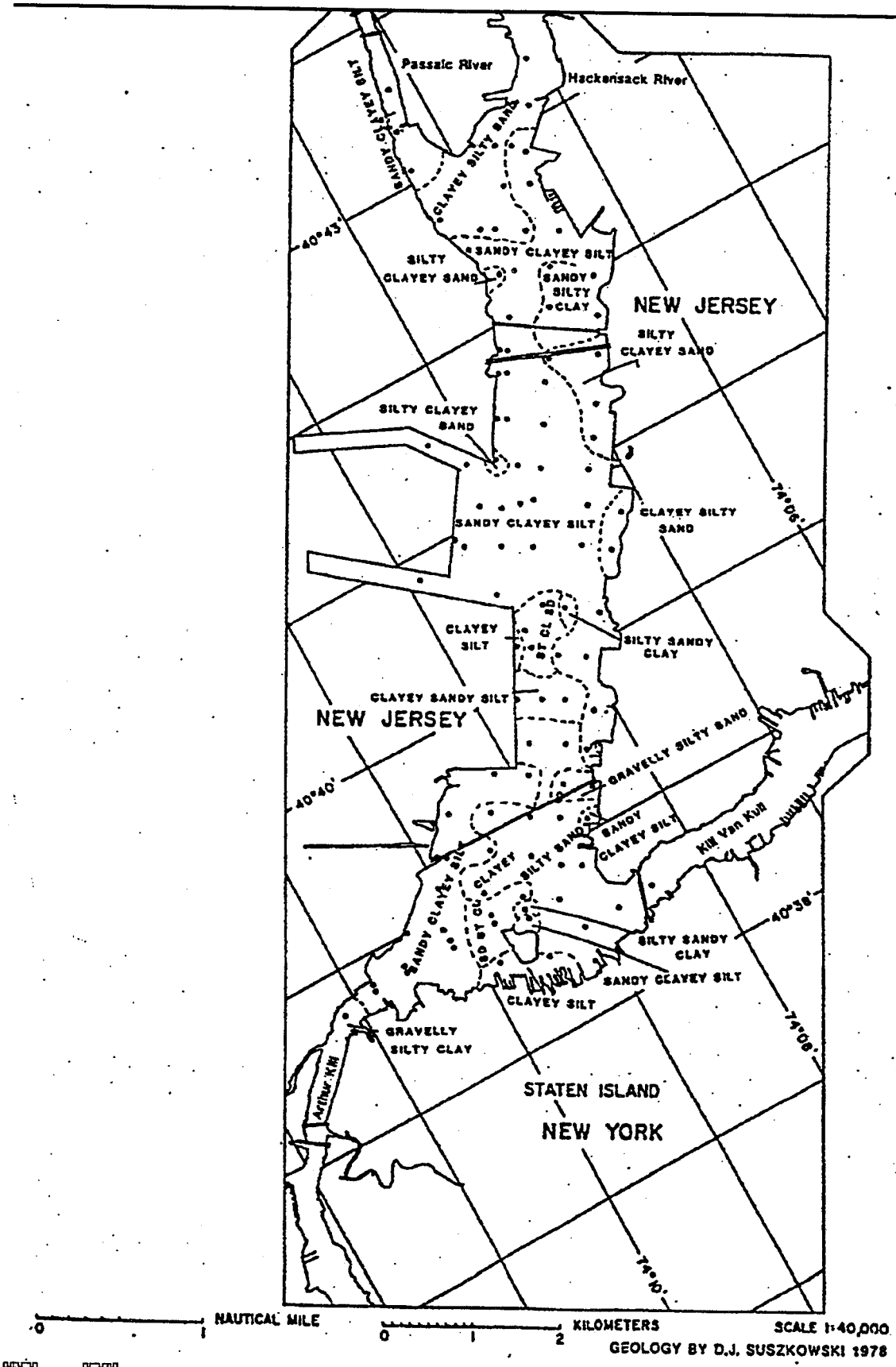


Figure 5.3-1 Sediment Characteristics Map of Newark Bay

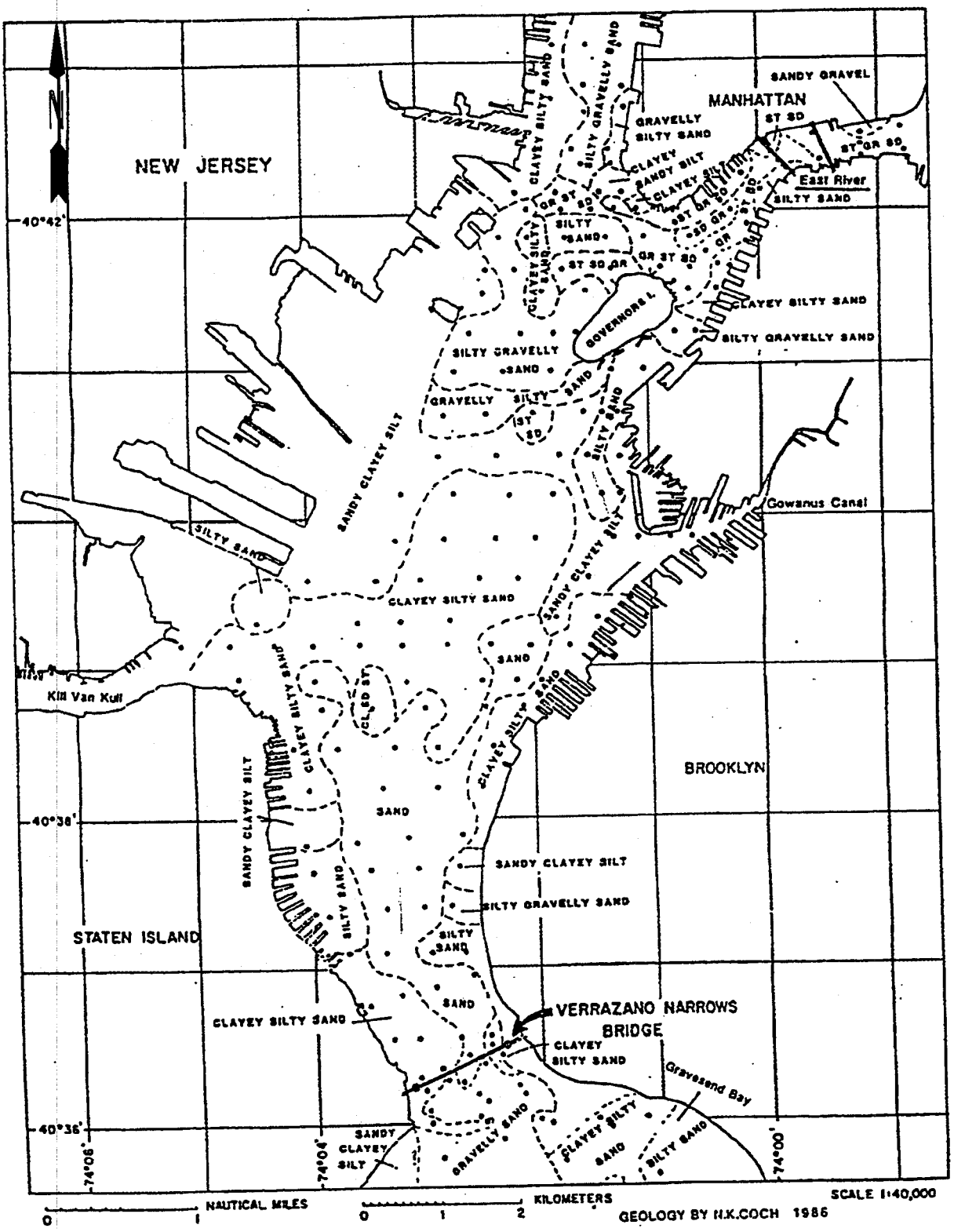


Figure 5.3-2 Sediment Characteristics Map of Upper New York Bay

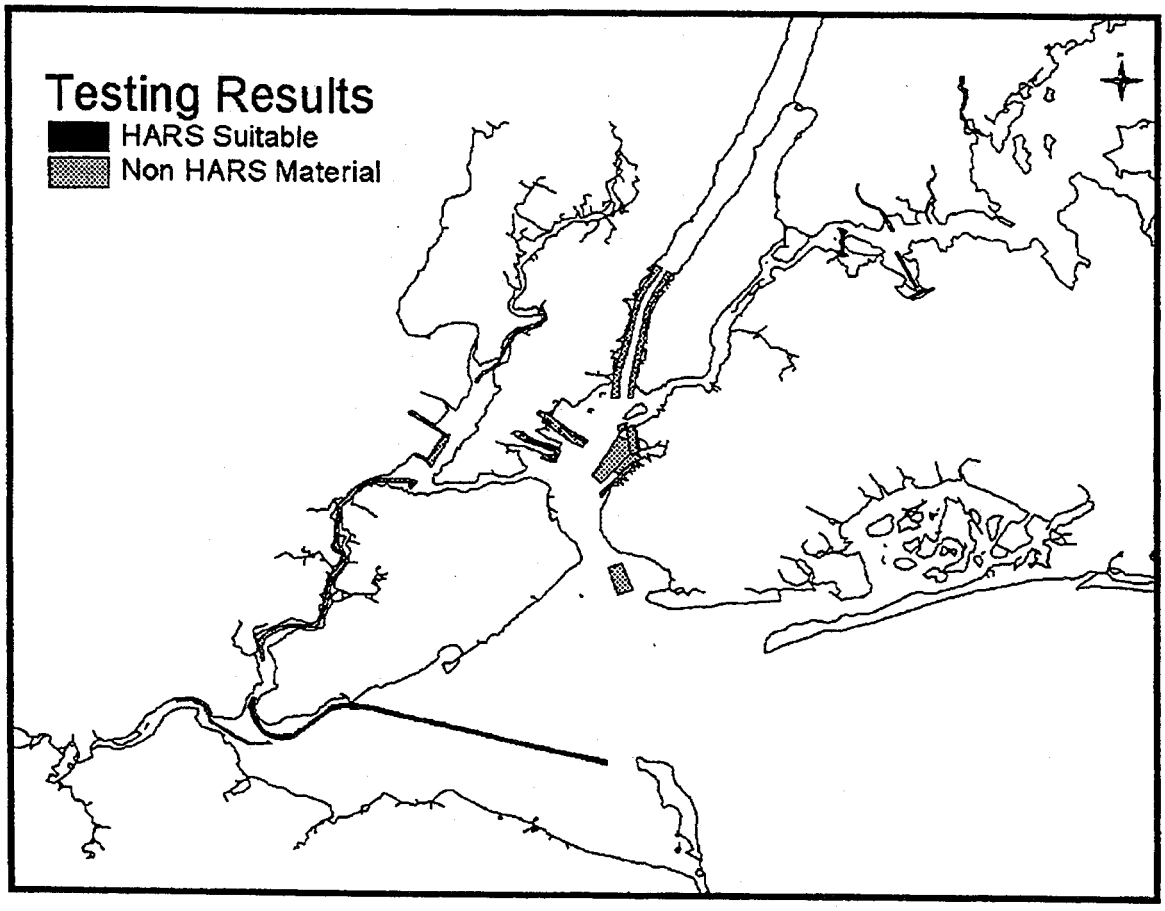


Figure 5.3-3 Quality Testing for New York Harbor Navigation Channels

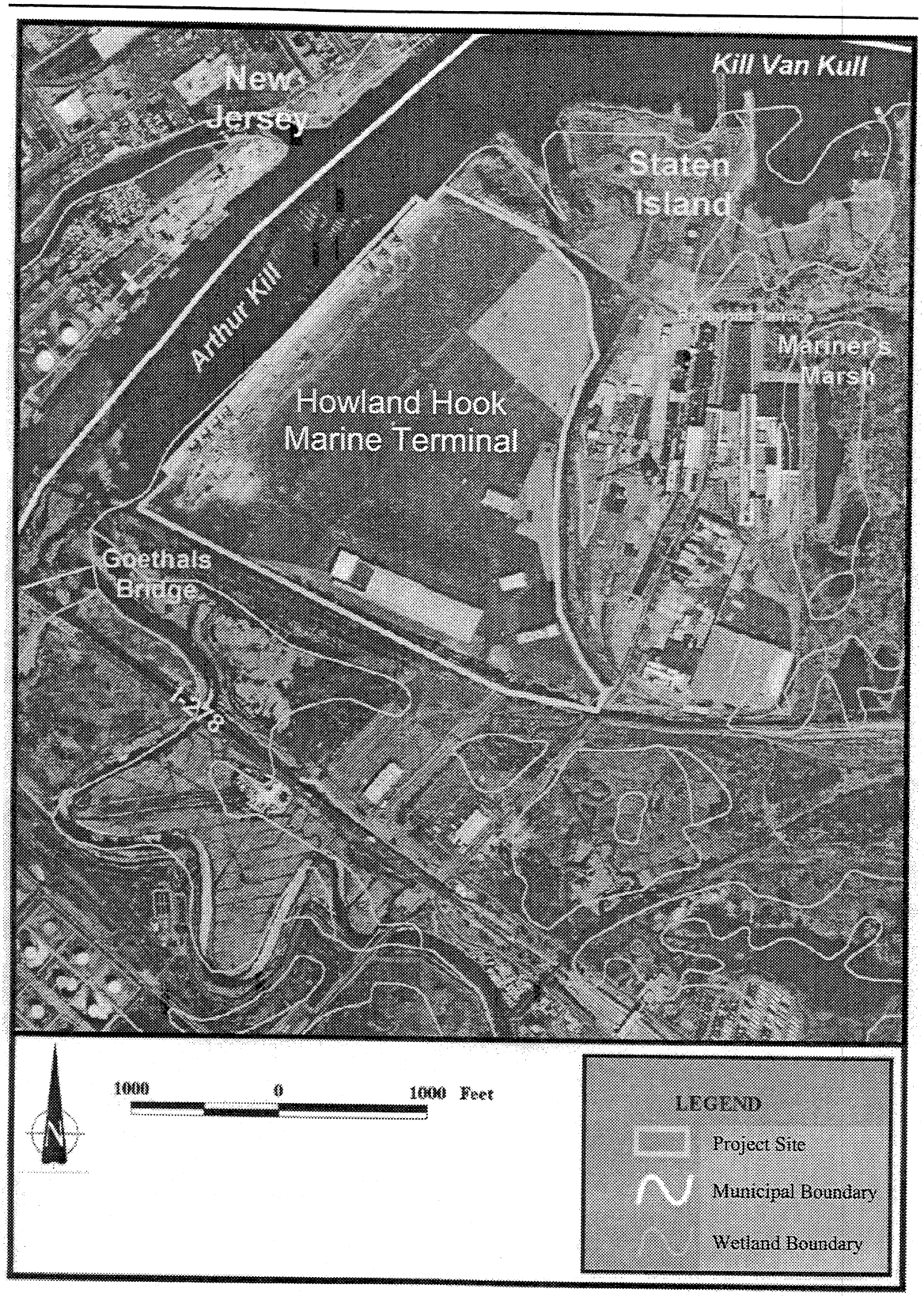


Figure 5.4-1 Aerial Photo Howland Hook Staten Island, NY

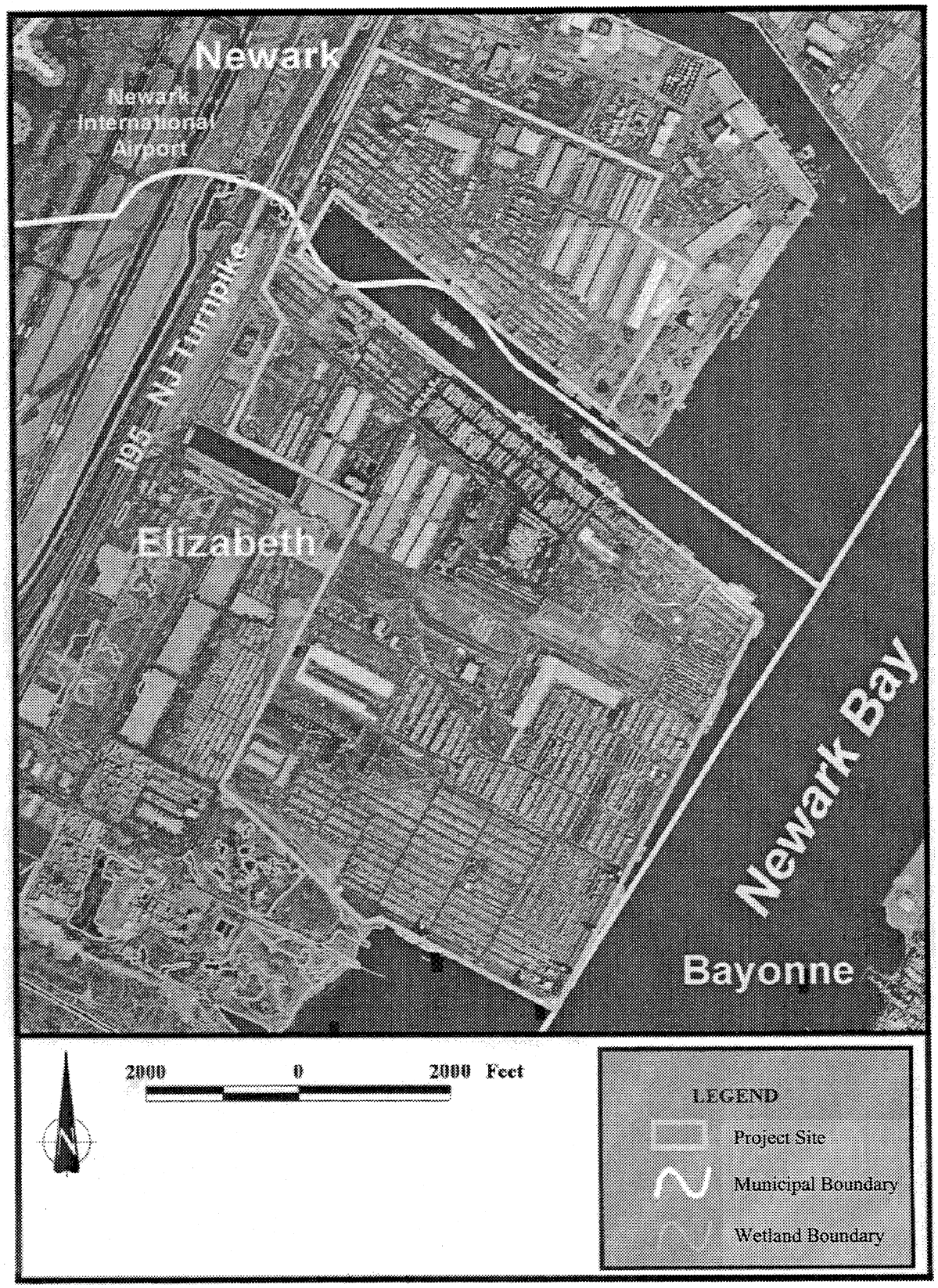


Figure 5.4-2 Aerial Photo Port Newark/Elizabeth Essex and Union County, NJ

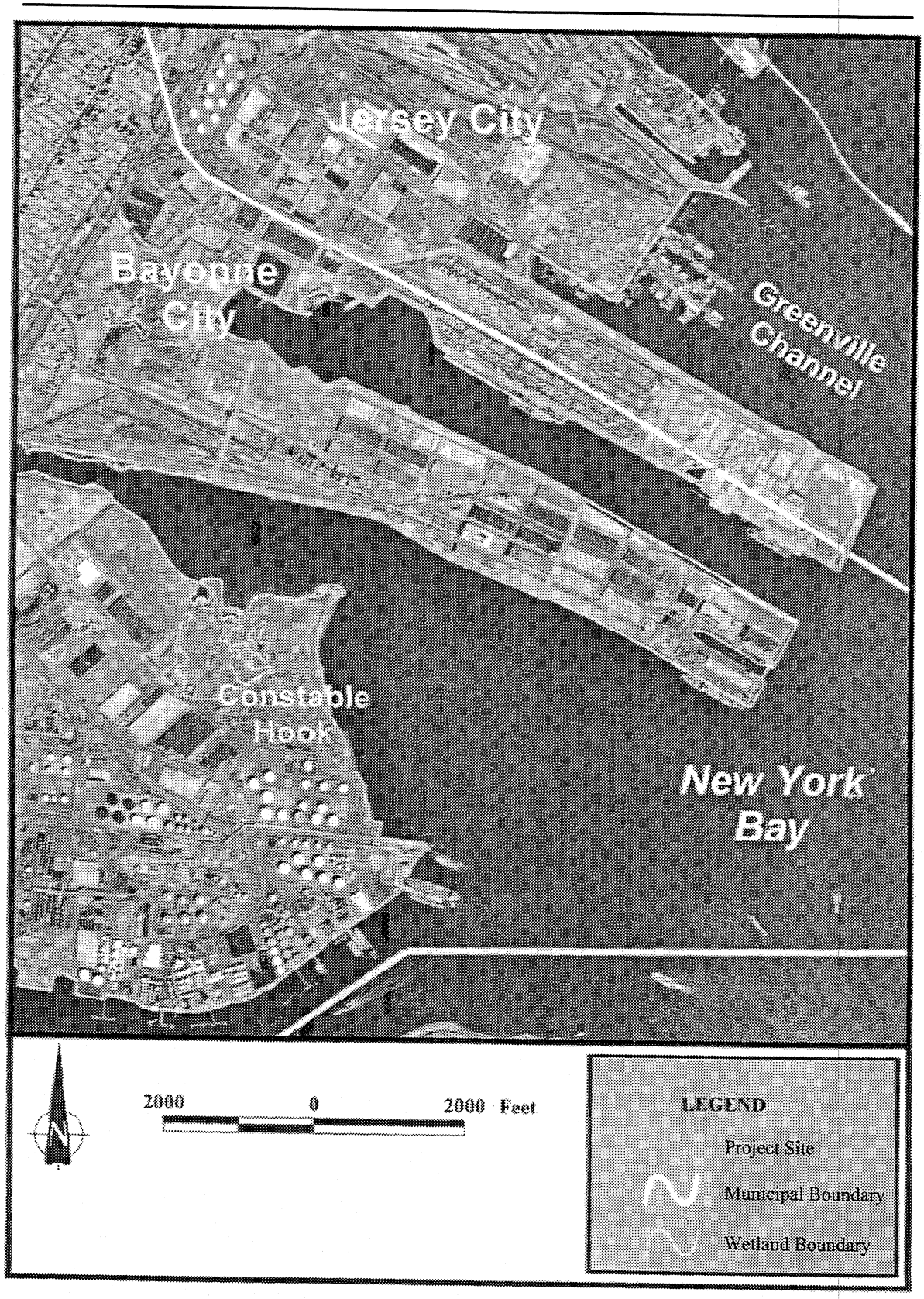


Figure 5.4-3 Aerial Photo Port Jersey/MOTBY Hudson County, NJ

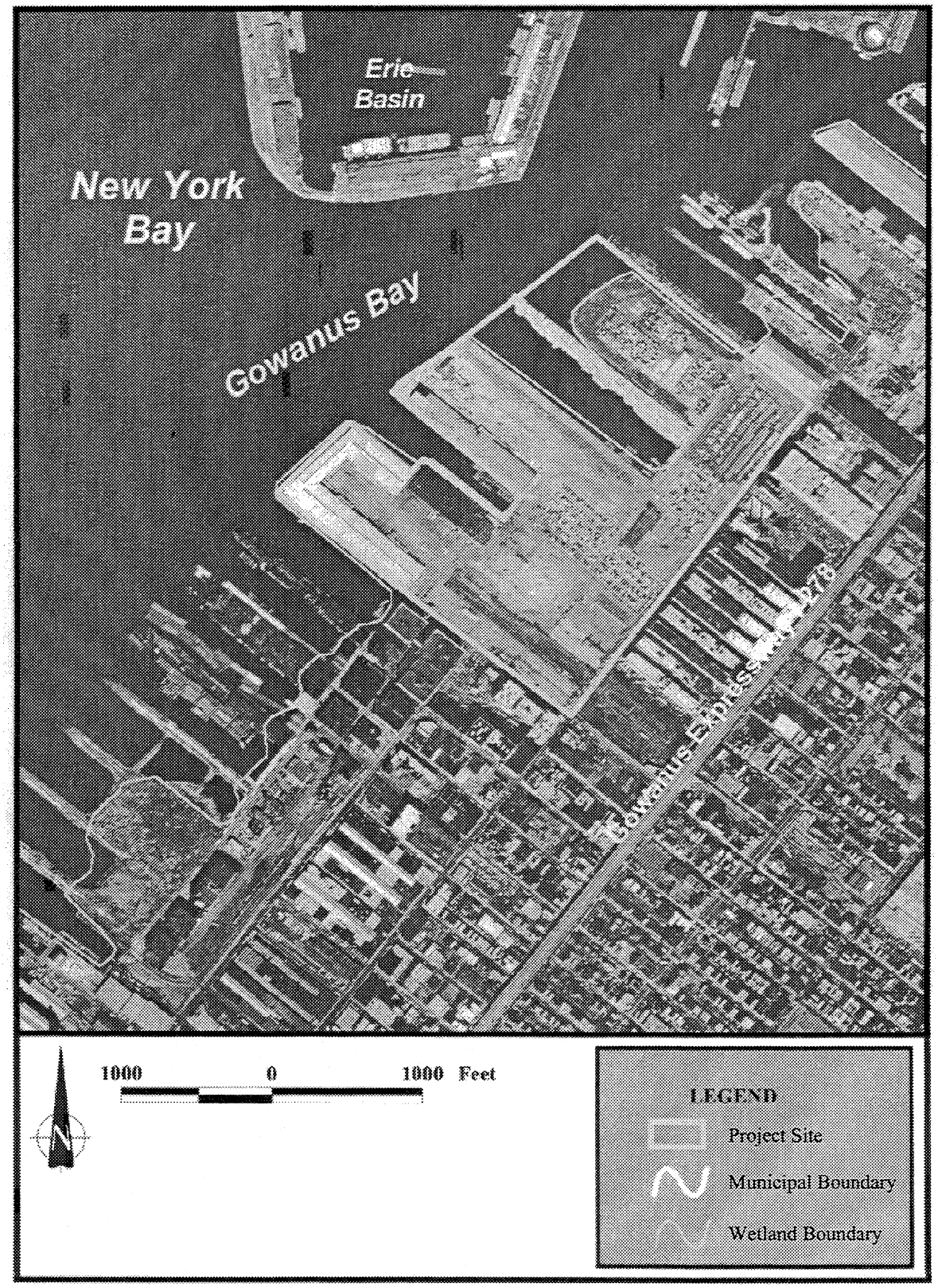


Figure 5.4-4 Aerial Photo South Brooklyn Marine Terminal, South Brooklyn, NY

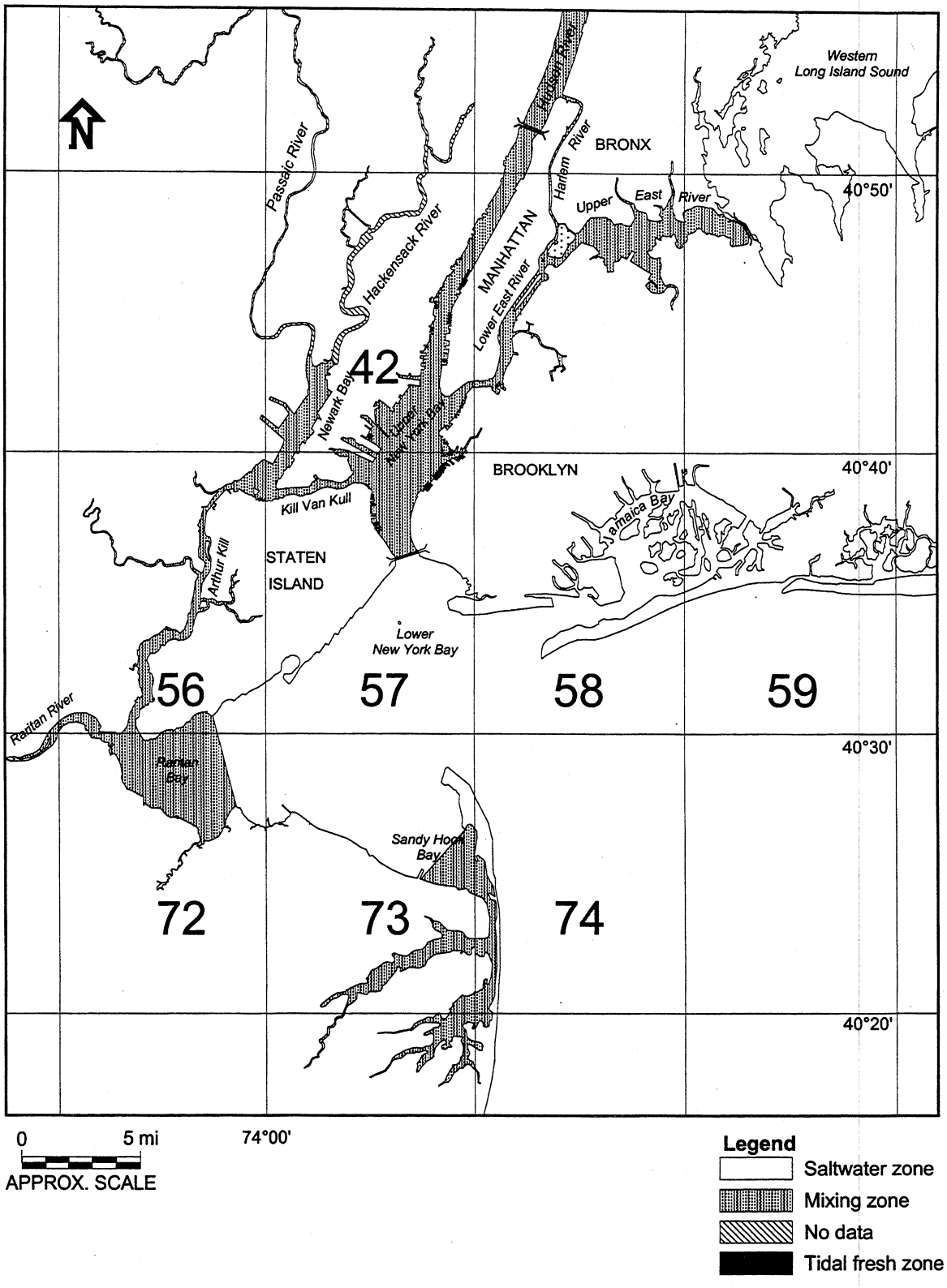


Figure 5.4-5 Map of summarized Squares of EFH Designation of Selected 10' x 10' latitude and longitude squares for the project area

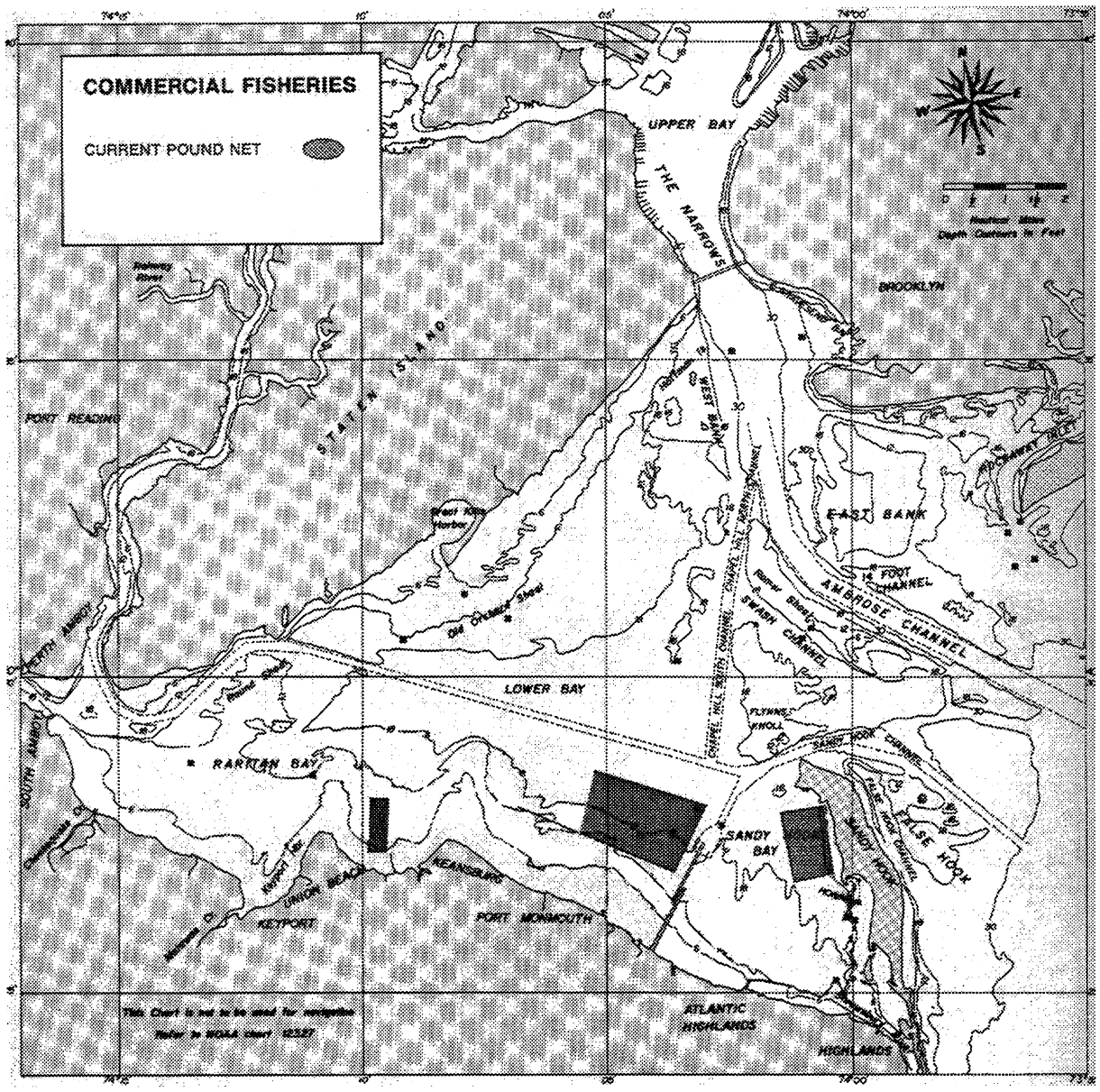


Figure 5.4-6 Commercial Fisheries Current Pound Net Locations

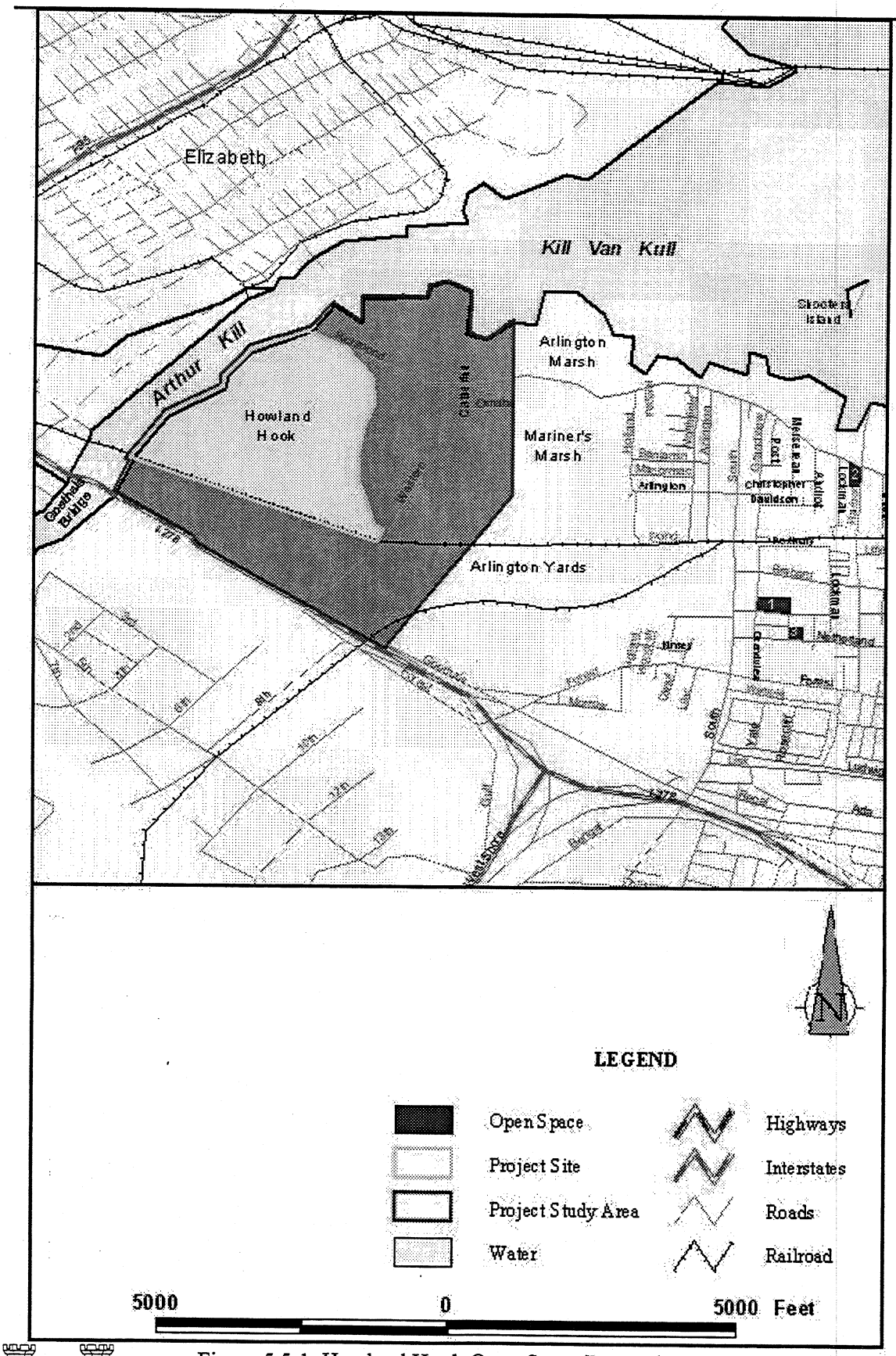


Figure 5.5-1 Howland Hook Open Space/Recreational Facilities

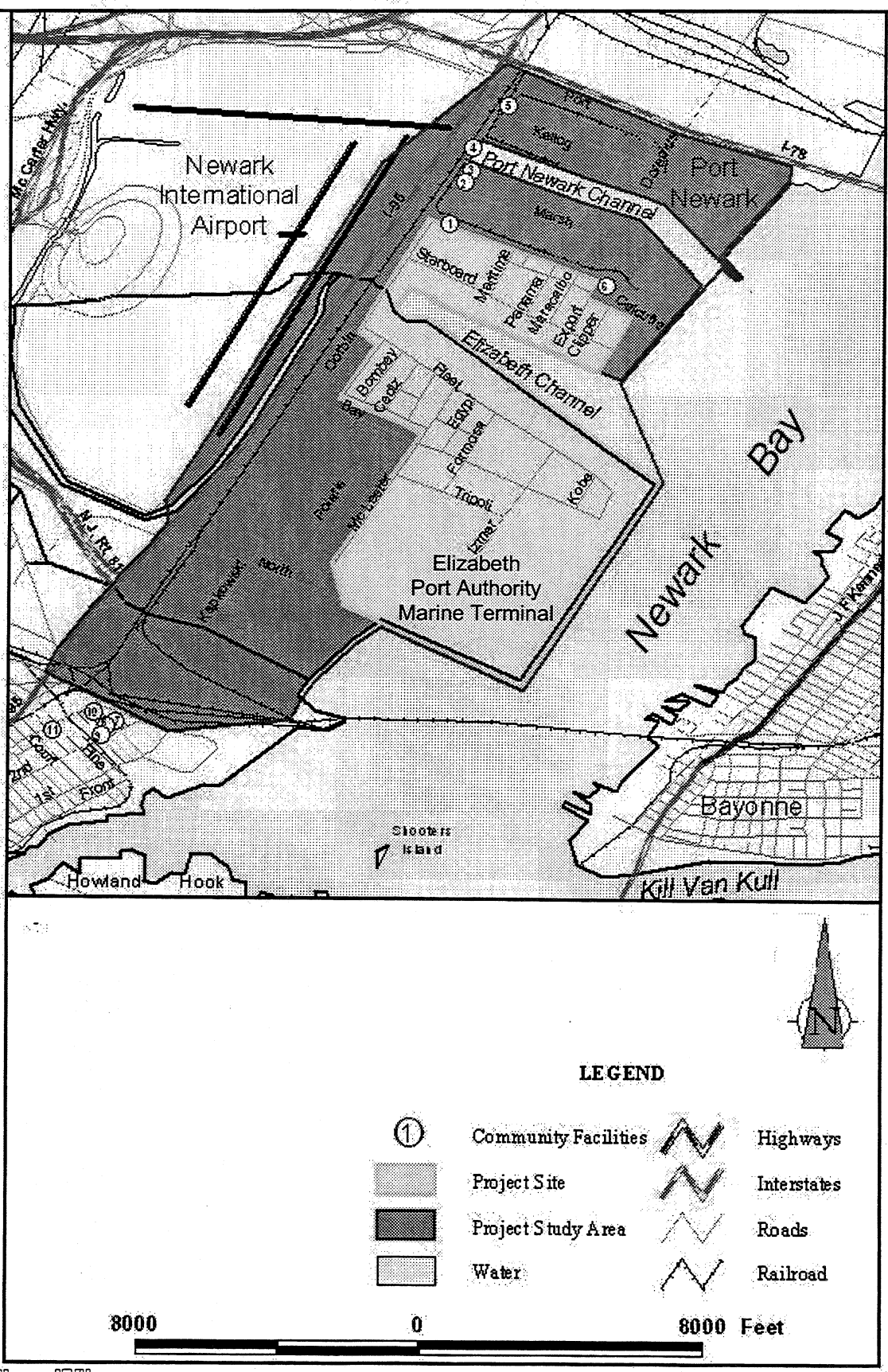


Figure 5.5-2 Port Newark/Elizabeth Community Facilities Map

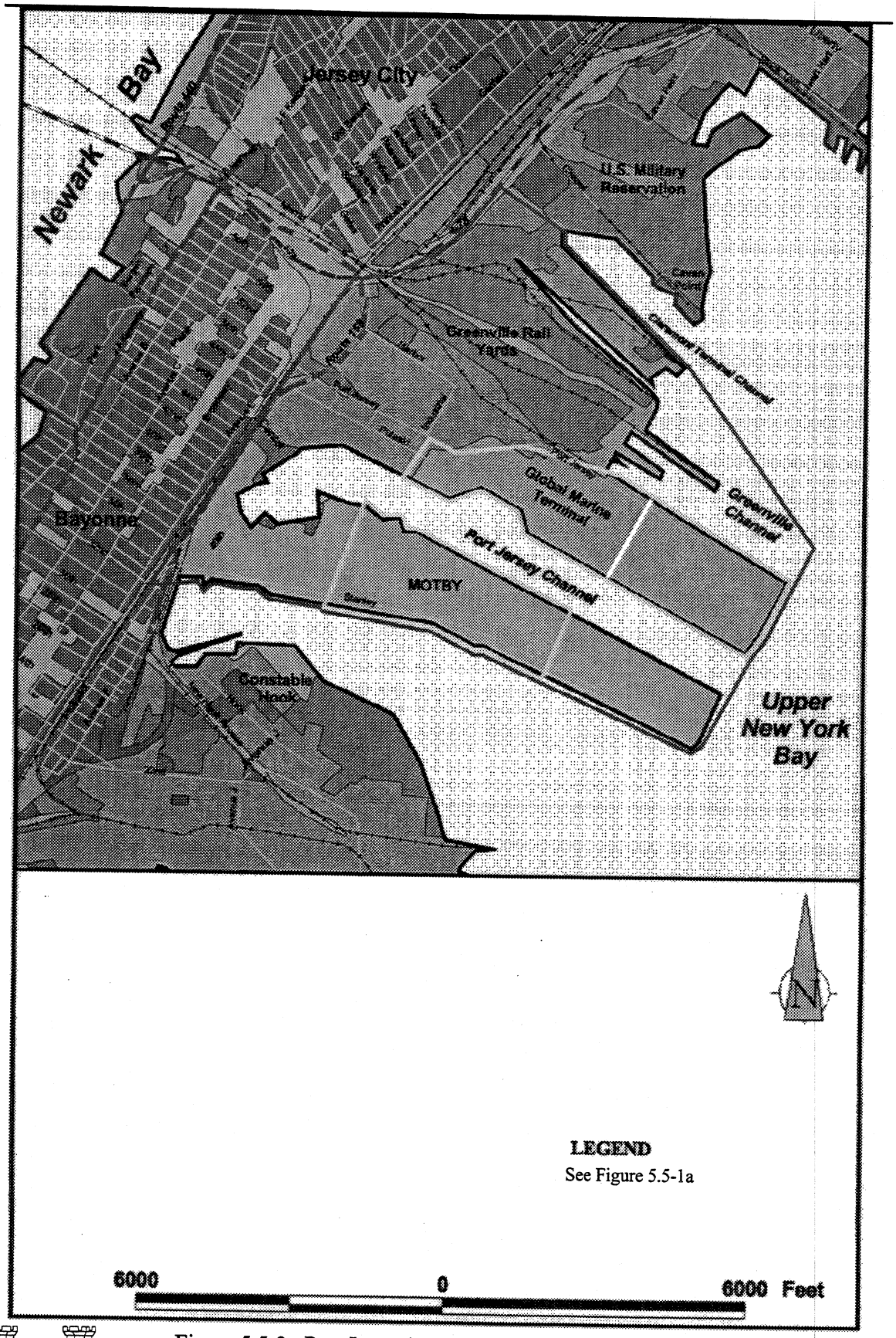


Figure 5.5-3 Port Jersey/MOTBY Study Area and Land Use Map

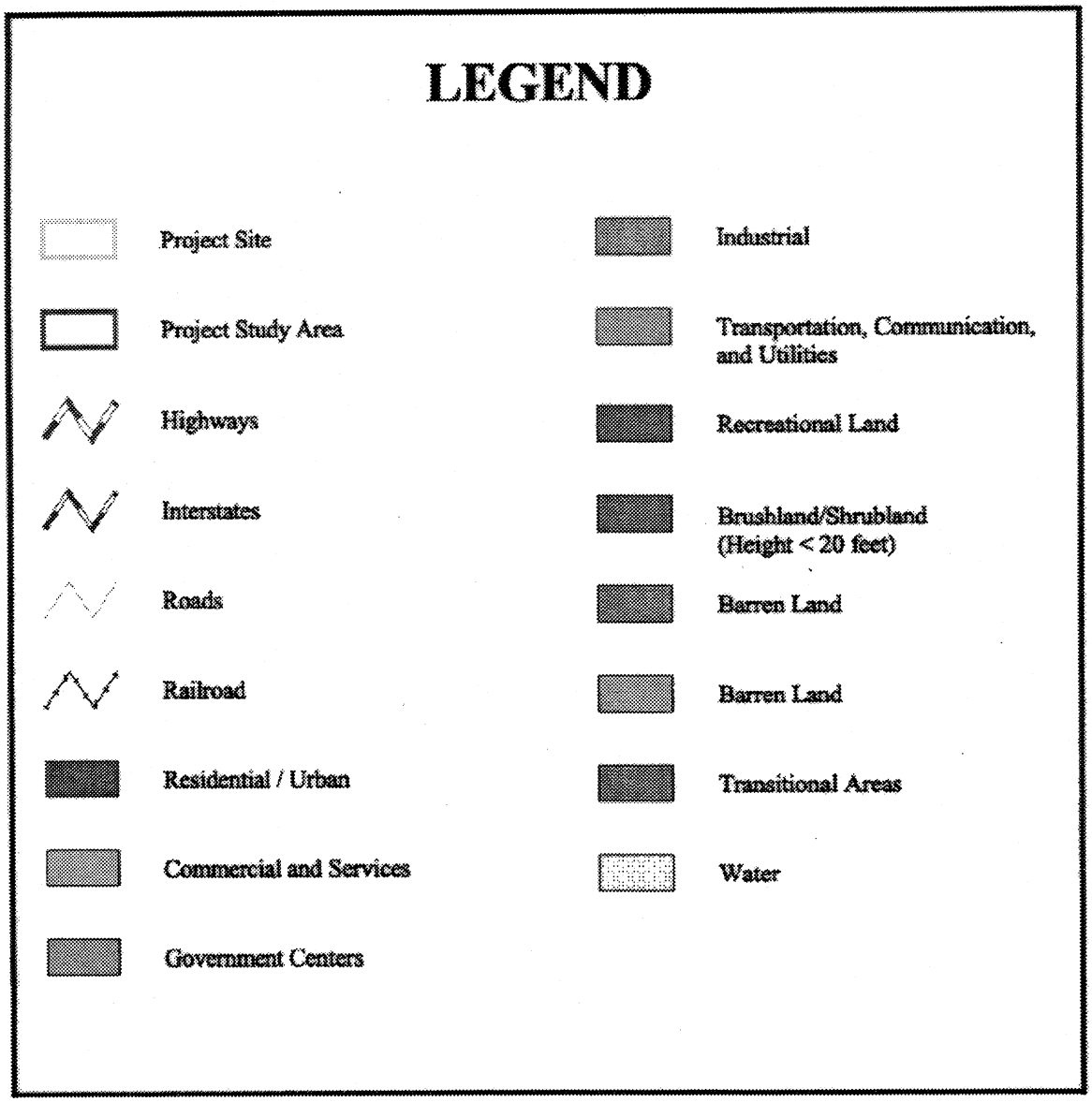


Figure 5.5-3a Port Jersey/MOTBY Study Area and Land Use Map Legend

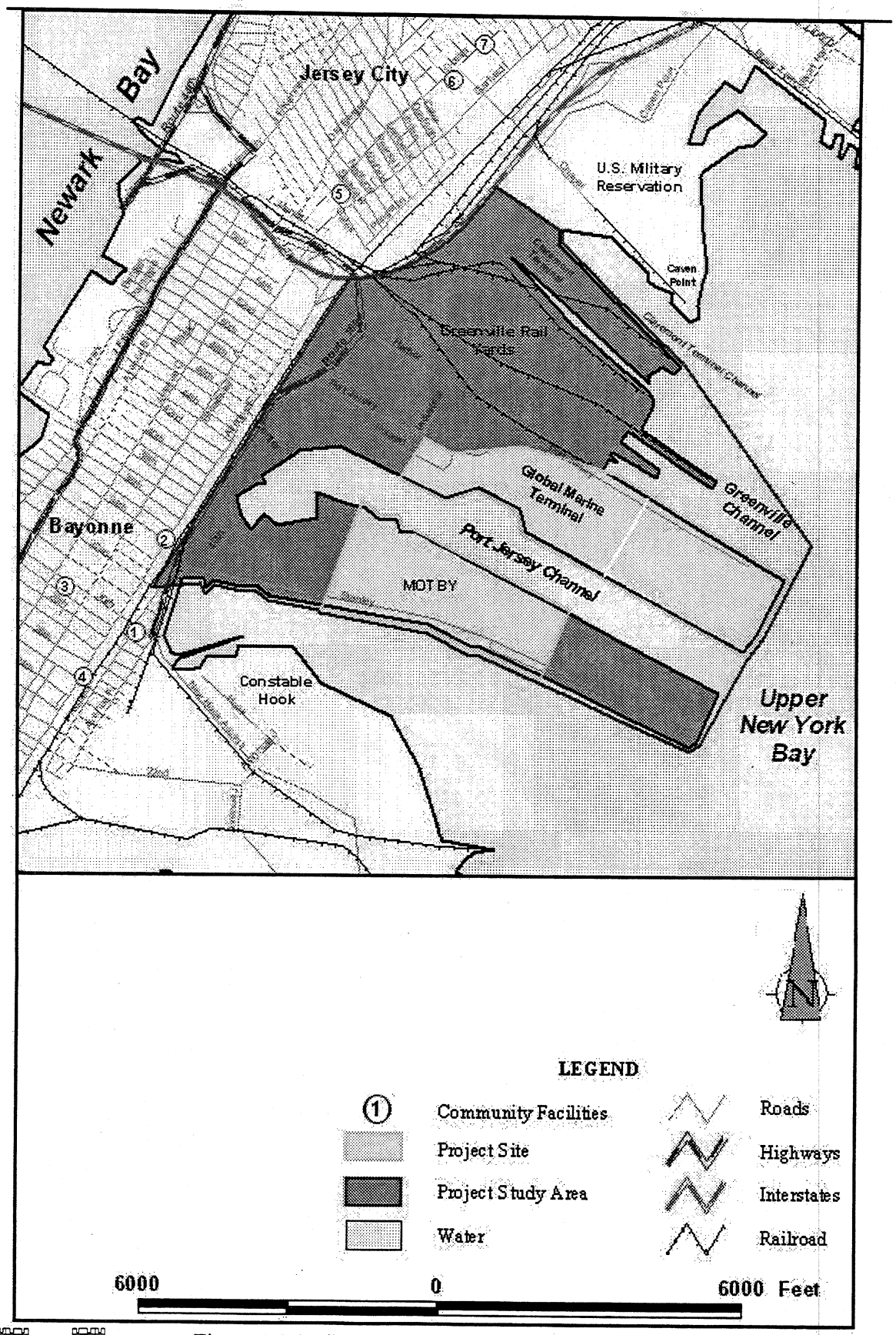


Figure 5.5-4 Port Jersey/MOTBY Community Facilities

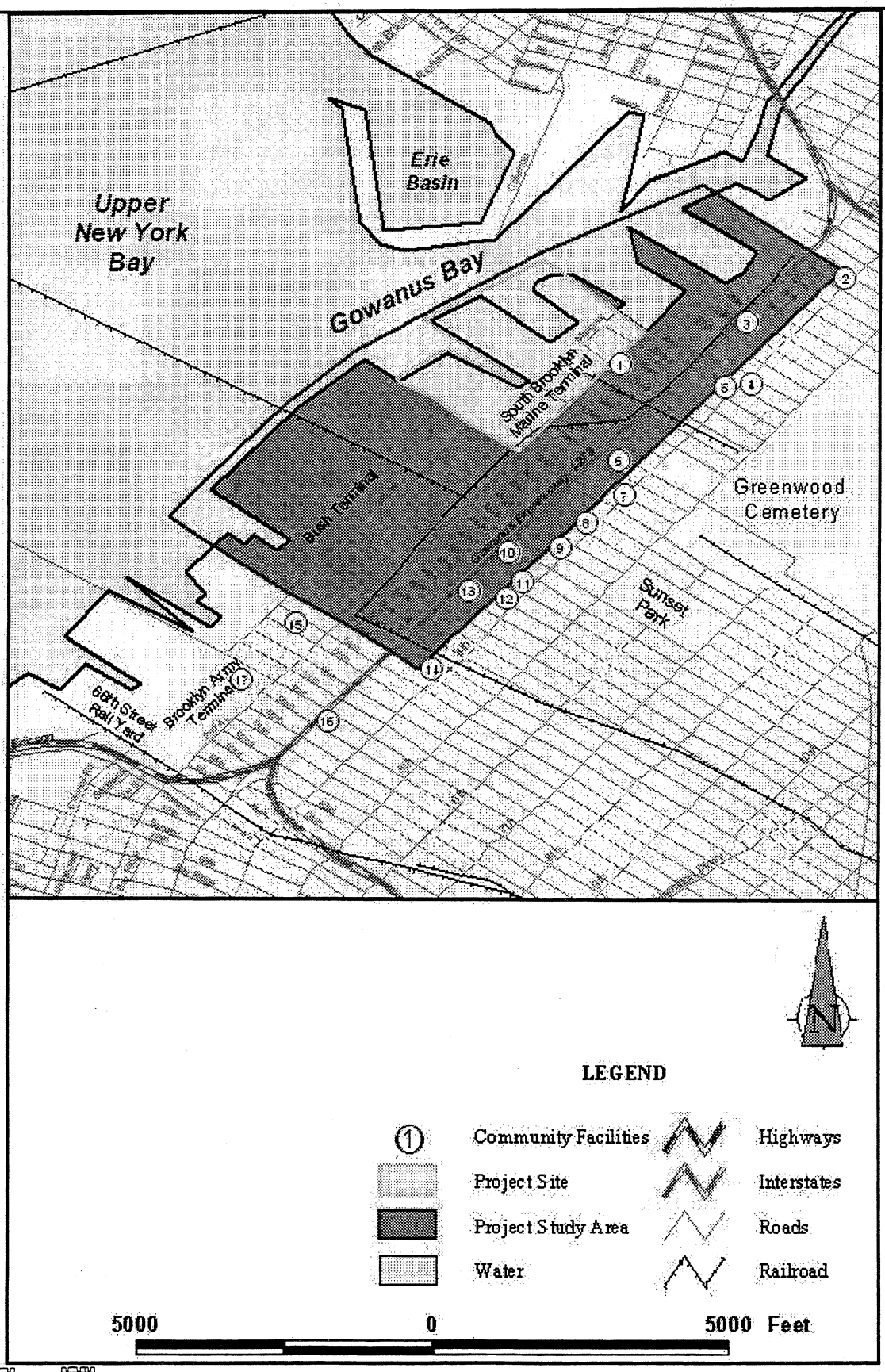


Figure 5.5-5 South Brooklyn Community Facilities

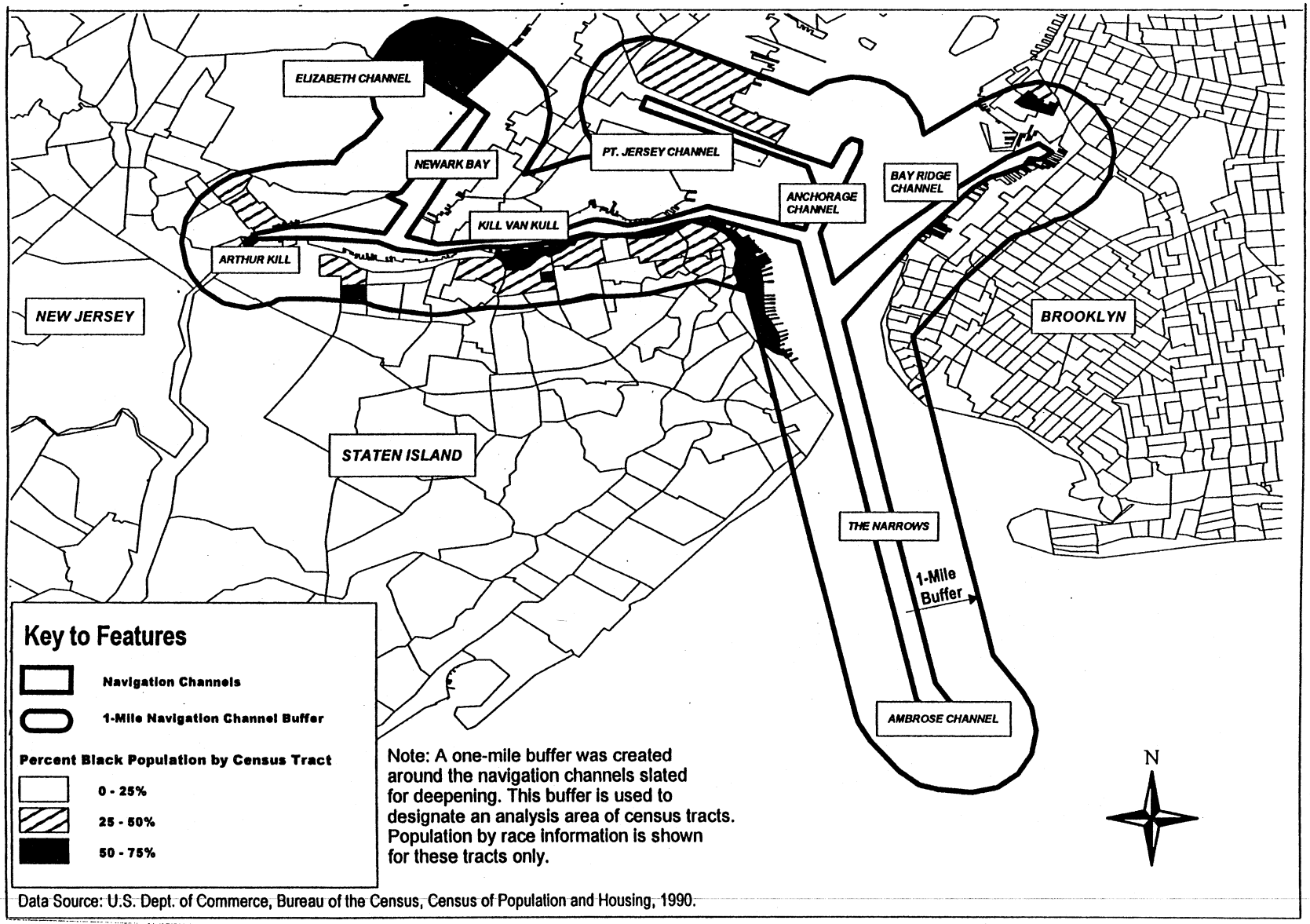


Figure 5.7-1 New York and New Jersey Harbor - Surrounding Area African-American Population by Census Tract, 1990

5-204

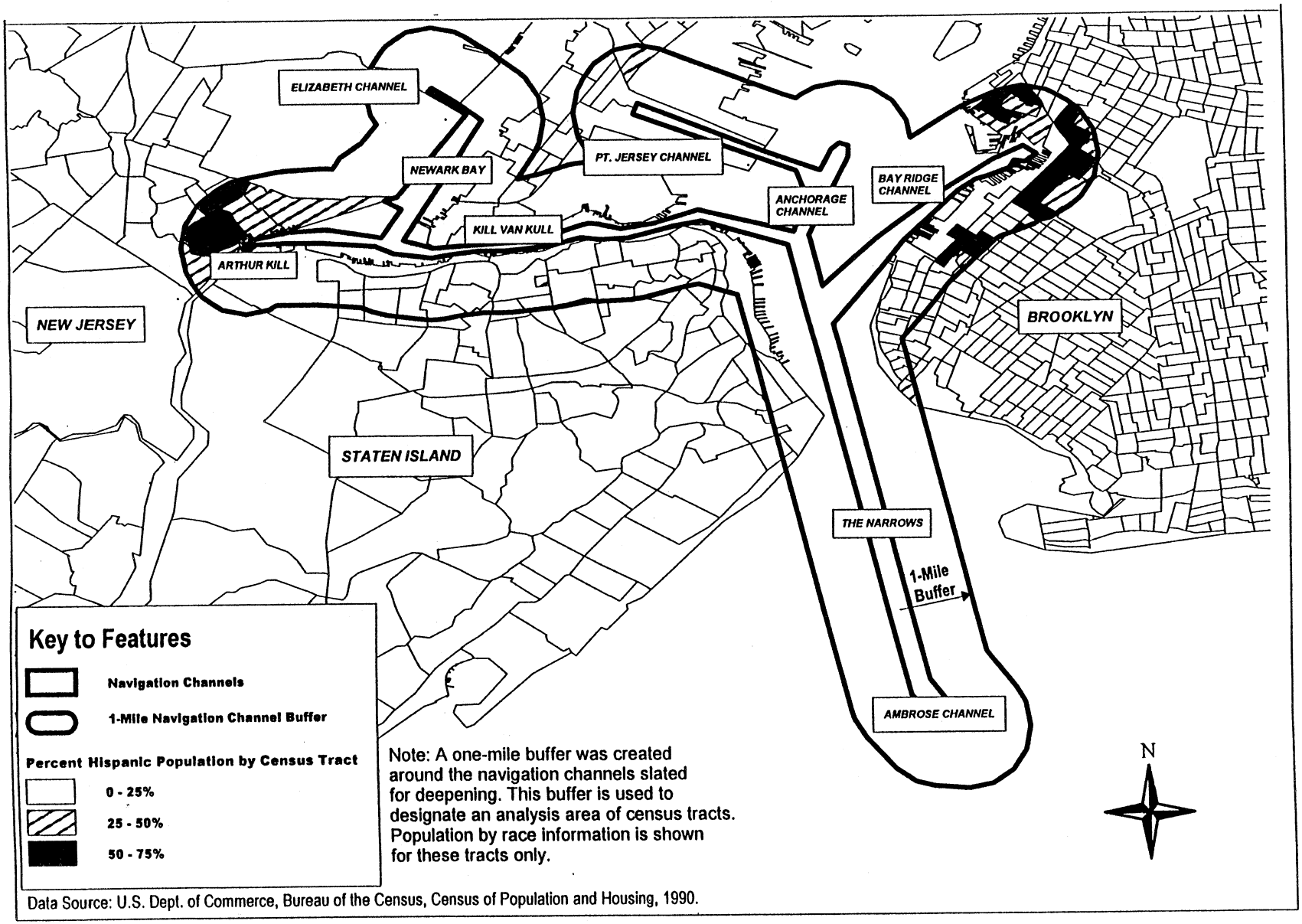


Figure 5.7-2 New York and New Jersey Harbor - Surrounding Area Hispanic Population by Census Tract, 1990

6 ASSESSMENT OF EFFECTS ATTRIBUTABLE TO THE RECOMMENDED PLAN

6.1 The Recommended Plan includes navigation improvements to nine New York and New Jersey Harbor channels leading to four destinations. As described in the Main Report, the recommended navigation channel improvements would be made over an extended period (8 to 12 years), meaning that the impacts from the recommended improvements would also be distributed over time. Channel habitats and their associated aquatic life recover quickly from the physical effects of dredging. Therefore, the distribution of impacts over time is an important consideration for direct project effects and cumulative effects. Impacts will also be distributed spatially, with the proposed project area extending from the seaward end of the Ambrose Channel (Lower New York Bay) to Upper New York Bay, Newark Bay, and the northern end of the Arthur Kill. While the area involved is large, the project effects are confined to existing channels that are currently maintained for shipping. Small areas of littoral zone (0 to 6 ft MLW) and sublittoral (6 to 15 ft MLW) habitat (48.29 acres in composite) would be impacted by the proposed navigation channel improvements. A portion of the deeper area would be changed to channel slope and bottom habitat. These areas, located along the sides of the channels, have not previously been disturbed for navigation channel or port facility maintenance, and would, therefore, be subject to disturbance for the first time as a result of this project (except for effects of propwash or sediment deposition, because of their proximity to maintained channels). These areas may contain varying types and levels of contaminants in the surficial sediments that have been deposited throughout the Harbor since industrial development of the watershed.

6.2 This section of the EIS evaluates the impacts of the Recommended Plan, thus providing an assessment of the cumulative effects of navigation channel improvements planned in the reasonably foreseeable future. This assessment relies upon the channel-specific impacts identified in the environmental screening analysis (Section 2), but extends the perspective to include construction impacts. The impacts attributable to the project were identified by comparing the future without-project condition (detailed in Section 4) with the future with-project condition.

6.3 Under the future without-project condition, or the no-action alternative, navigation channel improvements would be limited to those presently authorized (see Table 4.2-1). Physical habitats, hydrology, and water quality would remain the same as described under existing conditions in the case of the no-action alternative. The existing conditions are based on recent physical, chemical, and biological sampling conducted in the project area, as well as on recent biological sampling conducted for this assessment to provide baseline information for the channels, anchorages, and berthing areas considered for deepening.

6.4 The future with-project conditions are based on hydrodynamic model projections for physical conditions and water quality (See Appendix B-1.1). Future biological conditions are based on expected short- and long-term impacts resulting from the direct

effects of construction and the long-term effects of changes to physical and water quality conditions. A detailed presentation of the without-project condition and analysis of the projected environmental impacts is presented in Section 4.

6.1 Direct Impacts

Aquatic

Hydrodynamics and Water Quality

6.5 Based on hydrodynamic modeling results, there will be minimal to non-detectable changes in hydraulic conditions and water quality parameters such as water temperature, salinity, and dissolved oxygen (DO) as a result of the proposed navigation channel improvements. Results of the modeling work are presented in Appendix B-1.1. Model simulations were made to determine the impact of future without-project conditions and future with-project conditions. Modeling was performed for two flow conditions, however, emphasis in the modeling was placed on a low (summer) flow condition that corresponded to high salinity and low dissolved oxygen values. With-project model runs were conducted in order to assess the impact associated with the future channel improvements consisting of deepening portions of the Arthur Kill and Newark Bay, and the Kill Van Kull, Port Jersey, and Bay Ridge, to 50 ft MLW and deepening the Ambrose Channel to 53 ft MLW. Comparisons were made between the baseline (without-project) conditions and future (with-project) conditions.

6.6 The proposed future with-project deepening will produce minor changes in water surface elevations under low flow conditions (i.e., maximum difference in tidal range is less than 1.6 inches). The changes in salinity between with- and without project conditions for the low flow condition are small with a maximum average change of 0.7 ppt. The largest relative change occurred near Howland Hook and the maximum average salinity change in the remaining areas of the study area is 0.2 ppt or less. Changes in salinity for the low flow condition are summarized in Appendix B-1.1 which presents surface salinity contours for without and with-project conditions under low flow conditions. Overall, the average differences in dissolved oxygen between future and baseline conditions are very small and the maximum reduction in New York Harbor was 0.13 mg/l. Additionally, it should be noted that increases in dissolved oxygen are indicated for some areas of the harbor. Appendix B-1.1 summarizes changes in dissolved oxygen with surface dissolved oxygen contours for future and baseline conditions under low flow. The predicted changes in salinity and dissolved oxygen are very small in comparison to normal seasonal and annual variation in Harbor conditions: they are not likely to be detectable. Aquatic life is not expected to be adversely impacted by any predicted changes in Harbor water quality.

6.7 In order to determine the possible effects of project-related changes on DO, salinity, and temperature, several fish and shellfish species were placed in groups or guilds with similar habitat requirements (See Appendix B-1.1). Predicted changes in DO,

salinity, and temperature were compared to the biological thresholds of these species to determine if the change would have an undesirable effect. Water quality parameters in the Harbor are naturally variable and sometimes exceed the biological threshold of these species. The guild analysis shows that project- related changes would not significantly augment the natural variability in water quality parameters, and therefore would not have a significant impact on the aquatic species in the Harbor.

6.8 Species found in the Harbor tend to be highly adaptable residents or itinerants, moving through the area on a seasonal basis. The degree of project-related habitat changes will be negligible, and not sudden. Any change that occurred would be gradual, parallel to the incremental development of the project. Moreover, potential changes (such as in temperature) will not be of a magnitude that would trigger life-cycle changes, such as spawning during inappropriate periods.

6.9 Potential coastal erosion impacts as a result of channel deepening were evaluated using two wave models: a numerical model and an analytical model. Numerical wave model analyses for wind and swell in Lower New York Bay show that deepening the Ambrose Channel from 45 ft MLW to 53 ft MLW would increase wave heights in the immediate vicinity of the channel, but that waves reaching adjacent shorelines would be unchanged. For waves propagating from offshore, the model predicts a small shift in wave energy to the west (due to refraction along the navigation channel), which may modify wave conditions near Coney Island and Rockaway Point. These modifications are expected to be very small, as wave heights may decrease along Coney Island and increase at the western tip of Rockaway Point by a maximum of 1 to 2%. There were no changes in the propagation of locally generated wind waves for the channel depths modeled (See Appendix B-1.1).

6.10 An analytical model was developed for Upper New York Bay to evaluate potential wave impacts from ship wakes. The results suggest that the impact of ship wakes will decrease under without-project conditions. This is due to the fact that a deeper channels results in a smaller (lower energy) wave for the same vessel traveling at the same speed. More importantly, however, the project will result in an overall decrease in the number of ship calls over the life of the project (because of greater TEU capacity per ship). Accordingly, the overall reduction in ship cycles will reduce the total amount of wake energy absorbed at the shoreline, thereby reducing the potential for bank erosion (see Appendix B-1.1).

Biological Resources

6.11 Under the future without-project condition, no navigation channel improvements would be constructed, meaning that all direct impacts to aquatic life and habitats attributable to channel construction would be avoided.

6.12 Wetlands are defined as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation

typically adapted for life in saturated soil conditions (USACE 1982). For the purposes of this environmental assessment and the determination of unavoidable impacts, wetlands have been categorized as follows: high marshes, which are areas above mean high water (MHW); intertidal zone, which is the area between MHW and mean low water (MLW); and the littoral zone, which corresponds to the area from 0 to 6 ft below MLW. This wetlands classification system, used in the evaluation of construction impacts, is based on Cowardin et al. (1979).

6.13 The proposed project would not directly disturb any high marsh or intertidal wetlands (including vegetated low marsh or tidally exposed coastal shoals, bars, or mudflats). It would disturb approximately seven acres of littoral zone habitat and 42 acres of sublittoral (>6 to 15 ft MLW) zone habitat beyond what has been authorized for other projects. These disturbed-acreage estimates, which do not take into account potential slumping of channel slopes after dredging, are nonetheless conservative, because disturbance of this underwater acreage will not necessarily mean loss of the entire acreage as habitat. For example, while approximately seven acres of littoral habitat will be deepened, not all will be deepened to the point (i.e., below 6 ft MLW) where it is no longer littoral habitat. The same applies to sublittoral habitat: only a portion will become deeper than 15 ft MLW. Moreover, some of the littoral habitat that will become deeper than 6 ft MLW will by definition become sublittoral habitat. Therefore, while it is difficult to quantify how many acres of littoral and sublittoral habitat will actually be lost, the loss will certainly amount to less than the 48-plus acres to be disturbed by construction of the proposed project.

6.14 No disturbance of littoral zone wetland habitat is foreseen in the Ambrose Channel, the Anchorage Channel, the Bay Ridge Channel, the Port Jersey Channel, or the South Elizabeth Channel. In addition, no disturbance to vegetated or emergent marsh areas is envisioned in any area. Sublittoral habitat would be altered in the Port Jersey Channel, the Kill Van Kull, the Arthur Kill, Newark Bay, South Elizabeth Channel, and the Elizabeth Channel.

6.15 Deepening of the Arthur Kill Channel from Newark Bay south to Howland Hook would alter 3.23 acres of littoral habitat and 3.22 acres of sublittoral habitat (See Appendix B-1.12, Figures 1-8). The altered areas would become deeper, to the point that a portion of the littoral habitat would become sublittoral habitat, and a portion of the sublittoral habitat would become deep-water habitat. The altered areas stretch almost continuously from Newark Bay near Shooters Island south and west along both sides of the Arthur Kill to the Elizabeth River and the Howland Hook Marine Terminal. This area is characterized by a variable substrate that contains mud, sand, rocks, and bricks (Table 5.4-6). No habitat disturbance is projected for the wetlands surrounding the Goethals Bridge (including the project under construction by the Salt Marsh Restoration Team of the New York City Parks and Recreation Department).

6.16 Deepening of the Port Jersey Channel in the vicinity of the Jersey Flats would alter 12.35 acres of sublittoral habitat on the north side of the channel (See Appendix B-

1.12, Figures 2-3). No littoral habitat would be altered in this channel. Approximately two-thirds of the altered sublittoral habitat would be converted to deep water beyond the bottom edge of the 52-ft channel and approximately one-third of the area would be on a 3:1 slope. The existing area consists of moderate-depth habitat with clean substrate consisting of a mixture of mud, clay, and sand, with shells.

6.17 Deepening of the Kill Van Kull from Upper New York Bay to Shooters Island would alter 0.06 acres of littoral habitat and 1.41 acres of sublittoral habitat (See Appendix B-1.12, Figures 4-7). The altered areas occur intermittently along the northern and southern shores of the Kill Van Kull. The substrate in this area is characterized by sand and shells (Table 5.4-6).

6.18 Channel deepening in Newark Bay (including the South Elizabeth and Elizabeth Channels) would alter 2.97 acres of littoral and 25.05 acres of sublittoral habitat along the edges of the channels selected for deepening to 52 ft (See Appendix B-1.12, Figures 12-16). The bulk of the habitat alterations are confined to areas along the slopes of the deepened channels, except for the South Elizabeth Channel where an existing sublittoral area would be converted to deep channel habitat and a contiguous area would be on the new slope of the deepened channel. In those instances where existing habitat is converted to channel slope, a small portion of the habitat would remain in the existing depth range for each habitat type. The acreages for the areas disturbed are summarized in Table 6.1-1. Some altered areas are contiguous with altered areas in adjacent project segments.

6.19 The navigation channels and representative destination port facilities proposed for deepening were sampled for benthos, fish, and ichthyoplankton as part of a program to characterize existing conditions. The data derived from this sampling program in conjunction with the results of other recent sampling programs were used to evaluate the effects of the proposed navigation channel improvements.

Shoals and Shallow Water

6.20 Fish sampling conducted throughout the Harbor indicates that the shoal and shallow-water areas are used on a seasonal basis by both fish and invertebrate species. Changing shallow/shoal habitat into slope/channel habitat represents a shift in the role the habitats will play in the seasonal cycle of fish and benthic activity in the Harbor. Although this shift represents a permanent impact, the channel sideslopes would follow the existing sideslope profile. Little change in depth would be associated with disturbance at a particular location. Within a relatively short period, species composition would return to pre-disturbance composition. The amount of shoal/shallow habitat lost, moreover, is small relative to the shoal/shallow areas remaining throughout the Harbor. Because habitat changes will be phased in incrementally over a long period, the most shoal/shallow habitat will remain available during project implementation. This would prevent the impact from being stochastic in nature. Finally, mitigative measures will be

taken to restore much of the shallow/shoal areas lost, and may serve to provide habitat of higher quality than what was lost by project construction

6.21 The habitat alterations would have no adverse impact on ichthyoplankton, because ichthyoplankton are not dependent on specific water depths.

Channels

6.22 Dredging in the existing channels for deepening would have the same effect on aquatic life as maintenance dredging. The removal of the sediment would result in a loss of the invertebrates living in the sediment and a disruption of habitat for the epibenthos and fish using the area at the time of dredging. Benthic and epibenthic species would recolonize from adjacent areas, and fish species would soon follow.

6.23 The overwintering habits of blue crabs were studied to determine the possible impact of channel deepening on torpid individuals. Results showed that blue crabs were more abundant in shallow and shoal areas, where dredging will not occur, than in channel areas during February, March, and April in the New York and New Jersey Harbor. As a result, channel deepening would have minimal impact on overwintering populations of blue crabs.

6.24 The removal of rock outcroppings within the channels may have a permanent impact. These areas would no longer be available for invertebrate populations that require hard substrate (e.g., blue mussels).

6.25 No disruptions are expected to productive shellfish beds, which are primarily located in the shallower waters of Lower New York Bay. Nor are dredging activities expected to have a direct impact on commercially or recreationally important shellfish. Due to health advisories, commercial and recreational fisheries for crabs and other shellfish are closed in many parts of the study area. NJDEP prohibits the harvest and consumption of blue crabs in the Newark Bay Complex, which includes Newark Bay, the Kill Van Kull, and the Arthur Kill. The New York Department of Health has issued a health advisory for the same area, recommending that crab consumption be limited to 6 per week.

6.26 Commercial shellfish fisheries are located in Lower New York Bay and, with the exception of the Ambrose Channel, would not be affected by the proposed dredging activities related to channel deepening. Although lobsters are taken from the immediate vicinity, primarily the sideslope area of the Ambrose Channel, these areas are not expected to be affected by deepening activities, since widening of the channel is not included in the project design. Blue crab are regularly taken from the Romer Shoal, located adjacent to the Ambrose Channel. Since, however, channel deepening will not impact shoal areas, no direct impacts to this fishery are expected.

6.27 Since all sea turtles are listed as threatened or endangered, impacts to these organisms will be covered under "Protected Species" below. Similarly, since impacts to all marine mammals are identical to the impacts to threatened or endangered marine mammals, these impacts will also be covered in the Protected Species discussion.

Maintenance Dredging and Dredged Material Placement

6.28 It is anticipated that the proposed channel deepening will require periodic maintenance dredging to allow safe vessel passage. Channel deepening and subsequent maintenance would produce substantial amounts of dredged material requiring placement. The New York and New Jersey Harbor DMMP (USACE-NYD 1999a), which includes details of the NJDIG program, presents sufficient disposal alternatives to accommodate not only the dredged material expected to result from the proposed channel modifications, but also the material generated from Harbor maintenance dredging operations for the foreseeable future.

6.29 The proposed project may also affect bottom contours, resulting in changes to maintenance dredging procedures in associated channels. Tidal currents may be channeled into the deepened trenches, thus altering sediment transport patterns. The steeper post-dredge gradient that will exist from the shoal areas to the channel bed may contribute to an altered deposition rate in deeper areas as a result of export from shallow or shoal areas. The angle of repose or channel sideslope is a function of the combined effects of gravity flow of fluid sediments, slumping of compacted sediments, and erosion and transport by waves and tidal currents. In addition, sediments may be resuspended from the channel bed after passage of large vessels, particularly those entering the Harbor fully loaded. Resuspended sediments can be deposited in other areas of the Harbor, such as maintained access channels and berthing areas. Channels and berths that are regularly maintained may require more or less frequent dredging, and certain areas that do not currently require dredging may require it in the future. These changes may also affect the need for and frequency of maintenance dredging in the affected areas of the Harbor.

Dredged Material Transport

6.30 Dredged material transport through the navigation channels would be by tug and scow, a mode of transport prevalent throughout the project area. These activities are therefore not expected to disturb fish and wildlife beyond current levels. Similarly, since dredged material transport by truck or train will also transit previously disturbed areas, it is not expected to present additional disturbance to area fish and wildlife. In either both case, BMPs, along with local, state, and Federal regulations, will ensure the responsible handling of dredged material during transit. As a result, it is unlikely that dredged material transport will have an impact on fish and wildlife species.

Noise, Odor, and Aesthetics

6.31 The time restrictions for construction activities discussed in Section 5 relate to landside construction only. Previous dredging activities in the Kill Van Kull and Newark Bay have progressed 24 hrs/day, 7 days/week. It is assumed that this will also be the case for this project. However, noise produced by dredging and dredged material placement operations will be temporary and is likely to be overshadowed by existing noise levels from marine terminals, airports, and nearby transportation corridors. In addition, dredging and dredged material placement operations would be in compliance with the maximum permissible sound levels of surrounding municipalities. Therefore, no direct noise impact is anticipated.

6.32 Tug, truck, and railroad traffic is prevalent throughout the project area and as such contributes to current ambient noise levels. Dredged material transport related to the project is not expected to increase these traffic levels significantly, making it unlikely that dredged material transport will increase ambient noise levels.

6.33 The potential exists for odor to be produced by newly dredged material. The severity of the odor impact will depend on the condition of the material being dredged, time of year, direction of wind, and amount of material exposed to the air. Dredged materials may contain organic matter, which is associated with the release of hydrogen sulfide and methane gases. Dredging of typical channel sediments will not normally release these gases at harmful concentrations. Scows being filled at the dredging site will typically have a thin layer of water covering most of the load. This cover tends to reduce odor release. Moreover, once a barge is filled, the material is hauled away to the dredged material placement or transfer site. Released gas is readily dispersed and therefore does not persist once the material is removed from the area. Odor impacts will be less in colder months since the cold restricts growth of odor-causing bacteria.

6.34 Aesthetics within the Harbor area will not be impacted by construction of the project. The dredges and scows temporarily operating at the dredging sites will be the only visible sign of the project. Equipment with similar visual characteristics operates within the Harbor on a daily basis. Viewscapes will not be substantially altered by the presence of dredging equipment. No visible signs of channel deepening will remain after the project is completed.

6.35 No impact on aesthetics is expected as a result of dredged material transport. Depending on destination, dredged material might be transported by any of several methods. For placement at the HARS or in sub-channel placement cells, or for pierside off-loading, dredged material would be transported via tug-powered scow through the navigation channels. Since tug/scow combinations are currently common in the navigation channels, their project-related presence would result in no change in viewscape. Should the destination of the dredged material be upland, transportation would be via truck or railroad car. Since the piers where dredged material would be

loaded into trucks or onto railroad cars are already heavily industrialized, this operation would result in no change in viewscape. In neither case, then, would aesthetic impact be expected from dredged material transport.

6.36 Another issue that may be affected by the proposed project is the fact that buried cables and transmission lines currently in use will either be exposed or effectively moved nearer the substrate surface as a result of channel deepening. These buried utility lines may have to be re-lain or re-drilled. Abandoned subsurface cables or pipelines encountered during dredging will have to be removed.

Vessel Traffic

6.37 The proposed channel deepening would not be the cause of an increase in vessel traffic in the New York and New Jersey Harbor. An increase in vessel traffic is expected, however, simply as a result of growth in volume of trade. This increase in vessel traffic (and in size of vessels) might be expected to lead to expansion of the associated tug fleet. Both these factors have the potential of increasing the likelihood of accidents and associated petroleum-product spills.

6.38 It is likely that vessel traffic safety will be maintained at current levels, regardless of traffic volume. The U.S. Coast Guard operates the Vessel Traffic Service in New York (VTSNY) to improve safety and protect the environment. This service is designed to reduce the probability of collision or grounding by providing advance information on the movement of other vessels, as well as on traffic congestion, weather conditions, and other potential hazards. It is anticipated that the Coast Guard will continue to operate the VTSNY, and will therefore maintain vessel traffic safety within the Harbor in the future. As for the tug fleet, the Towboat Harbor Carriers Association reports that no growth in fleet size is expected, whether Harbor traffic increases or not. According to the Association, it is likely that a traffic increase will be handled by the replacement of aging vessels with larger, more powerful tugs, rather than by building more vessels (L. O'Leary, pers. comm.).

6.39 Tug and scow activity may increase as a result of the project. Tugs and scows would be used to transport dredged material from the construction sites to placement areas or to piers where the material would be loaded into trucks or trains. Since project-related vessel traffic would be regulated by VTSNY, however, it would be expected to transit the Harbor in a safe manner. Therefore no impact to vessel traffic safety is expected.

6.40 Channel deepening may actually *reduce* the potential for accidents and associated petroleum-product spills. Under current conditions, containerships and oil tankers often rely on favorable tides for passage. This results in increased traffic during certain periods and therefore an increase in the potential for accidents. Channel deepening would broaden the window suitable for passage, relieving congestion and ultimately reducing the potential for traffic-related accidents and associated spills.

Upland

6.41 Economic forecasts predict that Port efficiency will increase approximately 2 to 3% per year, from a present annual 1,500 lifts per acre to a maximum of 3,500 lifts per acre in the year 2040. As discussed in Section 4, the projected increase will occur regardless of whether the proposed channel improvements are implemented. The commercial increase will be handled through operational changes, advances in technology, and terminal facility reconfigurations, with no port facility expansions or infrastructure modifications involving filling of wetlands or open waters. These facility improvements will occur regardless of whether the proposed channel improvements are made, and are therefore included in the without-project condition. The potential impacts associated with these improvements are discussed in Section 4.4. No additional impacts, other than those associated with the without-project condition discussed in Section 4.4, are anticipated from these upland facility improvements.

6.42 Project partners have, however, advanced the concept of capturing additional commerce, beyond what could be achieved by improvements in container-handling capacity. If, as 2033 approaches, the various terminal operators find that investment in container-handling capacity improvements is desirable, such investment may take the form of adding land to existing terminal areas. With that possibility in view, the non-Federal partners have put forth plans for future facility expansions at Port Newark/Elizabeth Port Authority Marine Terminal, Port Jersey/MOTBY, Howland Hook Marine Terminal, and South Brooklyn Marine Terminal. The environmental impacts related to these potential expansions will be addressed in the Comprehensive Port Improvement Plan, and formally evaluated in EISs before any expansions would be implemented.

6.2 Indirect Impacts

Aquatic

Geology, Groundwater, and Site Stability

6.43 No adverse impacts on the geology of the project area are expected. Although deepening of the channels may affect the rate of sediment accumulation and scour, none of this is expected to affect existing geology. Groundwater flow through bedrock is also unlikely to be affected. Blasting will likely widen fractures in exposed bedrock, but this widening will be limited to the navigation channel and will not produce significant effects on groundwater.

6.44 Possible effects of removal of the sediment blanket over potential artesian aquifers should be investigated, as geologic data become available from USACE. No continuous water-bearing, unconsolidated formations are expected to be disturbed or exposed as a result of channel deepening. Although the Magothy and Raritan Formations

are important aquifers in the project area, preliminary information indicates that they are overlain by a considerable thickness of Pleistocene and Recent sediments. This finding should be confirmed when preliminary project plans and geologic maps (based on sediment borings) are finalized. Anticipated depths of current mining of sand from the Ambrose Channel should be considered when evaluating the depth of cover over the Magothy Formation. No economically important or significant mineral deposits have been mapped in the area to be deepened. In addition, no effects are expected on existing faults or shear zones.

6.45 Potential impacts of channel sideslope failure include damage to structures located near the top of the slope and frequent maintenance dredging if shoaling is produced by failure of sideslopes. Channel sideslope stability analysis identified 20 structures which may be impacted by extending channel sideslopes laterally. The structures are located along the Kill Van Kull, Arthur Kill, and Newark Bay Channels. The structures were assigned a level of predicted impact based on anticipated channel depths, geotechnical data, and channel geometry. The structures with the highest predicted impact were further evaluated to determine methods of stabilization. Structural impacts associated with channel sideslopes are relatively minor, and conceptual designs for stabilization of these structures have been developed (See Engineering Appendix of Main Report).

Biological Exposure Potential

6.46 The proposed deepening of the navigation channels in the New York and New Jersey Harbor could affect the degree of exposure of biological receptors to contaminants. A well-documented effect of dredging activities is the resuspension of sediments, increasing the potential for exposure of biological receptors. It is equally possible to view dredging of contaminated sediments as a means of removing contaminants from the system, thereby reducing the exposure of biota to contaminants. Both of these mechanisms will be discussed in this section. The degree to which either of these mechanisms influences the exposure of biological receptors to contaminants depends on a variety of factors: (1) magnitude and extent of contamination; (2) characteristics of the sediment; (3) types of contaminants present; (4) presence and life histories of biological receptors; and (5) method of dredging to be used. All these play a role in determining degree of exposure of biological receptors to contaminants, and will be considered in evaluating the extent to which Harbor channel deepening will influence the potential exposure of biological receptors to contaminants.

6.47 The NOAA National Status and Trends Program was initiated to collect information on contaminants from over 200 estuaries in the United States. Data from this program indicate that the New York and New Jersey Harbor estuary is among the 20 most contaminated estuaries in the country (Squibb, et al. 1991). A variety of historical studies have yielded information on the types and concentrations of contaminants present in the study area (Squibb, et al. 1991, Olsen, et al. 1984, Bopp, et al. 1991). Since the channels are maintained for navigational purposes, they are dredged regularly, thus

removing the top layer of sediment. This sediment layer is replaced by suspended sediments from throughout the Harbor. Therefore, the level of contamination of surficial sediments in the channels is expected to reflect the overall condition of the Harbor.

6.48 A variety of contaminants has been detected in Harbor sediments, including metals, PCBs, PAHs, chlorinated pesticides, dioxins, and furans. Of all the locations being considered for channel deepening in this study, the generally highest concentration of contaminants has been documented in Newark Bay, especially near Shooters Island at the juncture of the Kill Van Kull, Arthur Kill, and Newark Bay. Slightly lower contaminant concentrations are found in the Kill Van Kull and Upper New York Bay.

6.49 Within the Upper New York Bay, sediment contaminant concentrations adjacent to the South Brooklyn Marine Terminal in the Bay Ridge Channel are especially high, similar in magnitude to those observed in Newark Bay. The average contaminant concentrations in Lower New York Bay are generally lower than concentrations in Upper New York Bay. Very little information on contaminant concentrations in the New York Bight Apex is available. It may, however, be assumed that these concentrations would be lower than those observed in Lower New York Bay due to the general decreasing trend in concentrations from Upper New York Bay to Lower New York Bay (USACE-NYD 1999b, 1999c; Squibb, et al. 1991).

6.50 Trends in contaminant concentrations generally follow trends in sediment characteristics, particularly grain size and organic carbon content. Grain size has been shown to be one of the primary factors influencing the adsorption of contaminants onto sediment particles. Sediments characterized by larger grain sizes, such as gravel and sand, are not expected to have contaminants adsorbed to them to the same degree as sediments with smaller grain sizes, such as silts and clays (otherwise known as fines). Therefore, the percentage of fines in sediment is to some extent proportional to sediment contaminant concentrations.

6.51 Sediment characteristics within the New York and New Jersey Harbor have been described by Coch (1986). Lower New York Bay, where the Ambrose Channel is located, is characterized primarily by sandy sediments, with a higher percentage of silt and clay along the shoreline. Upper New York Bay is also characterized primarily by sandy sediments, especially toward the middle of the bay. Increasing amounts of silt are found along the shorelines and toward the north end of the bay. Specifically, the northern portion of the South Brooklyn Marine Terminal, where the Bay Ridge Channel is located, and the western shore of the bay, including Port Jersey, are characterized by silty sediments, possibly explaining the higher contaminant concentrations in these areas. The sediments in the Kill Van Kull were not characterized in Coch's paper. However, since the Kill Van Kull is a maintained channel, surficial sediments are expected to represent recently deposited fines.

6.52 Newark Bay is characterized by a mixture of sandy, silty, and clay sediments, depending on location. Shooters Island is surrounded by all three sediment types: clay,

silt, and sand. The northern reach of the Arthur Kill to Howland Hook is characterized by clays, and the confluence of the Arthur Kill with southern Newark Bay is characterized by silts. The predominance of fines in the sediments of these areas may explain the observed high concentrations of contaminants. Finally, sediments in the vicinity of the South Elizabeth and Elizabeth Channels are characterized as silty.

6.53 In addition to sediment characteristics, the physical properties of the contaminants also influence their potential to adsorb to sediment particles. Such physical properties include water solubility, the octanol-water partition coefficient (K_{ow}), the organic carbon partition coefficient (K_{oc}), and chemical charge. Most contaminants in the New York and New Jersey Harbor have been shown to adsorb readily to silt and clay particles (Olsen, et al. 1984).

6.54 Contaminants that are adsorbed onto sediment particles are actually in a steady state between adsorption and dissolution. Thus, when contaminated sediments are suspended in the water column, some adsorbed contaminants will dissociate from sediment particles and become dissolved. Once contaminants are dissolved, they become much more available for uptake by aquatic organisms. As described previously, materials characterized by relatively small particle size are generally correlated with a greater degree of contamination. The greater the degree of contamination, the greater the degree of contaminant dissolution. Furthermore, the smaller the sediment particle size, the longer it will remain suspended in the water column, and thus the more time its adsorbed contaminants will have to become dissolved in the water column. In addition, the longer a sediment particle remains suspended, the further it can be transported to potentially cleaner areas of the Harbor. In contrast, larger particles such as sand, that do not exhibit the same degree of contaminant adsorption, tend to settle out rather quickly due to their greater weight. Therefore, what little contamination is associated with these sands is expected to settle out in the vicinity of the dredging operations. It is not expected that associated contaminants will go into solution, nor that the particles themselves will be transported to other areas of the Harbor.

6.55 In 1995, a study was performed to evaluate the degree of resuspension of sediment particles into the water column from dredging activities (LMS 1997). This study took place in the northern reach of the Arthur Kill at the Howland Hook Marine Terminal, which is characterized by high current velocities and sediments that were determined to be contaminated and therefore unsuitable for ocean placement. These sediments, as described earlier, are primarily composed of clay, which is expected to remain suspended longer and to be transported farther than other types of sediment. This, together with the high current velocities in the vicinity of Howland Hook, suggested that sediments suspended during dredging operations in this area would have a tendency to be transported great distances. The study was designed to determine both the degree of suspension and the range of transport of sediment particles from dredging activities.

6.56 Dredging was performed using an environmental dredge with a variable hoist speed, usually regulated to less than 2 fps. Monitoring stations were set up 25, 50, 100,

and 500 ft from the dredge, and suspended-solids measurements were taken before and during dredging. Measurements were taken at three depths within the water column: 1.5 ft below the water surface, mid-depth, and 3 ft above the bottom. The study lasted 12 days, and measurements were taken both during dredging and between dredging events.

6.57 The results of the study indicated that total suspended solids (TSS) increased significantly during dredging operations only at the monitoring stations 3 ft above the bottom. The highest measured TSS was measured 50 ft away from the dredge, and no significant increases were measured at a distance of 500 ft. It was concluded that the range of transport of suspended solids in the water column after dredging operations with an environmental dredge was less than 500 ft from the dredge.

6.58 Of particular note in this study was the observation that TSS increased immediately following the passage of barge traffic and to a significantly greater extent than during dredging operations. This indicates that ship traffic within the navigation channels could be suspending sediments more consistently and to a greater extent than would dredging operations from deepening the channels. The data also indicated that TSS concentrations decreased to background levels when dredging operations were suspended intermittently during the 12-day study period. This indicates that suspended sediments remained in the water column for less than 12 days. This relatively short duration of sediment suspension is confirmed by a study performed by Olsen, et al. (1984), who measured the length of time required to remove one-half of the ^{7}Be input from the water column by deposition with settling particles. The half-removal times were calculated to be 5 to 10 days in Upper New York Bay and 10 to 30 days in Lower New York Bay (Olsen, et al. 1984). These studies indicate that the suspension of contaminants in the water column during dredging activities for channel deepening may be short-lived relative to the life-span of most aquatic biological receptors, thereby limiting the exposure potential of these receptors from the channel deepening project. Furthermore, the constant passage of barge traffic through these channels is probably suspending sediments to a greater extent than the dredging operations would.

6.59 The degree of sediment contamination as well as the sediment transport mechanisms described above all play a role in the potential for organisms to be exposed to contaminants. Based on the information presented above, the areas most likely to experience an increase in biological exposure to contaminants due to dredging activities are within 500 ft of the navigation channels in Newark Bay, the Arthur Kill, the Kill Van Kull, and in the vicinity of the South Brooklyn Marine Terminal. These regions are the most contaminated within the Harbor and also contain the highest proportions of fines in the sediment. Since the channels within these water bodies are within 500 ft of shore, the resuspension of contaminants into the water column could affect terrestrial species such as birds and mammals in addition to aquatic organisms.

6.60 A list of invertebrate species known to inhabit the Harbor is provided in Appendix B-1.2. Exposure of benthic invertebrates to contaminants as a result of dredging is not a significant concern. This is because dredging, and thus the temporary removal or

disturbance of the benthic habitat itself, is expected to impact benthic invertebrates to a much greater extent than any potential increase in exposure to contaminants as a result of dredging. Furthermore, dredging activities might actually decrease contaminant concentrations in the channels and thus decrease the potential exposure of invertebrates inhabiting the channel bottoms. This effect is discussed in greater detail below. In the areas adjacent to the channels, where suspended sediments from dredging are expected to be deposited, exposure of benthic invertebrates is also not expected to increase significantly since the sediments in the channel bottoms are expected to be as clean as or cleaner than the surrounding sediments. For these reasons contaminant exposure of benthic invertebrates as a result of dredging is not expected to be of significant concern. However, sediment suspension as a result of dredging could potentially increase contaminant exposure of invertebrates, such as squid and shrimp, that are found in the water column. As indicated in Tables 5.4-2 and 5.4-5, the long and short finned squid and several shrimp species have been found in Harbor area. Since these areas are among the most contaminated in the Harbor, these invertebrate species could be exposed to contaminants suspended in the water column during dredging.

6.61 Lists of fish species known to inhabit the Harbor are provided in Appendix B-1.2. Of these fish species, those residing primarily in the regions of greatest concern, as described above, would be at greatest risk for exposure to contaminants suspended in the water column from dredging activities. Furthermore, some species of fish are known to frequent the channels during certain parts of the year or certain portions of their life cycle. Examples of such species include striped bass, alewife, gizzard shad, bay anchovy, rainbow smelt, Atlantic tomcod, spotted hake, white perch, weakfish, and summer flounder (USACE-NYD 1999b). In addition, some fish species may utilize certain areas of the Harbor for spawning or as nurseries. For example, during a baseline biological reconnaissance survey conducted in 1998, the creeks entering the northern portion of the Arthur Kill were identified as potential spawning or nursery grounds for several species, including the mummichog and silverside (USACE-NYD 1999c). This is of particular concern because this region is located in a highly contaminated area, relative to other parts of the Harbor, and early life stages are known to be the most sensitive to contaminant toxicity.

6.62 A list of bird species identified in the New York and New Jersey Harbor area is provided in Table 5.4-8. During the New York and New Jersey Harbor baseline biological reconnaissance survey, a variety of birds were observed in the areas of most concern. For example, in the Kill Van Kull, cormorants, a great blue heron, mallard ducks, Canada geese, a peregrine falcon, various gulls, and other shorebirds and waterfowl were observed. At Shooters Island, which is part of the Harbor Herons Complex, wading birds, gulls, and cormorants were observed. Some newly fledged wading birds were also observed foraging there. In Newark Bay, near the tip of Bergen Point, kestrels were observed perching on electric power lines. In the wetlands associated with Old Place Creek (near Howland Hook), great egrets, green-backed herons, and snowy egrets were observed. In the vicinity of the South Brooklyn Marine Terminal, herring gulls, greater black-backed gulls, and double-crested cormorants were

observed (USACE-NYD 1999c). Many birds were also observed in areas that are believed to be within foraging range of the areas of concern. For example, Pralls Island, a known heron and egret rookery, is located approximately two miles south of Howland Hook near the contaminated northern portion of the Arthur Kill, where channel deepening is proposed. It has been shown that most great egrets and snowy egrets forage in areas within 2.5 miles of the breeding colony (Custer and Osborn 1978). It can therefore be expected that birds inhabiting Pralls Island might forage in the vicinity of Howland Hook, and thus could be exposed to contaminants suspended during dredging. Most of the birds identified above feed primarily on fish or invertebrates and therefore are at particular risk of exposure to contaminants during dredging operations. The peregrine falcon, which is state listed as endangered, is also known to nest in the Harbor area. This species may travel up to 18 miles in search of food, which includes shorebirds and waterfowl. Food-chain transfer of contaminants suspended during dredging operations could therefore be a very minor potential contribution as a contaminant pathway. Studies are currently underway to evaluate this exposure potential. Other threatened or endangered species, including the pied-billed grebe, least tern, roseate tern, and common tern, although not identified as nesting in the Harbor area, are potential transients that may forage on contaminated fish and invertebrates.

6.63 A list of amphibians and reptiles found in the New York and New Jersey Harbor area is presented in Table 5.4-9. Since amphibians are not found to any great extent in the aquatic habitat of the New York and New Jersey Harbor, they will not be exposed to contaminants as a result of channel deepening. The only reptile commonly found in Harbor salt marshes is the diamondback terrapin, which was recently spotted in the Old Place Creek drainage, near Howland Hook. This turtle is one of the top carnivores in its range, feeding on a variety of bivalves, crustaceans, gastropods, and fish. It is a primarily an aquatic species, only encountered on land during the six-week nesting season (Schoelkopf and Stetzar 1995a). This species could be exposed to contaminants either directly via the water column or indirectly via contaminant accumulation in its prey. Marine turtles suspected of seasonally utilizing the Harbor include Kemp's ridley, loggerhead, and to a lesser extent leatherback and green sea turtles. Since turtles forage on benthic invertebrates and vegetation, in which contaminants accumulate primarily from the sediment rather than from the water column, suspension of contaminants in the water column during dredging activities is not expected to increase the turtles' exposure significantly. However, direct exposure to contaminants in the water column could increase as a result of dredging operations.

6.64 Terrestrial mammals likely to be found in the New York and New Jersey Harbor area are listed in Table 5.4-10. The only fish-eating terrestrial mammals expected to inhabit the Harbor area are the muskrat (*Ondatra zibethica*) raccoon, and members of the weasel family (skunk). The muskrat's primary diet is marsh vegetation, but it does consume fish, mussels, and snails. These mammals could be indirectly exposed to contaminants suspended during dredging activities by consumption of contaminated fish. Such fish, however, may have already accumulated sediment contaminants to steady-state concentrations, and the degree to which sediment suspension during dredging may

increase contaminant concentrations in fish tissue is expected to be small. Therefore, any increase in exposure to contaminants by fish-eating terrestrial mammals is also expected to be small.

6.65 A variety of marine mammals (see Table 5.4-7) are also known to occur in the Harbor. However, many of these species, especially whales, only pass through the area. Residential species are not known to inhabit waters further inland than the New York Bight. Atlantic bottlenose and common dolphins have been spotted frequently in shallow waters of the Harbor, especially during the summer. These dolphins are known to feed on mullet, gizzard shad, squid, eels, herring, and mackerel. A variety of pinnipeds, including the Harbor seal, grey seal, harp seal, ringed seal, and hooded seal, are also known to visit Lower New York Bay. Since these marine mammals only temporarily visit the Harbor, and since the areas they visit were not identified above as areas of primary concern with respect to biological exposure due to dredging, marine mammals are not expected to experience a significant increase in biological exposure to contaminants due to dredging.

6.66 In addition to suspending contaminated sediments in the water column, and thus potentially causing an increase in exposure of biological receptors to contaminants, the dredging operation may be viewed as a way of removing contaminated sediment from the channel bottoms, thus decreasing exposure to contaminants for some organisms. This is because dredging the channels to the proposed depths is expected to remove the most contaminated upper layer of sediment, exposing relatively clean sediment below. The bottoms of the deepened channels would then be composed of this cleaner sediment, which would provide less contaminated habitat for benthic organisms and fish.

6.67 Two studies indicate that the deep sediments below the channels are less contaminated than the current surficial sediments. One of these studies was performed to evaluate sediment management alternatives as part of the DMMP. In this study, cores were taken from different locations throughout the Harbor, both within and outside of the channels. Two of these cores were collected from the Bay Ridge Channel, and one from Port Newark, both areas proposed for channel deepening. In addition, one core was taken from a channel in Newark Bay approximately one mile north of where this channel is proposed for deepening. Chemical analysis of these four cores provided information on the degree of contamination in the deep sediment that would constitute the channel bottom after dredging. Much of the material to be dredged as part of the proposed navigation improvements is "new work" and has not been exposed to anthropogenic contaminants.

6.68 The bottom of the Bay Ridge Channel is currently maintained at a depth of 40 ft MLW; it is to be deepened to 50 ft MLW. The proposed deepening would therefore remove 10 ft of sediment from the bottom of the channel. Chemical analysis of the cores collected from this channel indicates that at the northern end, contaminant concentrations are relatively consistent from the mudline down to 12 ft below mudline. At the southern end of this channel, however, contaminant concentrations appear to decrease drastically

below 8 ft below mudline. These data indicate that dredging 10 ft of sediment from the Bay Ridge Channel will expose a relatively clean layer of sediment.

6.69 The Port Jersey channel bottom is currently 35 to 38 ft MLW; it is to be deepened to 52 ft MLW. The proposed deepening would therefore remove 14 to 17 ft of sediment. Chemical analysis of the Port Jersey core indicates that contaminant concentrations below the mudline are relatively low and consistent down to 6 ft below mudline. Two exceptions were 2,3,7,8–tetrachlorodibenzodioxin (2,3,7,8-TCDD) and 2,3,7,8–tetrachlorodibenzofuran (2,3,7,8-TCDF), whose concentrations decreased gradually below 1 ft below mudline. Data were not collected in this channel below 6 ft below mudline. However, the contaminant gradient in this core indicates that contaminant concentrations should remain constant or continue to decline below 6 ft below mudline. Deepening the Port Jersey channel should therefore also expose a relatively clean layer of sediment at the bottom of this channel.

6.70 The bottom of the Newark Bay Channel is currently 40 ft MLW; it is to be deepened to 52 ft MLW. The proposed deepening would therefore result in the removal of the top 12 ft of sediment in this channel bottom. Analysis of the Newark Bay core indicates that contaminant concentrations either remain constant or decline below 10 ft below mudline. One exception is nickel, whose concentration increases below 10 ft below mudline. Although this sediment core was not collected from the area of the channel proposed for deepening, it is expected to have a similar sediment contaminant profile since it was collected only about one mile north. The removal of 12 ft of sediment in the Newark Bay channel is therefore expected to expose cleaner sediment in the channel bottom.

6.71 In another study, in which the use of sub-channel placement cells for dredged material placement was evaluated, deep core samples were collected from channels in Newark Bay to characterize the deep sediments below the channels (USACE-NYD 1999b). A thick layer of red clay was found below the channels; this clay was tested in a series of bioassays to evaluate its acceptability for ocean placement. In these tests, the red clay, which had not been exposed to any contaminants, caused no undesirable effects to aquatic organisms. The clay was therefore determined to be HARS-suitable. These data confirm that the deep sediments underlying the channels in Newark Bay are clean, and that deepening the channels would expose these cleaner sediments, resulting in a potential reduction in contaminant exposure to aquatic receptors inhabiting or otherwise making use of the channel bottoms.

6.72 Although, due to the removal of contaminated sediments in the channel bottoms, contaminant exposure could potentially decline for those organisms inhabiting or otherwise making use of the channels, this effect is expected to be temporary. This is because the deposition of sediment from other areas of the Harbor will gradually reestablish a layer of sediment at the bottom of the channels that reflects the ubiquitous contamination characterizing the Harbor. The length of time for this to take place depends on the rate of sediment deposition, which varies throughout the Harbor.

6.73 In Upper New York Bay, the rate of sediment deposition in the dredged channels has been calculated to be about 3.5 in./year; in the dredged channels of Newark Bay, the sedimentation rate was found to average approximately 2.5 in./year (Olsen, et al. 1984). Raritan Bay was found to have a sedimentation rate in the dredged channels of approximately 0.2 in./year (Olsen, et al. 1984). Although Raritan Bay is not part of the current study area, the sedimentation rate in this area indicates that the Ambrose Channel and Lower New York Bay may also have a slower sediment deposition rate than Upper New York Bay and Newark Bay. These data indicate that any benefits from a reduction in contaminant exposure from deepening the channels could last anywhere from a few months to a few years, depending on location.

6.74 In summary, two opposing effects on biological exposure to contaminants are anticipated from deepening the navigation channels in the New York and New Jersey Harbor. Dredging of the channels, and the resulting suspension of contaminated sediments into the water column, is expected to increase exposure of biological organisms. This is expected to occur, however, only in areas close to the dredging operations and should be relatively short-lived because suspended sediments are expected to settle out of the water column within a relatively short period. Furthermore, sediment suspension from ship traffic in shallow channels has been shown to be greater than from dredging activities. It is therefore possible that any increase in exposure due to dredging will be minimal compared to other more frequent disturbances in the Harbor. On the other hand, dredging the channels is also expected to remove a large amount of contaminated sediments from the bottom of the channels, thus exposing a new layer of relatively clean sediment. This is expected to result in a decrease in exposure for organisms that inhabit the channels. This effect, however, is also expected to be short-lived, since suspended sediments from elsewhere in the Harbor will be deposited in the newly dredged channels, thus covering the cleaner channel bottoms with potentially contaminated sediments.

6.75 Overall, the biological exposure potential will be different for different parts of the Harbor, with a temporary decrease in exposure in the channels themselves and a temporary increase in neighboring areas. These effects are expected to be relatively short-lived, since the system should stabilize and return to current conditions within a few months to a few years, depending on the area of the Harbor. Furthermore, Best Management Practices (BMPs) will be used during dredging operations to minimize the suspension of sediments and thus contaminants into the water column, in turn minimizing the potential for exposure of biological receptors to contaminants during dredging. In addition, sediment contaminant analysis, where necessary, will be performed for the next phase of the project, and will be coordinated with the appropriate regulatory agencies.

Human Health and Safety Issues

6.76 Transport of dredged material to aquatic (e.g., sub-channel placement cells or artificial reefs) or upland placement sites may raise human health and safety issues. Tugs and scows would be used to transport dredged material from the construction sites to aquatic placement areas or to piers for unloading onto trucks or trains. Onboard inspectors would be present at all times to ensure that dredged material was properly contained on the scow, and that permit requirements and BMPs were followed. Trucks or railroad cars would be used to transport dredged material to upland placement sites. State or Federal regulations, which may require lined or watertight trucks and rail cars or trucks/rail cars being covered to prevent spillage, would control this phase of the transport program. Implementation of permit conditions, BMPs, and regulations would be the responsibility of the dredging and transport companies. With proper adherence to prescribed procedures, dredged-materials transport is not expected to have a negative impact on human health or safety.

Recreation

6.77 Recreational fishermen may be impacted should sport fish in the vicinity of the dredging operations leave the area during that period.

Wetlands

6.78 Indirect impacts to intertidal wetlands could include sedimentation and increased turbidity from dredging operations, or changes in current speed and water quality as a result of channel deepening.

Upland

6.79 There are no indirect upland impacts (impacts related to port facility transitions) associated with the proposed improvements to the New York and New Jersey Harbor navigation channels. Any potential impacts related to the upland disposal of dredged material are discussed in the EIS for the Dredged Material Management Plan (DMMP).

6.3 Cumulative Impacts

6.80 A cumulative impact is defined in 40 C.F.R. §1508.7 as follows:

> 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.

6.81 Various types of cumulative impacts in the general vicinity of the New York and New Jersey Harbor could result from the project. These impacts, as well as any irreversible and irretrievable commitments of resources, are discussed next.

Framework for Cumulative Impact Analysis

6.82 A comprehensive framework is needed to evaluate cumulative impacts because the effects associated with both previously authorized and potential future projects are likely to overlap, both spatially and temporally, with effects associated with the proposed project. The geographic scope for the analysis includes the channels and anchorages in the project area and the adjacent ecosystems that may be affected either directly or indirectly by the proposed project. This wider area, the study area, includes the Hudson River to the Tappan Zee Bridge (and farther north for some modeling efforts), the Hackensack and Passaic Rivers downstream of the Pulaski Skyway, Raritan Bay, Sandy Hook Bay, the East River to the Throgs Neck Bridge, and the Harlem River.

6.83 The time frame for the cumulative-impact analysis extends through the construction phase and the required monitoring phases. Over this period, both previously authorized channel-deepening projects and the proposed project, if authorized, will be constructed. Economic growth will continue, thus increasing the volume of cargo passing through the port, and other agencies will construct projects to improve the port's efficiency. The impacts from all these sources must be evaluated even though they may occur simultaneously or in a sequence that is not clearly defined at this time.

6.84 The goal of the cumulative assessment is to predict the maximum impact that may occur, assuming that all the identified navigation improvement projects are constructed, and to prepare a mitigation plan that addresses this maximum-impact level. The impacts and mitigation are designed to go hand-in-hand with a project implementation plan. The implementation plan is designed to monitor effects associated with each project's construction, and at key future dates, using environmental indicators. If the indicators signal that additional mitigation is necessary or that the mitigation plan and BMPs are not ameliorating the impacts, USACE or the appropriate agency can call for a reevaluation an additional impact assessment prior to issuance of individual permits.

Relationship to Other Projects

6.85 A number of related projects have recently been completed, are in progress, or are planned for the New York and New Jersey Harbor. These projects are discussed in Section 1. The proposed channel deepening project will not preclude completion of these projects. During the plan formulation, the States of New York and New Jersey, the City of New York, PANYNJ, Federal resource agencies (FWS, NMFS, USEPA), and other public and private groups were included in the process to provide input and to review the plan's progress. While many other projects were discussed both within and outside of the Harbor area, none were identified that would be negatively impacted by construction of

the Recommended Plan. The Recommended Plan may, however, influence decisions related to other projects in the Harbor.

6.86 The use of sub-channel placement cells (SPCs), cells constructed below the authorized channel depths, is a contingency option proposed for the placement of contaminated dredged material if the recommended options are unavailable. One of the locations under consideration for the construction of SPCs is in the Newark Bay Channel. The siting of an SPC in a channel proposed for deepening may alter the schedule or location of SPCs.

6.87 The Recommended Plan could also affect decisions related to other channel-deepening projects that have already been authorized in Newark Bay, the Arthur Kill, and Port Jersey. The Kill Van Kull and Newark Bay Channels have been authorized for deepening to 45 ft MLW (47 MLW in rock); the Arthur Kill has been authorized for deepening to 41 ft MLW from the Kill Van Kull to Howland Hook, and to 40 ft MLW from Howland Hook to Gulfport; and deepening of the Port Jersey Channel has been authorized to 41 ft MLW. The Kill Van Kull and the Federal channels extending into Newark Bay to the Elizabeth Channel are already in the second phase of construction for deepening to 45 ft MLW, with construction of the project expected to span six years. It is therefore likely that the proposed deepening project, if authorized, could occur simultaneously with these other projects. This situation could limit the availability of dredging resources to maintenance projects and other projects not yet identified. If the currently proposed project is authorized before construction has begun on some of the previously authorized deepening projects, then it may be economically beneficial to postpone dredging until it can be performed to the newly authorized (lower) depths. Since USACE has responsibility for coordination of these projects, the agency might minimize potential cumulative impacts by appropriate scheduling or combining of projects.

Habitats and Biota

6.88 The habitats and shoreline in the New York and New Jersey Harbor region have been physically modified several times since Europeans settled in Manhattan. Changes were related to waterborne commerce, agricultural development and construction of residences. The original shorelines were a mix of rocky outcroppings, tidal creeks extending inland, mudflats and vast wetland areas, particularly on the New Jersey side of the Harbor. Historically, shorelines have been straightened, tidal creeks converted to drainage for runoff, and the many wetlands drained for mosquito control or filled to provide land for human use. A succession of fillings, bulkheading, and pier-building has moved the original shoreline into deeper waters to provide access to deep water for ships. Deep-water access is provided by the Federal Navigation Channels that extend to the New York Bight Apex.

6.89 The channel and shoreline changes represent significant permanent modifications to the aquatic habitat of the Harbor. Quantitative estimates of habitats lost or gained are

difficult to develop and can only be predicated upon anecdotal evidence or maps with undefined precision. Comparison of maps from the early nineteenth century to maps of the shoreline and habitat types occurring in 1980 demonstrate that substantial losses of wetlands and aquatic habitat have occurred in recorded history (Squires 1992).

Wetlands

6.90 Squires (1992), determined that by 1980, a total of 301,500 acres of underwater land, and 52,500 acres of marsh had been filled in the New York and New Jersey Harbor. Some of the underwater lands are likely to have been littoral wetlands. As shown in the table below, the acres lost in New Jersey far exceeded those lost in New York. Squires (1992) noted that the New York losses occurred in the late 1700s and early 1800s, while those in New Jersey occurred from the 1850s to the 1950s. Losses have been curtailed by implementation of wetlands protection regulations in both states during the early 1970s (Squires 1992).

Changes in the New York and New Jersey Harbor Shorezone Resulting from Dredging and Filling of Marshes and Underwater Lands Early 17th Century to the Present[1]

Harbor Area	New York (Acres)	New Jersey (Acres)	Harbor Total (Acres)
Original marsh	29,500	42,000	71,500
Filled marsh	23,900	29,500	52,500
Dredged marsh	3,000	1,000	4,000
New marsh[2]		500	500
Marsh remaining	3,500	12,000	15,500
Underwater lands filled	8,500	293,000	301,500

[1]Present condition is 1980.

[2]Indicates major marsh areas that has grown between Harbor mapping intervals.

6.91 Because there has been little shoreline filling in the past two decades, the position of the existing shoreline has been relatively stable. Minor shoreline habitat changes have occurred recently as some abandoned piers were removed and sedimentation filled the formerly maintained basins between the piers. These areas have become shallow-water habitats and in some cases provide littoral habitat. Wetland regulation by the states, coupled with the Federal requirement for no net loss of wetlands, has limited impacts and losses of upland and coastal wetlands in the past two decades.

6.92 Increased regional demand for goods will result in modifications and expansions of existing infrastructure in order to transport larger volumes of cargo through the area regardless of whether channels are deepened or not. Foreseeable future transportation initiatives associated with expected growth in container throughput are identified in Table 4.4-1 of Section 4. Many of these transportation projects are still in the planning stage. Few impact assessments are presently available; available information on the potential for impacts or losses to palustrine wetlands is presented in the table. All these initiatives will undergo environmental review. If impacts to coastal or freshwater wetlands cannot

be avoided, mitigation will be required to assure that there are no net losses of wetland values.

6.93 The Recommended Plan does not directly impact intertidal or freshwater wetlands (see Section 6). A compensatory mitigation plan for losses of more than 6 acres of littoral habitat is part of this project (see Section 7). In the course of developing the mitigation plan, a variety of mitigation alternatives were considered, including acquisition, creation, and restoration of intertidal and upland wetlands. In some cases conceptual designs for these wetlands are available. The information developed will be consolidated in a summary report that could serve as a resource for future mitigation planning. This information could be used for project-specific mitigation plans that will be required for any transportation project impacting wetlands or other protected habitats.

6.94 In addition, many regionally focused efforts are underway to ensure that increased growth in the region does not adversely impact harbor habitat, and that degraded habitat is restored. For example, The DMMP for the Port of New York and New Jersey has identified a wide variety of options for dredged material that would create, enhance, and restore various habitat types. Dredged material may be used to create oyster and shellfish habitat, create and enhance wetlands, create bird habitat, create reefs, remediate ocean disposal sites; restore degraded aquatic habitat, and remediate contaminated upland sites. Some of the remediated upland sites would be developed as wildlife habitat. It should be noted that many of these options would undergo pilot scale and demonstration testing prior to extensive application. These habitat-related options would utilize dredged materials resulting from Harbor navigation improvements, as well as materials from maintenance dredging in existing channels and berths in a long-term program of beneficial use of dredged material.

Aquatic Habitat

6.95 New York Harbor was one of the world's major ports by 1900. (see Section 1.1 for a history of the Port.) As the size of ships increased, channels were needed to allow safe transit in shallower areas. The channels increased the amount of deep-water habitat, as compared to the original condition. It should be noted, however, that even the proposed channel depths are not deeper than some of the naturally occurring depths. For example, the Verrazano Narrows is naturally 60 to 90 feet deep.

6.96 The Recommended Plan represents the channel modifications that are reasonably expected to occur to improve navigation for container shipping over the planning horizon. The plan was predicated on a class of ship expected to be representative of the fleet. It is possible that construction of a deep-water anchorage will be recommended at some point in the future. (See Section 1.1 for a discussion of related projects.) However, deeper anchorages are not needed to accommodate the ships and cargo projected for this study; the likelihood of this future decision, therefore, cannot be assessed at this time. For the reasonably foreseeable future, the channel and berth depths described herein represent the future condition of the harbor and the basis for the cumulative assessment.

Aquatic Biota

6.97 The aquatic life dependent on wetlands and on inshore, shallow-water habitat has been adversely impacted by historical changes in shallow-water habitat, but the aquatic life dependent on shoal and channel habitat remains less affected by change. Fish species common in the channels, such as Atlantic tomcod, grubby, white perch, and winter flounder are seasonally abundant. Striped bass occur throughout harbor waters, and at times make use of interpier basins.

6.98 Migratory species and tropical marine species occur regularly, following a pattern related to their movements and migrations. Many migratory species, such as alewife, blueback herring, American shad, and rainbow smelt, migrate through the Harbor as adults in spring and as juveniles in the fall, but do not have an important dependence on Harbor habitats. Tropical marine fish occur during summer and fall as they travel north along the Atlantic coast; their populations are dependent upon reproduction and recruitment occurring outside of Harbor waters.

6.99 The combination of a relatively stable shoreline and a system of navigation channels, which would not be significantly altered as habitat, creates generally favorable conditions for the aquatic life that can use the harbor in its existing state. Ongoing programs to improve water quality, particularly contaminant reduction, will contribute to a trend of stability or gradually improving conditions for aquatic life in the Harbor. Other programs related to dredged material management could bring about restoration and enhancement of existing degraded habitats, which in the long term would also contribute to improving habitat conditions.

6.100 Fish and invertebrates have been shown to return to dredged areas in less than one year. This rapid rate of recovery is important with regard to the potential for adverse cumulative impacts related to habitat. It is likely that, during the construction of each phase of this project, a number of dredging and material-placement operations will take place in the Harbor. The location and timing of these projects is uncertain, but it is reasonable to assume that they will not occur simultaneously. As a result, large areas of undisturbed habitat would remain as a source of recolonizing species, facilitating rapid recovery. Because of the rapid recovery rate, the temporary disturbance associated with each individual project is not expected to be cumulative over the construction period of the project.

Water Quality

6.101 The first half of the twentieth century saw a rapid population increase, with an associated increase in commercial activity in the New York and New Jersey Harbor area. The increase in commercial activity was primarily concentrated along the Harbor's waterways. Environmental concerns were virtually non-existent during this period, and

this, coupled with a general lack of pollution control capability, resulted in major degradation of Harbor water quality.

6.102 The passage in 1972 of the Federal Water Pollution Control Act (Public Law 92-500) provided the framework for comprehensive rules and regulations to reverse the trend in water quality degradation, as well as providing money to construct and upgrade water pollution control facilities. The Federal and state governments established water quality standards that, when achieved, would ensure a viable and safe environment.

6.103 Since that time, point-source discharges have been regulated, and overall most substances are effectively controlled. The success of the control on discharges is documented by improvement in harborwide water quality, as well as by water quality improvements in tributary streams and rivers (Interstate Sanitation Commission 1998). Conventional water quality parameters such as DO, coliform bacteria, and transparency show a general improvement in water quality throughout the New York and New Jersey Harbor between 1970 and 1998 (NYCDEP 1999). This general trend is attributable not only to the upgrades in wastewater treatment systems, but also to pollution control programs such as the elimination of raw sewage discharges (through regulation of CSOs), reduction in illegal discharges, and increased wet-weather floatables capture.

6.104 Nonpoint-source discharges are currently receiving the attention of the regulatory agencies. Existing sources are not fully known or controllable. However, new projects undergoing environmental review are required to include BMPs and Best Available Technologies (BATs) to control nonpoint-source discharges.

6.105 Toxic contaminants in the New York and New Jersey Harbor have been investigated considerably during the last three decades. Metals (cadmium, chromium copper, lead, and mercury) and organic compounds such as PCBs, dioxins, and PAHs, were found at elevated concentrations in the water and sediments of the Harbor as compared to the surrounding water bodies, namely, New York Bight and Long Island Sound (Squibb et al. 1991, Long et al. 1995). Contaminants were discharged from STPs, CSOs, urban runoff, industrial discharges, illegal dumping, atmospheric deposition, and accidental spills.

6.106 Mueller et al. (1982) estimated that WWTPs accounted for 40 to 60% of the total input of several trace metals in the Hudson-Raritan estuary. Approximately 20 to 40 % of the total metals load was contributed by tributaries, and 10 to 30% by urban runoff. The data for estimating sources of toxic organic compounds were less complete than for metals. Based on available data, STPs and tributaries accounted for 40 %of the total PCB load, with most of that coming from the Hudson River (with two upriver General Electric manufacturing plants being the principle PCB source) (Bopp et al. 1991). A major source of dioxin (2,3,7,8-TCDD) was an industrial plant that manufactured Agent Orange components primarily for the military between 1948 and 1969, and which discharged to the Passaic River, upstream of Newark Bay.

6.107 Deep sediment cores taken from the New York and New Jersey Harbor waterways have been analyzed for radioactive tracers (^{137}Cs, ^{60}Co, ^{7}Be) to determine the time when sediments were deposited and thereby to show time-related trends in contaminant loadings (Bopp et al. 1991). In general, peak PCB and dioxin concentrations were found in layers below the surficial sediments, and were associated with sediments deposited when these industrial sources were at their maximum loading. For example, sediment cores collected in Newark Bay showed peak concentrations of 2,3,7,8-TCDD of 1,100 and 2,900 pg/g in layers approximately 12.5 in below the sediment-water interface, corresponding to sediments deposited in the mid-1960s (Bopp et al. 1991). The contamination chronology of Newark Bay sediments was closely related to the operation of an industrial plant along the Passaic River (at 80 Lister Avenue), which has been identified as a Superfund site and is undergoing remediation.

6.108 The spatial distribution of sediment contaminants and toxicity to benthic organisms in the New York and New Jersey Harbor was investigated by NOAA's National Status and Trends Program for Marine Environmental Quality (Long et al. 1995). The first phase of this study encompassed the entire New York and New Jersey Harbor system and western Long Island Sound. Toxicity was shown to be relatively high in Newark Bay, the Arthur Kill, and western Raritan Bay, and to diminish southward and eastward toward the mouth of the estuary. The lower Hudson River, Upper New York Bay, portions of Lower New York Bay, and northern Raritan Bay exhibited relatively low contaminant levels. Overall, contaminant levels were highest in the East River, diminishing eastward toward Long Island Sound and southward into Lower New York Bay. Causes of toxicity were not determined, although two measures of toxicity (acute 10-day survival test using the amphipod *Ampelisca abdita*, and a 15-minute microbial bioluminescence test, Microtox^{tm}) were significantly correlated with increasing concentrations of PAHs. This relationship was strongest in samples from the upper East River that were highly toxic and highly contaminated with PAHs.

6.109 Additional sediment sampling (Phase 2) of Newark Bay, the Hackensack and Passaic Rivers, and the Kill Van Kull showed significant correlations between amphipod survival and total cadmium, mercury, PCBs, pesticides, and 2,3,7,8-TCDD. However, none of the Phase 2 correlations between amphipod survival and PAHs were significant in Newark Bay. (Phase 1 testing had found a significant harborwide correlation.)

6.110 The Contaminant Assessment and Reduction Project (CARP) being conducted by NYSDEC and NJDEP are using trackdown methods to identify and reduce contaminant sources to the Harbor. The target chemicals are PCBs, dioxans/furans, DDT, dieldrin, chlordane, PAHs, and the metals mercury, cadmium, and lead. Innovative field sampling of CSOs, stormwater drains, STPs, and tributaries is being conducted to provide data for analyzing the sources of these contaminants. Similar sampling of the water and sediments is providing an extensive database. Assessment of the trackdown data using a hydrodynamic and toxic contaminant model will support the evaluation of management alternatives to improve Harbor sediment quality.

6.111 Based on analyses presented in the EIS, the proposed project is not anticipated to result in significant water quality impacts,. Any new projects, such as the transportation improvement measures or other harborwide projects included on Table 4.4-1, will be required to comply with current stormwater management regulations. Environmental reviews and permitting actions associated with these projects will not allow significant water quality impacts to result. Temporary impacts to water quality during construction may occur, although mitigating measures to minimize such impacts will be required throughout the environmental review and permitting process.

6.112 The removal of sediments in navigational channels deepened by dredging will result in a slight reduction of contaminant mass in the bottom sediments. The scour of harbor sediments and their deposition in the deepened navigational channels and continuing sediment inflows will result in minimal changes in sediment contaminant concentrations. If contaminant sources are reduced in the future due to regulatory programs (e.g., CARP, CSO abatement, stormwater permits), concentrations in surficial sediments throughout the Harbor should decrease over the long-term.

Habitat Disturbance

6.113 Fish and invertebrates have been shown to return to dredged areas in less than one year (LMS 1984, Parish and Weiner 1989). This rapid rate of recovery is important with regard to the potential for adverse cumulative impacts upon habitat. TES birds use intertidal and littoral areas only intermittently, and these areas represent only a small portion of the area to be dredged. Sea turtles and marine mammals may also move through these habitats but are not expected to remain long in any area. Dredging may result in movements of resident species, including benthic fish and invertebrates, from these areas. Because, however, most fish are not territorial, they are not expected to be seriously affected. It is anticipated that some fish and crabs will remain close to dredging operations through the Harbor area to feed on displaced benthic animals. Benthic invertebrates will be removed in the dredged material or displaced and probably eaten by predators.

6.114 No long-term loss of fish-rearing, bird-foraging, or turtle-feeding habitat is expected as a result of this project. A mitigation plan (summarized in Section 7) has been developed, which replaces the lost habitat values associated with the disturbed littoral areas through littoral zone restoration/creation and intertidal wetlands restoration. The recommended mitigation plan will also mitigate at a ratio of no less than one acre of mitigation per acre of littoral habitat disturbed. Furthermore, short-term impacts on fish and wildlife will be reduced or eliminated by use of BMPs, including agency-recommended dredging windows and procedures.

Traffic

6.115 A summary of the cumulative traffic impacts associated with the without-project condition is provided in Section 4.4. No additional cumulative traffic impacts, above

those attributable to the without-project condition, are a result of the proposed navigation channel improvements under the with-project condition (based on an increase in cargo throughput to 9.6 million TEUs/year).

Noise

6.116 A summary of the cumulative noise impacts associated with the without-project condition is provided in Section 4.4. No additional cumulative noise impacts, above those attributable to the without-project condition, are a result of the proposed navigation channel improvements under the with-project condition (based on an increase in cargo throughput to 9.6 million TEUs/year).

Air Quality

6.117 A summary of the cumulative impacts to air quality associated with the Without-Project Future Condition is provided in Section 4.4. No additional cumulative impacts to New York and New Jersey Harbor air quality, above those attributable to the Without-Project Future Condition, are a result of the proposed navigation channel improvements under the With-Project Condition (based on an increase in cargo throughput to 9.6 million TEUs/year). An evaluation of the upland air quality impacts associated with satisfying the demand for the additional 9.5 million TEUs/year (based on a total demand of 19.1 million TEUs/year by the year 2060) is provided below (See "Future Port Improvement").

6.118 The proposed navigation channel improvements will be carried out in phases under a number of separate construction contracts and over a period of several years. Construction activities will involve the use of hydraulic and mechanical dredges, support vessels, and other items of equipment that generally run on diesel power. Emissions from diesel engines have the potential to impact air quality. Any air quality impacts, however, would be short-term and localized. Moreover, these localized potential impacts would occur over a relatively wide area that is characterized by coastal winds that are expected to rapidly disperse the emissions. Furthermore, these emissions can be reduced through the use of low sulfur fuels and through the phasing of construction.

6.119 The proposed navigation channel improvements will not increase the amount of cargo through the Port, but will permit the movement of the cargo in larger containerships. Consequently, the volume of containers that flows through the Port can be carried by fewer, larger ships with the Recommended Plan relative to the Without-Project Future Condition. This less total time in the Port can be roughly translated into fewer total tons of fuel burned by containerships in the port. With the navigation improvements in-place, there will be a reduction of approximately 665,000 metric tons (mt) of fuel burned in the Port over a thirty-year period. This fuel savings stems from the increased transport efficiency of the largest containerships. Because the larger ships will burn less fuel in the Port than smaller ships carrying the same total volume of cargo, the

total air emissions for the Recommended Plan is expected to be less than for the Without-Project Future Condition.

6.120 The 665,000 mt fuel savings is derived from estimates of reductions in fuel burned by ship's main engines and auxiliary engines. Approximately 415,000 mt of fuel savings are attributed to main engines and 250,000 to auxiliary engines. Main engine fuel savings are based on the assumption that each vessel uses its main engines for four hours during each vessel call (two hours getting in and two hours getting out). USACE *Economic Guidance Memorandum 99-05, Deep Draft Vessel Operating Costs (February 1999)* was used as the source of information for hourly metric tons of fuel burned for containerships of various sizes. For each year, 2010-2040, the projected number of vessels calls for each vessel size was multiplied by the corresponding tons of fuel burned to arrive at an annual total tonnage burned in the Port. These calculations were performed under both the Recommended Plan and Without-Project Future Condition. The difference between total annual main engine fuel consumption under the Recommended Plan and Without-Project Future Condition indicates an overall 30-year fuel savings of 415,000 mt under the Recommended Plan.

6.121 In-Port auxiliary engine fuel savings are based on annual projections of the number of TEUs transported by each vessel size under both Recommended Plan and Without-Project Future Condition. The auxiliary engines were assumed to be running only during the time that the vessel was alongside the dock. The amount of time spent alongside the dock was calculated as the time required to load and unload Port TEUs at a rate of 40 TEUs per hour. Auxiliary engine fuel consumption for the various vessel sizes was similarly taken from the *Economic Guidance Memorandum 99-05, Deep Draft Vessel Operating Costs*. As with the main engine calculations, annual auxiliary engine fuel consumption for each vessel size was calculated under both the Recommended Plan and Without-Project Future Condition. The difference between total annual auxiliary engine fuel consumption indicates an overall 30-year fuel savings of 250,000 mt under the Recommended Plan.

6.122 As part of its SIP process, the NYCDEC has estimated emissions from marine traffic in New York using calculations in which emissions were estimated from fuel consumption. The proposed action will result in the use of fewer, larger ships and these ships will be both newer and more fuel efficient than the older, smaller containerships which they will ultimately replace. Therefore, since the cargo throughput is equivalent for the Recommended Plan and Without-Project Future Condition. It is expected that overall emissions will be lower for the proposed action, since the fleet will be dominated by the larger, newer, more fuel efficient vessels. On this basis, the project is expected to conform to the State Implementation Plans.

Future Port Improvement under Recommended Plan

6.123 A CPIP for the New York and New Jersey Harbor is currently under development. The goal of this port improvement plan is to increase the capacity of the

various terminals in the port to handle containers beyond the increases already planned to occur by 2035. The CPIP anticipates the expansion of container terminal facilities to provide at least some of the additional throughput capacity that would be required to satisfy the total quantity of container-handling services demanded at the current price of those services after 2033. One method that has been suggested to accomplish such facility expansion is fills. A discussion of the impacts resulting from fills at port facilities will appear in the EIS resulting from the CPIP.

6.124 Regardless of this fact, an evaluation of cumulative air quality impacts associated with an increase in throughout to satisfy the projected demand of 19.1 million TEUs/year by the year 2060 was performed. This mesoscale analysis is discussed in detail in Appendix B-1.10. A summary is provided below.

Mesoscale Analysis

6.125 The mesoscale analysis considers the regional emissions associated with transporting increased volumes of cargo through New York and New Jersey Harbor, as compared to alternative ports. In this analysis, the Port of Baltimore was determined to be more efficient and favorable as compared to the Port of Halifax. The analysis determined that regional air emissions are directly related to the total vehicle miles traveled in transporting cargo to its destinations within the 14-state region served by the Port of New York. Since transportation of cargo into this 14-state region through the New York and New Jersey Harbor required significantly fewer vehicle miles than routing cargo through Baltimore, the regional emissions burden was significantly lower for the Port of New York.

6.126 If the cargo throughput within the Port under the Recommended Plan (9.6 million TEU/year) is compared to the present throughput level (about 3 million TEU/year) and the balance of the unconstrained 2060 cargo demand (19.1 million TEU) were routed through Baltimore in each case, it has been estimated that the regional emissions would be lower by the following amount for the Recommended Plan:

VOC - 2 tons per day
NOx - 12 tons per day
PM_{10} - 81 tons per day

6.127 These estimates reflect the reduced emissions, which are projected when cargo throughput in the Port is *maximized* as compared to routing cargo through an alternative port, such as Baltimore. In this example, routing the balance of the unconstrained 2060 cargo demand (9.5 million TEU/year) through the Port of New York & New Jersey instead of Baltimore results in the projected reduction in regional air emissions.

6.128 Given the increase in growth in the region, and the corresponding growth in air emissions, the use of a more favorable port location to minimize vehicle miles traveled will reduce the cumulative impact of regional air emissions by the amounts indicated

above. The ultimate demand for cargo within the region will not be affected by infrastructure developed within the Port of New York. Given the availability of reasonable alternatives, such demands will be satisfied due to economic pressures. At issue are the regional emissions associated with cargo handling. This analysis indicates that air quality impacts will be reduced if cargo is routed through the Port of New York.

6.129 The analysis did not consider the impacts of ship emissions (not regulated at this time), which are not expected to materially alter the conclusions reached in the analysis. Emissions of carbon dioxide (related to fuel consumption) from ships on the basis of emissions/mile/TEU are approximately fifteen times lower than comparable emissions from trucks.

Contamination

6.130 The New York and New Jersey Harbor is characterized by widespread contamination from both historic and modern-day sources. While additional contamination is being added to the system due to accidental spills, permitted releases, disposal site leachate, and illegal dumping, some areas are scheduled for or are undergoing remediation. It is not possible at this time to develop accurate estimates of the magnitude and timing of these remedial actions or of future releases of contaminants into the Harbor. However, a general discussion of some potential cumulative impacts related to contamination is provided here.

6.131 Dredging operations during channel deepening have the potential for suspending contaminated sediments in the water column. The resulting resuspended contaminants could interact with contaminants from other sources in the Harbor. Chemicals that are part of complex mixtures, such as contaminated sediments in the Harbor, can undergo synergistic or antagonistic reactions that result in biological effects greater than or less than the sum of each chemical's individual effects. However, these chemical interactions are not well understood and are therefore difficult to predict, especially given the extremely complex nature of the chemical mixtures in the Harbor. Therefore, it is not possible to predict the potential synergistic or antagonistic effects of the release of contaminants into the water column during dredging.

6.132 Deepening of channels could also result in alterations to the patterns of sediment deposition and flow throughout the Harbor, as discussed above. The deepened channels could act as settling basins for sediments moving throughout the estuary from other sources. The accelerated rate of sedimentation in the deepened channels could, at least temporarily, keep contaminated sediments from wider dispersal. This would, however, cause only a minor redistribution of a very small quantity of contaminated sediments compared to the overall extent of Harbor contamination.

Irreversible and Irretrievable Commitment of Resources

6.133 Petroleum is the primary resource that will be irreversibly and irretrievably committed for the project. Petroleum products will be used to power the machinery for deepening channels and maintaining channel depths, in addition to powering ship traffic in the Harbor, and other related activities.

6.4 Essential Fish Habitat (EFH)

6.134 Potential impacts to EFH include: changes in physical or chemical properties (e.g., water temperature, salinity) of the water column; changes in underlying substrate, including sediment type and presence/absence of aquatic vegetation; and changes in water depth. These potential impacts may occur temporarily (short-term impact) during construction of the proposed project, or permanently (long-term impact) due to ultimate changes in bathymetry, sedimentation, and hydraulic patterns (e.g., estuarine mixing).

6.135 Modeling of salinity, water temperature, and DO under proposed project conditions indicates that no detectable changes in water quality are likely to occur due to channel deepening. This includes no appreciable changes in salinity regime, location and persistence of the salt wedge, nor changes in tidal flows or height (See Appendix B-1.1). Therefore, no impacts to EFH physical water quality parameters are expected due to construction of the proposed project.

6.136 Short-term water quality impacts to EFH due to project construction (e.g., blasting, dredging) would most likely be limited to changes in turbidity levels and suspended solids in the immediate construction areas. Some change in DO may also occur, concomitant with sediment resuspension. Potential increases in suspended solids and turbidity would be minimized by using approved equipment and techniques for sediment dredging and rock removal (e.g., sealed-bucket dredge, designated hoist speeds), with this equipment and these techniques to be specified in state water quality certifications. For these reasons, no appreciable impact is expected.

6.137 Other potential impacts due to the proposed project include changes in underlying substrate and changes in water depth. Impacts to sediment type would result from the removal of fine-grained sand and mud from channel areas. Sediment removal impacts would be realized most in areas requiring channel excavation below bedrock (Arthur Kill Channel, Kill Van Kull Channel, and Newark Bay Entrance Channel). Only minor impacts to sediment type would occur in other project areas, since sediment type below existing bottom sediments is expected to be similar to the bottom sediments.

6.138 Existing sediments in the channel areas support a benthic community which is dominated by polychaete worms living on the substrate, and a variety of amphipods and shrimp living on the surface of the substrata (epibenthos). Benthic studies conducted throughout the Harbor in channel and shoal areas have shown that this type of benthic

community is common where fine-grained sediments (e.g., silts, clays) predominate. This community is an important food resource for fish, particularly the epibenthos. Impacts to EFH sediment type would be short-term, since natural sedimentation and subsequent recolonization of benthic invertebrates is expected to occur rapidly, within months following construction activities. Because of its widespread occurrence and rapid recovery after disturbance, the short-term loss of the benthic community to deepening activities would not be a significant adverse impact to EFH.

6.139 Changes in water depth and bathymetry would be long-term, since both channel and shoal habitat will have been excavated. Construction of the proposed project would impact 6.26 acres of littoral zone (i.e., shallow water 0 to 6 ft below MLW) habitat. A portion of this area would be permanently lost or be made deeper than its current depth; no longer meeting the definition of littoral zone habitat. The largest littoral zone alteration is projected for the Arthur Kill/Howland Hook vicinity (3.23 acres), followed by the Newark Bay Channel (2.72 acres), the flats area on the western side of Newark Bay south of Port Elizabeth Channel (0.25 acres), and the Kill Van Kull (0.06 acres).

6.140 Deepening would also disturb 42.03 acres of sublittoral (i.e., depths >6 to 15 ft MLW) habitat. Some of this habitat would be permanently altered from existing physical conditions to channel sideslope and channel bottom habitat. Some portion of the 42.03 acres would become permanently deeper than 15 ft below MLW, and thus would no longer meet the definition of sublittoral zone habitat.

6.141 Long-term potential impacts to EFH due to channel deepening would differ from species to species, depending upon life history, habitat use (demersal vs. pelagic), distribution, and abundance. Potential EFH impacts in the project area would be limited primarily to demersal (i.e., bottom-oriented) species and life-stages. Pelagic species and life-stages are expected to continue using the water column following channel excavation and construction. During construction, pelagic species might experience disturbance to a small portion of EFH due to a need to avoid the active project area. Most of the project area, however, would remain available for foraging, breeding, and growth. Pelagic larval and egg life stages (i.e., those life stages with limited motility) would be carried through the active project area with prevailing tides and currents, resulting in only limited exposure to construction-related disturbance.

6.142 EFH has been defined for thirteen species, ten of which occur in the project area. Recent biological sampling and previous studies provide information on the seasonal occurrence and abundance of the listed species in distinct areas or water bodies of the study area (See Section 5.4 Ecological Resources, and Appendix B-1.2 Baseline Biological Monitoring Report). A brief summary of EFH species' general habitat parameters by life stage is provided in Table 5.4-4. Potential impacts to EFH due to changes in underlying substrate and water depth for each species are discussed below.

Red hake

6.143 EFH is designated within the project area for larval, juvenile, and adult red hake, in both estuarine and marine waters. EFH for adult red hake includes bottom habitats of sand, muddy sand, and mud and gravel substrate, and water depths of approximately 30 to more than 400 ft.

6.144 Adult red hake are seasonally common in the Hudson-Raritan estuary between November and May (Stone et al. 1994). Larval and juvenile red hake are pelagic, becoming demersal after reaching a length of 0.9 to 1.6 in. Juveniles seek shelter along the continental shelf bottom among protective structures, but are most commonly associated with sea scallop beds. Juveniles remain associated with sea scallop beds through their first fall and winter (until reaching a length of approximately 3.5 to 4.6 in.), and then occupy either estuarine or inshore marine waters over sand or mud substrate, prior to joining adults in the offshore migration during their second winter.

6.145 Red hake have been collected in most biological sampling programs conducted in the study area. (See Section 5, Affected Environment.) Juvenile red hake have been reported as abundant in Sandy Hook Bay during March and April (Pacheco 1983). NMFS (1998) also reported red hake present in bottom trawl samples collected in the Hudson-Raritan estuary. Red hake occurred in 17% of all trawl samples collected in Raritan Bay, Lower Bay, Sandy Hook Bay and Gravesend Bay from January 1992 through December 1997. Red hake were found primarily in channel areas and were abundant during December and January, and again from April through July. The majority of these fish were juveniles, less than 260 mm in length (Steimle et al. 1998).

6.146 No red hake were collected at shoal stations sampled in Newark Bay during 1995-1996 (LMS 1996); however, they were present at channel stations during 1993-1994 (NMFS 1994). Although red hake was not among the most abundant species collected in Newark Bay, it was collected at channel stations during May through June, and again in December, January, March and April (NMFS 1994). Abundance was highest during May and June, with most individuals between 100 and 170 mm in length (NMFS 1994). Similar to studies conducted in 1995-1996 (LMS 1996), no red hake were collected at shoal stations. No hake eggs, larvae, or juveniles were collected in plankton net samples (NMFS 1994).

6.147 Red hake were collected infrequently during the recent biological sampling program. Juveniles (all fish collected < 220 mm in length) were collected in bottom trawl samples during November, March, June and August. Average CPUE was less than 4 fish per 10-min. tow during each month. The highest number of fish was collected at the Port Jersey approach channel during June. Red hake were not collected in the Arthur Kill, Kill Van Kull, Newark Bay, Red Hook, or Lower Harbor areas. No red hake eggs, larvae or juveniles were collected in epibenthic sled ichthyoplankton samples.

6.148 Spatial distribution and relative/seasonal abundance data used in the ELMR program suggest that both juvenile and adult red hake are common in the Hudson-Raritan estuary from November through May, and that larvae are common in June (Stone et al. 1994). Data reliability for the Hudson-Raritan estuary, however, was classified as that of reasonable inference, indicating that little or no sampling data was available (Stone et al. 1994). Data from recent sampling programs indicate that red hake is not among the dominant species collected in the study area. May and June are the months of highest juvenile red hake abundance. Relative abundance is low, however, compared to other species and areas (Steimle et al. 1998). No adult or larval red hake were collected in the recent biological sampling program nor in the Newark Bay sampling program (NMFS 1994). Red hake larvae were also absent from icthyoplankton samples collected during entrainment monitoring programs in the Arthur Kill (LMS 1993).

6.149 Potential impacts to red hake EFH would be limited primarily to the short-term disruption of juvenile bottom habitats in deep-water channels. For early juveniles (scallop stage), these potential impacts would be further limited to those areas primarily associated with scallop beds or other protective structures. Scallop beds within the project area would be found only in the deep-water areas of Lower New York Bay. Potential short-term impacts would be seasonal, primarily during May and June, when juvenile red hake are most common in the estuary, and would be limited to the immediate construction area. Juvenile red hake, which prefer deep-water areas, may actually benefit from long-term changes in littoral and sublittoral habitat from channel deepening activities.

Winter flounder

6.150 EFH for winter flounder within the project area includes shallow-water shoals and subtidal areas (< 20 ft deep) over bottom habitats of sand, muddy sand, mud, and gravel substrate. Found throughout the estuarine and marine portions of the project area, these habitats provide EFH for spawning winter flounder adults, and for eggs and larvae. EFH for early juvenile (i.e., young-of-year) and juvenile winter flounder also includes shallow water, as well as deep water, estuarine, and marine waters of the project area. Although found in the project area throughout the year, seasonal abundance of these life stages varies with season.

6.151 During summer months, adult winter flounder reside in nearshore coastal waters, with the distance offshore dependent upon water temperature, i.e., the warmer the water temperature the further offshore adults move. Adults move into shallow bays and estuaries in the early fall in preparation for spring spawning. Spawning in the mid-Atlantic Bight (and the study area), occurs between February and April in estuaries and bays (Howe et al. 1976). Young-of-year and yearlings are more tolerant of higher water temperatures and remain in the estuary during the summer while mature adults disperse offshore as coastal waters warm (Rose et al. 1996). By July, mature adults have left the inshore waters for offshore areas with lower water temperatures.

6.152 Winter flounder eggs are demersal and adhesive. They range from 0.6 to 1.0 mm (0.03 to 0.04-in.) in diameter, with an average diameter of 0.6 mm (0.2-in.) (Topp 1968, Klein-MacPhee 1978, Buckley 1989). The optimal salinity for egg development and survival is 15 to 30 ppt (Buckley 1989), with 100% mortality at low salinities (5 to 10 ppt), and high mortality and a high percentage of deformed larvae reported at salinities of 35 to 40 ppt (Klein-MacPhee 1978).

6.153 Larvae are nonbuoyant and have a strong benthic orientation, often resting on the bottom between swimming efforts (Pearcy 1962). Since the early life stages of this species are nondispersive, the spawning grounds and nursery grounds are essentially the same (Pearcy 1962). Howell et al. (1992) indicate that the nursery habitat for larvae and juveniles includes littoral and sublittoral saltwater coves, coastal salt ponds, estuaries, and protected embayments.

6.154 Following metamorphosis from larvae to juveniles, winter flounder are benthic and seldom lose contact with the substrate (Buckley 1989). The majority of juvenile winter flounder spend most of their first two years in or near shallow, natal waters and on the edge of channels, preferring sand or sand/silt substrate (Topp 1968Wilkkley 1989). Early juveniles (6 to 9 cm) have been shown to be photopositive, which, because of generally low light penetration in coastal waters, limits their movements to shallow cove areas, while late juveniles (12 to 18 cm) reside in deeper-water areas and are photophobic (Howell et al. 1992). Briggs and O'Connor (1971) evaluated shore-zone fish populations in Great South Bay, Long Island, NY and found significantly more juvenile winter flounder over natural bottoms (mixture of sand, clay, mud, and detritus and covered with dense growth of eelgrass [*Zostera marina*]) compared to open sand-filled bottoms.

6.155 Winter flounder have been collected in most biological sampling programs conducted in the study area. (See Section 5, Affected Environment.). Sampling programs in the channel and shoal areas of Newark Bay provide seasonal abundance information in both deep-water (i.e., channel) and shallow-water habitat (NMFS 1994, LMS 1996). Winter flounder were most abundant in channel areas from July through December, while shallow-water abundance was highest from May through July. Overall abundance was higher in deep-water channel areas.

6.156 Winter flounder were collected during every month of the most recent biological sampling program, but were most abundant during March, April and again in June (Appendix B-1.2). Limited sampling events (i.e., site-specific stations only) during May likely influenced the drop in winter flounder CPUE during this month. The majority of winter flounder collected during this period appeared to be yearling or older fish, ranging between 100 and 230 mm in length. Young-of-year winter flounder became evident in bottom trawl samples during June, ranging up to 70 mm.

6.157 Data from recent sampling programs indicate two periods of winter flounder abundance in the study area, one occurring during early-spring to early summer

(generally late-March through early August) and one occurring during late-fall to early-winter (generally late-October through December).

6.158 Deepening channel reaches in the Arthur Kill, Kill Van Kull, Newark Bay (including the Elizabeth Channel and South Elizabeth Channels), and Port Jersey would disturb just over 40 acres of bottom habitat in the 0 to 15 ft MLW depth range. Potential impacts to winter flounder EFH include temporary disruption of spawning and early life-stage development (i.e., larval settlement) and permanent loss of shallow-water habitat in these areas. Scheduling project construction activities (namely, blasting and dredging) to exclude periods and areas of winter flounder abundance, spawning, and early development will avoid these potential temporary impacts to spawning and nursery EFH. Potential impacts due to the permanent loss of shallow-water littoral zone areas will be mitigated.

6.159 Potential impacts to EFH associated with the loss of littoral zone habitat will be mitigated as described in the Mitigation Report summarized in Section 7. Beneficial use will be a priority for the management of dredged materials from this project. Given the volume of dredged material likely to be created from the project (approximately 51 million cubic yards from the initial construction alone), the anticipated benefits from the beneficial use of such material are great. Furthermore, the acreage of wetland habitat that will be created or restored in the recommended mitigation plan greatly exceeds the requirement to compensate for the littoral zone disturbances. While it is impossible to directly compare the impacts associated with the sublittoral disturbances with the benefits obtained from beneficial use of dredged material and the additional wetland compensation, it is believed that the net beneficial effects resulting from these factors outweigh the disturbances to 42.03 acres of sublittoral habitat.

Windowpane flounder

6.160 EFH for windowpane flounder is designated in both the estuarine and marine waters of the project area. Designated EFH of spawning adults and of eggs is limited to the seawater salinity zones, specifically Lower New York Bay, Raritan Bay, and Sandy Hook Bay.

6.161 Spawning occurs from February through November in coastal, inner continental shelf waters, peaking in the mid-Atlantic Bight during May (Able and Fahay 1998). Some spawning may also occur in the high-salinity portions of estuaries in the mid-Atlantic Bight, including Sandy Hook Bay (Croker 1965). Windowpane spawn in the evening or at night on or near the bottom (Bigelow and Schroeder 1953, Ferraro 1980).

6.162 Eggs and larvae, which are pelagic (larvae settling to the bottom at approximately 0.4 to 0.8-in Total Length, [TL]), are found in the polyhaline portion of estuaries, primarily in spring (Morse and Able 1995). No windowpane flounder eggs were collected in recent epibenthic icthyoplankton sampling conducted in the study area (Appendix B-1.2). Windowpane eggs, however, are buoyant and would not be expected

to occur in epibenthic samples. Windowpane eggs have been collected in icthyoplankton samples in association with entrainment monitoring at electric generating station cooling water intakes in the project area (LMS 1994).

6.163 Larval windowpane flounder were collected in epibenthic icthyoplankton samples in the study area during May and June (Appendix B-1.2). Windowpane larvae were most common during May, when they were collected in all Harbor areas except Red Hook. Densities were highest in the Upper Harbor. No windowpane flounder larvae were collected in the Port Jersey or South Brooklyn Channels or at shoal stations during June. Very few windowpane flounder larvae were collected in Newark Bay icthyoplankton sampling (NMFS 1994, LMS 1996).

6.164 Although windowpane flounder occur at all depths in the Hudson-Raritan estuary, juveniles and adults are seasonally most abundant in deeper channels. Able and Fahay (1998) considered the habitats of juvenile windowpane flounder not well defined but noted that during extensive collections in estuarine shallows, juveniles were never collected in intertidal areas (Able et al. 1996), but occurred frequently along subtidal shores and in a variety of deeper (< 1 – 8 m) habitats (Szedlmayer and Able 1996). In laboratory studies, early demersal (8-18 mm Standard Length [SL]) and larger juveniles (32-89 mm SL) preferred sand over mud substrate (Neuman and Able in press, see Able and Fahay 1998).

6.165 Bottom trawls in the Hudson-Raritan estuary showed that juveniles were fairly evenly distributed throughout the estuary, but they were most abundant in the deeper channels in winter and summer (Wilk et al. 1998. Windowpane flounder was the third most abundant species collected in bottom trawls in the Hudson-Raritan estuary, juveniles were most abundant at bottom temperatures of 5-23°C, at depths of 7-17 m, at salinities of 23-30 ppt, and at DO levels of 7-11 mg/l (Wilk et al. 1998. Bottom trawls in Newark Bay showed a similar depth distribution, with very few juvenile windowpane flounder collected at shoal stations (NMFS 1994, LMS 1996).

6.166 Windowpane flounder were collected during every month of the recent biological sampling program, but were most abundant during April (Appendix B-1.2). A large portion of these were older, possibly mature (> 220 mm) (Chang 1998) fish. Bottom trawl catch was highest in the deeper more saline portions of the project area, primarily the Lower Harbor. Young-of-year windowpane flounder were evident in bottom trawls from June through October. Older fish were noticeably scarce in late-fall samples.

6.167 Potential impacts to juvenile, adult, and spawning adult EFH for windowpane flounder include temporary disruption of bottom habitat during channel deepening/dredging activities as well as disturbance to littoral and sublittoral bottom habitat. Potential impacts to spawning adult and egg EFH would be likely limited to deepening activities in Lower New York Bay (i.e., Ambrose Channel). Potential impacts would be seasonal, primarily in April and May when spawning adults and eggs are most likely to be found in the Ambrose Channel. Since windowpane flounder eggs are pelagic,

impacts would be limited to disturbances within the water column (such as bucket-hoisting operations) and in the immediate construction area. These potential impacts could be easily avoided and mitigated through seasonal dredging restrictions and dredge operation limitations (e.g., hoist speeds).

6.168 Disturbance to littoral and sublittoral bottom habitat would be temporary and would be mitigated as described in the Mitigation Report summarized in Section 7. Because windowpane flounder prefer channel areas over shallow areas, deepening and changes in sublittoral habitat may actually increase juvenile and adult EFH in the study area. Therefore, no detrimental or unmitigatible impacts to windowpane flounder EFH are expected to occur.

Atlantic herring

6.169 EFH for larval, juvenile and adult Atlantic herring has been designated for both the estuarine and marine salinity zones of the project area. Juveniles and adults are found in the project area during winter months (January through May), when water temperatures are below 50°F, and are most common at mid-water depths in the channels.

6.170 Juvenile and adult Atlantic herring undergo complex north-south and inshore-offshore migrations (Reid et al. 1998). Three general migratory patterns and three distinct spawning stocks are recognized off the northeast Atlantic coast (Sindermann 1979). Juvenile and adult Atlantic herring that occur in the Hudson-Raritan estuary are most likely from the Georges Bank/Nantucket Shoal stock, which spawns over Georges Bank and Nantucket Shoals during September and October, and overwinters south of Cape Cod and along the mid-Atlantic coast (Anthony 1982, Reid et al. 1998).

6.171 Atlantic herring were collected in the study area during January through March and again in May and June during the most recent biological sampling program (Appendix B-1.2). The majority of Atlantic herring collected from January through March were adults (length > 260 mm). Juveniles made up the majority of fish collected in May and June (length < 105).

6.172 Larval Atlantic herring collected in the study area are most likely from offshore spawning in the northern portion of the Middle Atlantic Bight. No spawning occurs in the study area. Able and Fahay (1998) hypothesized that the resurgence of spawning by Atlantic herring over Georges Bank and Nantucket Shoals has also increased reproductive activity in the northern part of the Middle Atlantic Bight, but sampling data in support of this hypothesis are lacking.

6.173 Some juveniles were most abundant at 4-6°C and at 16°C, which was due to summer collections at the estuary mouth. Few differences in abundance appeared over the range of depths and salinity sampled (Reid et al. 1998). Adults were most abundant at 3-6°C in deeper parts of the estuary.

6.174 Changes in depth and disturbance to bottom sediments would not impact this schooling pelagic species that is not generally associated with bottom habitats. Short-term impacts would be limited to disturbances within the water column (such as bucket-hoisting operations) and in the immediate construction area. These potential impacts could be easily avoided and mitigated through seasonal dredging restrictions and dredge operation limitations (e.g., hoist speeds).

Bluefish

6.175 EFH is designated for juvenile and adult bluefish within the project area, including both the estuarine and marine salinity zones. Stone et al. (1994) considered juvenile bluefish as seasonally abundant in the estuarine and marine areas of the Hudson-Raritan estuary; adult bluefish were considered common (i.e., frequently encountered but not in large numbers). Both juveniles and adults are most common in the Hudson-Raritan estuary between April and October.

6.176 Bluefish spawn offshore over continental shelf waters during a protracted spawning period (March through July). Eggs and larvae are rarely collected in estuarine ichthyoplankton samples. Most of the bluefish population in the New York Bight probably originates from spring-spawned eggs (Chiarella and Conover 1990). Juvenile bluefish produced in the spring travel north with the Gulf Stream (Hare and Cowen 1993) and migrate across the continental shelf to the mid-Atlantic bays and estuaries (which act as productive nursery areas) in early to mid-June (McBride and Conover 1991).

6.177 Bluefish were collected in bottom trawls in Newark Bay in both shoal and channel areas (NMFS 1994, LMS 1996), but were most abundant in experimental gill net samples, reflecting their pelagic behavior (NMFS 1994). Overall, catches were low compared to other species. Abundance was generally highest in September, comprising mostly young-of-year.

6.178 Juvenile and adult bluefish were collected in very low numbers in the study area during the most recent sampling program (See Appendix B-1.2). As would be expected, early life stages (i.e., eggs and larvae) were not found in the study area. Bluefish were most common during October when they were collected in the Kill Van Kull, Arthur Kill, Newark Bay and approach channels to Port Jersey and South Brooklyn.

6.179 Young-of-year have been collected successfully in neashore habitats using beach seines, as well as in shallow tidal creeks and shoals using bottom trawls (Able and Fahay 1998). The majority of fish are collected in shallow, high salinity (25.0-34.0 ppt) areas. Older bluefish, including adults, occasionally enter the lower estuary during summer and feed on a wide variety of available forage fish such as bay anchovy, young menhaden, and river herrings.

6.180 Bluefish is a schooling pelagic species, not generally associated with bottom habitats. Their brief occurrence in the study, low abundance, and pelagic behavior greatly limits any potential impact due to deepening activities. Potential impacts would

be short-term, and limited to actual deepening activities (e.g., blasting). Detrimental impacts to EFH due to channel deepening are therefore not expected.

Butterfish

6.181 EFH for butterfish within the project area is designated for larvae, juveniles, and adults. Juvenile and adult EFH includes both the estuarine and marine salinity zones, while larval EFH includes only estuarine waters.

6.182 Butterfish range along the Atlantic coast from Nova Scotia to South Carolina and in deeper offshore waters as far south as Florida. Butterfish migrate seasonally between offshore waters in the southern part of their range during winter and coastal waters in the northern part of their range during summer. Spawning occurs primarily over continental shelf waters in the middle Atlantic Bight between May and October, although some eggs and larvae have been collected in coastal and estuarine waters (Able and Fahay 1998).

6.183 Larval, juvenile, and adult butterfish are pelagic, occurring in the project area during warmer summer months in both shallow and deeper bay waters. Juveniles form loose schools, often near the surface, and are found over a range of sand, mud, and mixed fine-grained substrates (MAFMC 1998). During the summer, butterfish have been reported over shallow flats, sheltered bays, estuaries, and the surf zone. Larger juveniles and adults may congregate near the bottom during the day and move upward at night.
6.184 Data from sampling programs conducted within the study area indicate that butterfish were present in bottom trawls collected at channel stations but were extremely rare in shoal areas (NMFS 1994, LMS 1996). In Newark Bay, no butterfish were collected at shoal stations between May 1993 and April 1994; while only three were collected between April 1995 and March 1996. Butterfish was the most abundant species collected in bottom trawls in the Hudson-Raritan estuary (NMFS 1994).

6.185 Butterfish occurred in bottom trawl samples collected during the most recent biological sampling program from May through December (See Appendix B-1.2). Very few were collected in May and June, with the majority collected during July and August. Butterfish were ubiquitous in the study area during August, collected in all Harbor areas except Red Hook. Catches were highest in the Lower Harbor.

6.186 Icthyoplankton sampling has revealed very few butterfish larvae in the study area. One larval butterfish was collected in plankton net tows conducted in Newark Bay between May 1993 and April 1994 (NMFS 1994). No butterfish larvae were collected in recent epibenthic sled samples (See Appendix B-1.2). Icthyoplanton sampling associated with entrainment monitoring at electric generating stations in the study area also failed to collect butterfish eggs or larvae (LMS 1993, 1994).

6.187 Butterfish is a pelagic species, not generally associated with bottom habitats. Based on recent biological sampling programs, juvenile butterfish EFH occurs throughout the project area. It occurs in greatest abundance, however, in the open-water

areas of Raritan Bay and the Lower Harbor. Adult butterfish also likely occur in the open water areas of the Lower Harbor and Raritan Bay, but have been collected in very few numbers. Due to the pelagic behavior of juvenile butterfish, potential impacts are limited to short-term disturbances in the water column associated with actual deepening activities. No long-term impacts associated with littoral or sub-littoral disturbances would occur. Short-term impacts would be limited to areas of butterfish abundance, primarily the Lower Harbor. Larval butterfish EFH does not appear to occur in the study area.

Atlantic mackerel

6.188 EFH designation for Atlantic mackerel within the project area is limited to juvenile and adult life stages within the seawater salinity zone. Spatial distribution and relative/seasonal abundance data used in the ELMR program suggest that both juvenile and adult Atlantic mackerel are common in the Hudson-Raritan estuary during April through June and again in October and November (Stone et al. 1994). However, data reliability for the Hudson-Raritan estuary was classified as that of reasonable inference, indicating that little or no sampling data was available (Stone et al. 1994).

6.189 No Atlantic mackerel were collected in recent sampling programs conducted in Newark Bay (NMFS 1994, LMS 1996) and the Hudson-Raritan estuary (NMFS 1994). Only one Atlantic mackerel was collected during the recent biological monitoring program (See Appendix B-1.2).

6.190 Because Atlantic mackerel is a pelagic species, and not generally associated with bottom habitat or very susceptible to bottom trawl sampling, Atlantic mackerel may be underrepresented. However, fish sampling programs associated with impingement monitoring at electric generating stations in the study area, also failed to collect Atlantic mackerel (LMS 1993, 1994).

6.191 Based on the extremely rare occurrence of Atlantic mackerel in fish sampling programs in the Harbor, Atlantic mackerel EFH does not appear to occur in the study area. Therefore, no impacts due to channel deepening are expected to occur.

Summer flounder

6.192 EFH designations for summer flounder include the freshwater, brackish, and seawater salinity zones of the project area. EFH has been designated for larvae, juvenile, and adult life stages. Adult and juvenile summer flounder are found in the project area during warmer months, primarily May through October, in shallow water over sand and mud substrate. Larval summer flounder, although generally considered rare in the Hudson-Raritan estuary, may occur in pelagic waters between April and December (Stone et al. 1994).

6.193 Summer flounder spawn during their offshore migration to open ocean areas of the continental shelf beginning in early-fall and continuing through winter (Packer and Griesbach 1998). Spawning generally occurs outside the project area. Eggs and larvae are pelagic, migrating inshore to coastal and estuarine nursery areas from October to May (Able et al. 1990).

6.194 Summer flounder eggs and larvae have been collected in the study area during previous biological sampling programs. Both eggs and larvae were collected in epibenthic sled samples at shoal stations in Newark Bay (LMS 1996). Eggs were collected in September and October; larvae were collected in September only. Summer flounder eggs were also found in epibenthic sled samples collected in the Arthur Kill channel during this same period (LMS 1996).

6.195 Unlike epibenthic sled samples, no summer flounder eggs or larvae were collected in plankton net tows in Newark Bay (NMFS 1994). Summer flounder eggs and larvae were also absent from epibenthic sled icthyoplankton samples collected during the most recent biological sampling program (See Appendix B-1.2). Summer flounder eggs and larvae (prior to settlement) are pelagic, however, and may not be effectively sampled by epibenthic gear. Summer flounder post-yolk-sac larvae have been collected in icthyoplankton sampling programs associated with entrainment monitoring at electric generating stations in the study area (LMS 1993, 1994). Larvae were present in icthyoplankton entrainment samples from November through March.

6.196 Following settlement, early juveniles inhabit a variety of high-salinity, subtidal habitats, including subtidal marsh creeks, coves, bays, and inlets in both vegetated and unvegetated habitats (Able and Fahay 1998). Summer flounder were present in bottom trawl samples collected at shoal and channel stations in Newark Bay between April and September (NMFS 1994, LMS 1996). Abundance was highest during July. The majority of these fish were greater than 200 mm in length. Early juvenile summer flounder (< 200 mm TL) were noticeably absent from bottom trawls (NMFS 1994, LMS 1996). Summer flounder were generally more abundant at channel stations than at shoal stations (NMFS 1994).

6.197 Summer flounder were collected during the most recent biological sampling program from April through October, with abundance highest during June (See Appendix B-1.2). Summer flounder were generally distributed evenly throughout the project area and were collected at all Harbor Areas. The largest collections were made in South Brooklyn during May and in the Kill Van Kull during July. Adult and juvenile summer flounder migrate offshore in late-summer and early fall, as water temperatures decline.

6.198 Potential impacts to summer flounder EFH include temporary disruption of bottom habitat during channel deepening/dredging operations, as well as disturbance to littoral and sublittoral habitat. Potential impacts would be limited to primarily demersal life-stage EFH (i.e., older juvenile and adult), and would be localized and confined to the immediate excavation area. No excavation would occur in tidal creeks or shallow

subtidal marshes or bays, primary habitat for early juvenile summer flounder. Most of the project area would remain available for foraging and growth. Potential impacts to EFH would be restricted to warmer months (May through October), when adults and juveniles are most common. Juvenile and adult summer flounder would continue using the shoal and channel habitat in other portions of the project area.

6.199 Short-term impacts to pelagic summer flounder larvae would be limited to disturbances within the water column (such as bucket-hoisting operations) and in the immediate construction area. These potential impacts could be easily avoided and mitigated through seasonal dredging restrictions and dredge operation limitations (e.g., hoist speeds).

6.200 Disturbance to littoral and sublittoral bottom habitat would be temporary and would be mitigated as described in the Mitigation Report summarized in Chapter 7. Therefore, no detrimental or unmitigatible impacts to windowpane flounder EFH are expected to occur.

Scup

6.201 EFH designation for the egg, larval, juvenile, and adult life-stage of scup is limited to the seawater salinity zone of the project area.

6.202 Spawning occurs in coastal waters from May through August, when temperatures are above 10°C. Spawning has been reported to take place over weedy or sandy areas (Morse 1978). During earlier studies (e.g., Croker 1965, Berg and Leviton 1985) scup eggs were not collected in the Hudson-Raritan estuary. Similarly, no eggs were collected in recent epibenthic icthyoplankton sampling conducted in the study area (Appendix B-1.2). However, eggs are pelagic and would not be expected to occur in epibenthic samples.

6.203 Scup larvae are found in the waters of southern New England from May through September, when water temperatures range from 14 to 22°C (MAFMC 1998). Newly hatched larvae are pelagic up to a length of about 0.6 – 1.2 in. TL. At that time the larvae become demersal and are found in shoal waters (MAFMC 1996, Able and Fahay 1998). Although earlier studies report scup larvae in southern New England waters, Able and Fahay (1998) have stated that there has not been a verified collection of scup larvae in these waters since Sisson (1974). Their assertion is supported by recent icthyoplankton sampling during which no scup larvae were collected (NMFS 1994, LMS 1996). Moreover, no scup larvae were collected during the 1998-99 epibenthic icthyoplankton sampling conducted in the study area. Although early stages are pelagic, and would not be expected to occur in epibenthic samples, larger demersal larvae should have been collected if present.

6.204 Within the project area, juveniles and adults occur in similar demersal habitats, using intertidal and subtidal waters over a variety of substrates. Juvenile scup are most

common in inshore estuarine waters during the warmer months, when water temperatures are between 7 and 27°C. Juveniles were collected during bottom trawls in October 1998, and from May through September 1999 (Appendix B-1.2). Abundance was greatest at South Brooklyn and Port Jersey sites during July through September. Juveniles were collected at several other stations in August.

6.205 Adult scup use coastal habitats until water temperature falls below 7.5-10°C (MAFMC 1998). Adult scup are often found over soft, sandy bottoms and on or near submerged structures, rocky ledges, or mussel beds (MAFMC 1996). Older, possibly adult scup were collected in October 1998, and from July through September 1999. As was the case for juveniles, adults were found in greatest numbers at South Brooklyn and Port Jersey stations from July to September. Adults were collected at several other stations in August.

6.206 Potential impacts to juvenile and adult scup EFH include temporary disruption of bottom habitat during channel deepening/dredging activities, as well as disturbance to littoral and sublittoral bottom habitat. Since scup eggs and larvae are pelagic, impacts would be limited to disturbances within the water column (such as bucket hoisting operations) and in the immediate construction area. However, because eggs and larvae have not been collected in the project area, it is unlikely that these life-stages will be impacted.

6.207 Potential impacts to scup EFH include temporary disruption of bottom habitat during channel deepening/dredging activities. Potential impacts would be limited to demersal life-stage EFH (i.e., juvenile and adult). These impacts would be localized and confined to the immediate excavation area. Most of the project area would remain available for foraging and growth. Potential impacts to EFH would be restricted to warmer months (May through October), when adults and juveniles are most common. These potential impacts could be easily avoided and mitigated through seasonal dredging restrictions and dredge operation limitations (e.g., hoist speeds). Disturbance to littoral and sublittoral bottom habitat would be temporary and would be mitigated as described in the Mitigation Report summarized in Chapter 7. Therefore, no detrimental or unmitigable impacts to scup EFH are expected to occur.

Black sea bass

6.208 EFH designation for juvenile and adult black sea bass includes the marine and estuarine waters of the project area. Juvenile and adult black sea bass move to inshore coastal waters from late-spring through fall, and are strongly associated with structured habitats (e.g., reefs, pile fields). Annual occurrence in the Hudson-Raritan estuary and the project area is highly variable.

6.209 Due to their preference for structured habitat, black sea bass are not generally collected in bottom trawl sampling programs. No black sea bass were collected during previous sampling programs in Newark Bay at channel or shoal stations (NMFS 1994,

LMS 1996). Bottom trawls conducted in the Hudson Raritan estuary between January and December 1993 collected only 50 individuals. Black sea bass were most abundant in the Hudson-Raritan estuary in fall (NMFS 1998).

6.210 As expected, very few black sea bass were collected during the most recent biological sampling program (Appendix B-1.2). Black sea bass were present in bottom trawl samples during June, August-October, and December. The majority of these were collected during October, at the Port Jersey and South Brooklyn Marine Terminal areas. Black sea bass were not collected at Red Hook, Kill Van Kull, Newark Bay Arthur Kill, or South Brooklyn approach channel areas.

6.211 Due to the strong affinity of this species for structured habitats, rough bottoms, and shallow waters, potential impacts to black sea bass EFH within the project area are minimal, since these habitat types do not occur within the channels to be deepened. Some impact may occur due to the temporary disturbance of shallow-water habitat. Since these areas, however, are not associated with pile fields or structured habitat, such impacts would likely be minimal.

6.5 Protected Species

Federally Protected Species

6.112 The following section references the Biological Assessments for Threatened and Endangered Species in the Port of New York and New Jersey (USACE-NYD 1999d), the Draft Fish and Wildlife Coordination Act Section 2(b) Report for the New York and New Jersey Harbor Navigation Study (USFWS 1999), and the USFWS Biological Opinion on the Effects of Channel Deepening on the Peregrine Falcon (USFWS 1997).

Species Under the Authority of USFWS (Section 7 Consultation)

Peregrine Falcon

6.213 Although it is likely that peregrine falcons residing in the study area have become acclimated to daily levels of noise and line-of-sight visual disturbance that are much higher than that of non-urban environments, the threshold disturbance levels that may induce nest abandonment or reproductive failure are not well understood and may vary among individual birds. Dredging and blasting in the immediate vicinity of the project-area bridges used for nesting will initially produce an increased level of disturbance, which could cause excessive stress during incubation, possibly leading to adults inadvertently expelling eggs from the nest. It might also result in an increase in metabolism that could cause an increase in foraging and less attention paid to young. Subsequent maintenance activities throughout the projected 50-year life of the project might have similar effects, as might vessel presence in the vicinity of nesting sites. None of this disturbance is expected to have a long-term impact.

6.214 The primary indirect impact to peregrine falcons from the project is the potential for exposure to contaminants as a result of dredging. This was discussed in detail under "Biological Exposure Potential". In summary, dredging may release contaminants into the water column, thereby making them more available to aquatic organisms. Contaminants could then bioaccumulate in aquatic organisms, and in turn could be magnified through higher trophic levels in the food chain. The peregrine falcon could, therefore, be exposed by consuming more highly contaminated prey. The suspension of contaminants in the water column, however, is expected to be temporary, and the removal of contaminated sediments from the channels by dredging may offset such an effect.

Piping Plover

6.215 No direct impacts to piping plovers due to dredging or changes in tide levels and shoreline erosion are anticipated at either Breezy Point or Sandy Hook. Neither vessel nor human activity in this area, approximately 2.5 miles from either of the documented nesting areas, is likely to disturb piping plovers.

6.216 The dredging activity proposed for the Ambrose Channel and other areas of the Harbor, based in part on hydrodynamic model results and shore zone erosion analysis, is not expected to involve any indirect impacts to existing or future piping plover populations during the expected life of the project (50 years). It is, moreover, highly unlikely that future maintenance activities would involve an increase in human or vehicular traffic at Sandy Hook, Breezy Point, or other beaches in the New York and New Jersey Harbor region.

Roseate Tern

6.217 No direct impacts to roseate terns at Breezy Point are anticipated. Neither vessel nor human activity in this area, approximately 2.5 miles from the documented nesting area, is likely to disturb roseate terns.

6.218 The potential indirect impact to roseate terns from the project is exposure to contaminants as a result of resuspended sediments. This is, however, not expected to pose a threat to the terns or their potential prey species.

6.219 The dredging activity proposed for the Harbor is not anticipated to result in any other indirect impacts to existing or future roseate tern populations during the expected life of the project (50 years). It is, moreover, highly unlikely that future maintenance activities would involve an increase in human or vehicular traffic at Breezy Point or other beaches in the New York and New Jersey Harbor region.

Northeastern Beach Tiger Beetle

6.220 Dredging activity in the Ambrose Channel or anywhere else in the study area does not pose a threat to the reintroduced Sandy Hook population of northeastern beach tiger

beetle, or to any future populations that may become established along the northern and central New Jersey Coast. The proposed construction activities will not involve human or vehicular traffic at any beaches in the New York and New Jersey Harbor.

6.221 The dredging activity proposed for the Harbor is not expected to involve any indirect impacts to existing or future northeastern beach tiger beetle populations during the expected life of the project (50 years). It is, moreover, highly unlikely that future maintenance activities would involve an increase in human or vehicular traffic at Sandy Hook or other beaches in the New York and New Jersey Harbor region.

Seabeach Amaranth

6.222 Dredging activity in the Ambrose Channel or anywhere else in the study area does not pose a threat to the seabeach amaranth population at Arverne, or to any future populations that may become established at Breezy Point. The proposed dredging activities will not involve human or vehicular traffic at any beaches in the New York and New Jersey Harbor area.

6.223 The dredging activity proposed for the Ambrose Channel and areas of the Harbor is not anticipated to result in any indirect impacts to existing or future seabeach amaranth populations during the expected life of the project (50 years). It is, moreover, highly unlikely that future maintenance activities would involve an increase in human or vehicular traffic at Breezy Point sites. Placement options (which would be evaluated under a separate Placement EA) would not be likely to include beach nourishment (with possible burial of plants) in this area.

Species Under the Authority of NMFS

Marine Mammals

6.224 Three endangered marine mammals have been identified by NMFS as occurring within the project area. These include the northern right whale, the humpback whale, and the finback whale (NMFS 1999). These species are migratory, using the Harbor in transit to other habitat areas, or have been recorded in the Lower New York Bay area, although some individuals have been documented as far up the Hudson River as the Troy Dam.

6.225 Dredging equipment is not likely to impact marine mammals that occur in the area. During dredging, marine mammals would be able to avoid the dredge, since they swim quickly and the dredge moves very slowly during normal operations.

6.226 No direct or indirect impacts are expected to marine mammals as a result of channel deepening. If dredged material from the project is taken to the HARS, NMFS mammal observers will be required to minimize direct contact impacts.

Sea Turtles

6.227 The disturbance of macroinvertebrate habitat in the channel bottoms and the littoral zone would indirectly impact sea turtles, since they feed on organisms such as crabs and some mollusks that inhabit these areas. The loss of bottom feeding areas would be temporary because natural sedimentation is expected to return these habitats to pre-existing conditions relatively quickly. In the interim, sea turtles would avoid these less desirable areas. The loss of littoral zone feeding areas in the Kill Van Kull, Newark Bay, and Arthur Kill would be permanent, although these areas are very small compared to the total feeding area remaining (channel and littoral combined). Because sea turtles are infrequent visitors to the inner Harbor, the proportion of individuals affected by this loss would most likely be small.

Fish

6.228 The shortnose sturgeon is the only fish species occurring in the project area that is on the Federal endangered species list. Although the shortnose sturgeon prefers the less saline waters of the Hudson River, it does occasionally move into the Harbor area. No shortnose sturgeons were collected during the 12-month harborwide sampling program conducted for the Harbor Navigation Study. Therefore, no direct impacts on the shortnose sturgeon from dredging activities are projected.

6.229 The primary indirect impact to the occasional shortnose sturgeon that enters the Upper Harbor area is the potential for exposure to contaminants as a result of sediment resuspension and consumption of more highly contaminated prey species.

State Protected Species: New York and New Jersey

Birds

6.230 The states of New York and New Jersey have extensive listings of endangered bird species. Of these, only the pied-billed grebe, piping plover, short-eared owl, American bittern, and the northern harrier are believed to occur in the project area. The states of New York and New Jersey also have extensive listings of threatened bird species. Threatened bird species likely to occur in the project area include: the osprey, the barred owl, and the yellow-crowned night heron.

6.231 Except for the yellow-crowned night heron, it is unlikely that TES bird species will be affected by loss of littoral zone habitat because most forage over open water or on land. The yellow-crowned night heron may lose a small portion of littoral zone habitat that will become too deep to forage in.

6.232 Also among the state-listed species are the roseate tern (endangered), common tern (threatened), least terns (endangered) and black skimmers (endangered). No direct impact to these species is anticipated.

6.233 The primary indirect impact to terns, ospreys, herons, and skimmers from the project is the potential for exposure to contaminants as a result of sediment resuspension.

Invertebrates

Northeastern Beach Tiger Beetle: Endangered in New Jersey

6.234 Dredging in the Ambrose Channel or anywhere else in the study area will not pose a threat to the reintroduced population of northeastern beach tiger beetle at Sandy Hook, or to any future populations that may become established along the northern and central New Jersey Coast. The proposed construction activities do not involve human or vehicular traffic at any beaches in the New York and New Jersey Harbor area.

6.235 The dredging activity proposed for the Ambrose Channel and other areas is not expected to result in any indirect impacts to existing or future northeastern beach tiger beetle populations during the expected life of the project (50 years). It is, moreover, highly unlikely that future maintenance activities would involve an increase in human or vehicular traffic at Sandy Hook or other beaches in the New York and New Jersey Harbor region.

Plants

6.236 The states of New York and New Jersey have extensive listings of threatened and endangered plant species. Of these, only the saltmarsh bulrush, seabeach knotweed, coastal flatsedge, and the red goosefoot are likely to occur in the project area.

6.237 The heartleaf plantain and saltmarsh bullrush are listed as threatened and endangered, respectively, in New York. However, the age of the records (pre-1900) and absence of any recent-occurrence records make it logical to conclude that the plants and their habitat no longer exist in this highly industrialized area.

6.238 Harbor dredging activities related to navigation improvements do not pose a threat to plant populations at Arverne, or to any future plant populations that may become established naturally or by human reintroduction in the project area. The proposed dredging activities will not involve human or vehicular traffic at any beaches in the New York and New Jersey Harbor area.

6.239 The dredging proposed for the Ambrose Channel and other areas of the Harbor is not expected to result in any indirect impacts to existing or future plant populations during the expected life of the project (50 years). It is, moreover, highly unlikely that future maintenance activities would involve an increase in human or vehicular traffic in

the project area. Placement options (which would be evaluated under a separate Placement EA) would not be likely to include beach nourishment/remediation (with possible burial of plants) in this area.

6.6 Cultural Resources

Prehistoric Resources

6.240 The geomorphological and archaeological study conducted for the Harbor Navigation Project by Geoarchaeology Research Associates (GRA) indicates that the Port Jersey, Claremont, and Anchorage Channels have a moderate-to-high potential for prehistoric resources and recommends that several additional borings be taken and analyzed from each location. The channel margins of Newark Bay have been determined to have a moderate potential; further borings are also recommended there. Areas thought to have a low potential are the Port Newark Channel, Elizabeth Channel, and Buttermilk Channel. No further cultural resource work is recommended for these areas. Further study is recommended along the Ambrose Channel, where boring data were insufficient.

6.241 Because the Bay Ridge Channel was examined previously by LaPorta, et al. for the Dredged Material Management Plan (DMMP), this area was not included within the GRA study. This channel was assessed at a moderate-to-low sensitivity and it was recommended that additional samples be excavated and analyzed.

6.242 The Kill Van Kull navigation channel has been dredged to bedrock, thereby removing any prehistoric deposits that may have existed there. Excavation into the sideslopes, however, may impact sensitive areas, and additional borings are therefore recommended.

6.243 The Arthur Kill was evaluated in connection with an ongoing study to deepen the channel to 40-41 ft MLW. The area just northeast of Shooters Island was evaluated as sensitive for prehistoric deposits. Additional borings were excavated in the autumn of 1999 and the resulting report will be available early in 2000. This study should preclude the need for any further identification work in the Arthur Kill with regard to prehistoric resources.

6.244 Since the South Elizabeth Channel was not under consideration as part of the Harbor Navigation Study when the cultural resources work was contracted, no data were recovered from this channel. Further studies, in the form of borings and analyses, will be required.

Historic Resources

6.245 It is not anticipated that dredging to deepen any existing channels will have an effect on any structures or districts listed or eligible for listing in the National Register of Historic Places (NRHP), nor will there be any effect on National Historic Landmarks

within or adjacent to the project. Blasting, however, if determined to be necessary for the removal of hard material, will require additional agency coordination, and possibly an architectural survey, to ensure that no damage occurs to significant historic structures.

6.246 A blasting program will be developed that entails pre- and post-blast condition surveys and that details precautions to be undertaken by the blasting contractor in the vicinity of historic structures. This type of activity has been previously coordinated by USACE with both the New York and New Jersey State Historic Preservation Offices. The channels most sensitive for historic properties are the Kill Van Kull, Arthur Kill, Newark Bay Channel, and the Bay Ridge Channel. The scope of this program is stipulated in a Programmatic Agreement (PA) for the Harbor improvement project. "Section 106 Coordination," below, provides a detailed discussion of this PA.

6.247 Channel widening associated with Harbor improvements may impact abandoned vessels that have been determined eligible for the NRHP. Detailed project plans are required to determine if there will be any such impacts associated with work in any channel. The most sensitive channels are the Arthur Kill, the Kill Van Kull and the Bay Ridge Channel. If there are impacts related to the Harbor Navigation Project and the project advances to construction before the USACE Collection and Removal of Drift Project, mitigation measures may be necessary if avoidance of the resources is not feasible. Such treatment measures are included in the PA for the current project. (See "Section 106 Coordination" below).

6.248 The results of these previous studies have been integrated into the Section 106 coordination for the Harbor Navigation Project. A draft preliminary Case Report was prepared which summarized two decades of work in the Harbor. This report was reviewed by both SHPOs and the New York City Landmarks Preservation Commission. No revisions were requested. Other studies will be programmed as necessary. The need for and scope of these additional studies is stipulated in the PA developed for the Harbor Navigation Project.

6.249 Due to the nature of the Harbor Navigation Project, shipwrecks—submerged or buried vessels that have foundered, or been stranded or wrecked—have not been considered. Most work for the proposed deepening of the Harbor will occur in existing navigation channels that are subject to ongoing maintenance dredging. These channels represent a disturbed environment. Any historic resources that may have existed in these channels would have been significantly disturbed, if not completely destroyed, by dredging activities. It is unlikely that intact historic resources eligible for listing on the NRHP will be affected by the proposed dredging if all proposed dredging operations are limited to areas previously disturbed by channel construction and maintenance. In certain locations, where additional excavation beyond previously disturbed areas is required, additional cultural resources studies will be necessary.

6.250 Placement sites for dredged material are addressed in the DMMP (USACE-NYD 1999a). Cultural resources issues related to such sites are being coordinated through the

DMMP project as it proceeds. If other dredged material placement areas are proposed specifically for the Harbor Navigation Project they may require a cultural resources evaluation.

Section 106 Coordination

6.251 Section 106 coordination with the New York and New Jersey SHPOs, and the New York City Landmarks Preservation Commission (NYCLPC) was initiated for this study with letters dated 5 June 1997, submitting the Project Study Plan for SHPO information and comment. The New Jersey SHPO concurred with the proposed cultural resources studies but noted that additional surveys may be required in areas of proposed blasting. NYCLPC also accepted the study. No comments were received from the New York SHPO. Since that time, cultural resource studies were altered to more accurately reflect the nature of the Harbor Navigation Project as it developed through feasibility. The draft report generated by GRA was reviewed by both SHPOs and NYCLPC and no revisions were requested. Relevant correspondence is contained in Appendix A-1.3.

6.252 As discussed in previous sections, USACE has conducted numerous projects within the New York and New Jersey Harbor area over the years and has generated many cultural resources reports. These reports and project impacts have been coordinated with the appropriate SHPO. The correspondence associated with this previous work is extensive and has been used, where relevant, as part of USACE's identification, evaluation and treatment of cultural resources within the Area of Potential Effect (APE) associated with the Harbor Navigation Project.

6.253 A series of public meetings was held in May and June of 1998, providing a forum for public discussion of cultural resources. Poster boards explaining various facets of the Harbor Navigation Project and the NEPA review process were on display. A poster board that discussed the potential for prehistoric and historic cultural resources and the Section 106 process was included at each session. The USACE project archaeologist was available to discuss any issues or to answer any questions from the public.

6.254 Letters were sent in October 1998 to more than 30 state and local historical, maritime, and archaeological societies and museums, as well as to municipal historical commissions, notifying them of the Harbor Navigation Project (Appendix A-1.3). Seven organizations responded and indicated their interest in being included in the Section 106 process as interested parties. Letters will be sent to notify the interested parties of the availability of the geomorphology study and the FEIS. Further coordination with interested parties will be undertaken as the project proceeds.

6.255 USACE is consulting with the appropriate SHPO concerning the effects of the Harbor Navigation Project on National-Register-listed and eligible cultural resources, pursuant to 36 C.F.R. §800. Since the potential exists for adverse effects on cultural resources due to future actions associated with the Harbor project, such as blasting, and given that additional archaeological and historic architectural inventories may be required

based on these actions and the results of ongoing cultural resource investigations, USACE has drafted a PA for the project. This PA outlines the responsibilities of USACE to avoid, minimize, or mitigate any adverse effects on cultural resources that may occur as a result of the project, and stipulates the scope and scheduling of any additional cultural resource investigations that may be required. The Draft PA was reviewed by both SHPOs and NYCLPC. Their comments were incorporated into the document, which will be routed for signature. The Advisory Council was informed of the project and a copy of the Draft PA was provided to them. The PA is included as Appendix B-1.3.

6.256 Future actions associated with the project may impact areas that have been demonstrated to have a high potential to contain inundated prehistoric resources. As noted in Section 5.6, if such resources are found, they would be considered eligible for listing in the NRHP. However, these investigations (which involve the use of corings/ borings) may not locate specific prehistoric sites, given the difficulty of identifying such sites in these inundated environments using these field methods. It should also be noted that no technologies are currently available for use in inundated areas that are comparable to the procedures used for identifying and assessing the content of terrestrial archaeological sites. Even though it may not be possible to identify and evaluate specific inundated prehistoric sites, it is not possible to state, with confidence, that such sites will not be adversely affected by aspects of the proposed project, given the potential identification of intact, inundated prehistoric landforms within the APE. Therefore, USACE has included within the PA treatment measures to mitigate this potential adverse effect. Such measures may include the collection of environmental information preserved in submerged areas of the project's APE. This work may entail a synthesis of relevant studies completed to date, coupled with related archival material to develop a preliminary sensitivity model for the location and integrity of these inundated prehistoric landscapes. Testing of the model in the form of limited, appropriately located, borings would be undertaken. This work would lead to the development of a working model that would provide an important and innovative research tool as well as a useful and much needed planning aid for future USACE actions within the Harbor. The scope and scheduling of such work would be stipulated in the project's PA.

6.257 Additional stipulations within the PA include a remote sensing program to locate shipwreck sites that may be affected by the channel widening. Procedures for evaluating the NRHP eligibility of these resources and development of appropriate data recovery measures are also stipulated. Locations where such historic properties may exist include the mud flat areas near the Port Jersey, South Elizabeth, and Newark Bay Channels, and adjacent to the channel edges along Anchorage and Ambrose Channels.

6.258 Future detailed project engineering and design will define areas for which blasting is required as part of construction. Construction specifications will require that blasting be conducted according to BMPs to avoid vibration impacts to upland buildings and structures. To identify structures eligible for the NRHP, historic architectural surveys will be conducted for the upland areas adjacent to channel reaches where blasting is

proposed. These structures would be subject to monitoring during blasting to ensure that no impacts resulted from construction. To date, the monitoring of blasting effects has been coordinated with the appropriate SHPO along the Kill Van Kull and part of Newark Bay. Details of these additional surveys, evaluations, and subsequent monitoring program are stipulated in the PA.

6.7 Hazardous, Toxic, and Radioactive Waste (HTRW)

6.259 Hazardous, toxic, and radioactive waste (HTRW) consequences are applicable only to landside areas. Dredged material associated with channel deepening will be tested under disposal criteria. Since no landside areas are expected to be impacted by the proposed project, no project-related HTRW consequences are anticipated.

6.8 Environmental Justice

6.260 Information on race and income for census tracts falling within and around the study area is provided in Section 5.7. Based on a review of the 1990 census data and of the expected project impacts, it appears that, within a one-mile buffer area delineated around all channel-deepening areas, dredging activities will not cause disproportionately high and adverse human health or economic effects on minority or low-income populations,

6.261 In upland areas, the potential exists for environmental justice complaints based on the higher proportion of low-income and minority populations in the upland project area vicinities. However, the projected upland terminal improvements will occur regardless whether the proposed channel improvements are implemented. Therefore, no environmental justice issues are associated with the project.

6.9 Impacts Associated With Rock Blasting

6.262 Potential aquatic impacts associated with blasting include noise, thermal energy release, increased turbidity, damage to structures, and effects on aquatic life, all of which are expected to be minor. These impacts would be generated as a result of vibrations, explosion-induced surface water waves, or air overpressure.

- Using current construction procedures, controlled blasting, and seismic monitoring, potential vibration impacts can be minimized, and in fact are expected to be minor, as demonstrated by the earlier blasting for the Kill Van Kull/Newark Bay Channel deepening.

- Based on experience with previous blasting in the Kill Van Kull, a peak particle velocity (PPV) of about 0.3 in/sec will be the likely threshold of complaint from blasting. Because of the short duration of the vibrations, there should be no threat to human health.

- No impacts to bridge foundations, piers, bulkheads, or marinas are expected.

- Blasting using similar patterns and explosives as used in the Kill Van Kull and Newark Bay is not expected to produce waves that are detrimental to shoreline structures. However, it has been recommended that wave propagation during initial blasting in the Arthur Kill be monitored.

6.263 No damage due to air overpressure was reported from previous channel deepening projects, and the use of similar techniques should result in no damage from the proposed channel deepening. Because the same patterns and explosives are being proposed for this project, it is unlikely that air overpressure will have any significant adverse impact.

6.264 Impacts to aquatic populations would be localized, with the most pronounced effect on aquatic species in the immediate vicinity.

Invertebrates

6.265 The effect of blasting on hard-bodied invertebrates would tend to be small except in the immediate vicinity of the blast. Damage to hard-bodied invertebrates near the blast site might include cracked or broken shells and carapaces. Soft-bodied invertebrates in the immediate vicinity would be killed, while populations of those in outlying areas would sustain less damage.

Fish

6.266 The extent of damage to fish populations depends on the presence or absence of a swim bladder. Fish with swim bladders (e.g., Atlantic herring) will be unable to adjust to the abrupt change in pressure propagated by the blast. These fish may be killed or injured. Fish without swim bladders (e.g., winter flounder) are less likely to be injured, and would in fact sustain injuries only if they are in the immediate vicinity of the blast. Blasting may displace resident fishes, although this impact is expected to be only temporary.

Sea Turtles and Marine Mammals

6.267 Although infrequent visitors to the inner Harbor, sea turtles or marine mammals may also be affected by blasting. If present during a detonation, individuals of these species would most likely sustain injuries as a result of pressure waves produced by the blast.

6.268 Several precautionary measures could be taken to prevent or reduce the incidence of injury due to blasting (See Section 8.3, Best Management Practices [BMPs]). Fish deterrent systems might be employed to prevent fish from entering the area. Blasting operations could be made contingent upon use of sonar, and with a fisheries observer present. Blasting might be prohibited during the passage of schools of fish, or in the

presence of sea turtles or marine mammals. Through application of BMPs, impacts to aquatic populations can probably be reduced.

INDEX

#

2,3,7,8-TCDD 18, 27
2,3,7,8-TCDF 18

A

Air quality impacts 29–32
Aquatic habitat and biota 24–25

B

Best Management Practices (BMPs) 19
Biological exposure potential 11–20
Biological resources impacts 3–8

C

Comprehensive Port Improvement Plan 10, 30
Cultural resources 52–56
  historic 52–54
  prehistoric 52
  Section 106 coordination 54–56

D

dioxins 12
DMMP 17, 52, 53

E

EFH 33, 34, 35, 36, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47
Environmental justice 56
estuaries 11

F

furans 12

G

Geology, groundwater, and site stability impact 10–11

H

Habitat disturbance under Recommended Plan 28
HARS 18, 49
HTRW 56
Human health and safety 20

I

Irreversible and irretrievable commitment of resources 33

M

Maintenance dredging and dredged material placement under Recommended Plan 7, 28

N

Noise 29, 30
Noise, odor, and aesthetics impact 8–10

P

PAHs 12
PCBs 12
PPV 56
Protected species 47–52
  Federally protected 47–50
    NMFS 49–50
    USFWS 47–49
  State-protected 50–52

R

Recommended Plan 1
Recommended Plan, assessment of impacts 2–59
  cumulative impacts 20–33
  direct impacts 2–10
    aquatic 8
    upland 10
  impacts upon Essential Fish Habitat (EFH) 33–47
    Atlantic herring 40
    Atlantic mackerel 43
    black sea bass 46
    bluefish 41
    butterfish 42
    red hake 35
    scup 45
    summer flounder 43
    windowpane flounder 38
    winter flounder 36
  indirect impacts 10–20
    aquatic 10–20
    upland 20
Recreational impact 20
Relationship of Recommended Plan to other projects 21–22
Rock-blasting impacts 56–59

S

SPCs 22
Sub-channel placement cells (SPCs) 22

T

Traffic, vessel 9

W

Water contamination and Recommended Plan 32–33
Water quality 25–28
Wetlands 23–24

TABLE 6.1-1 New York and New Jersey Harbor Navigation Study Recommended Plan Estimated Disturbed Areas by Channel and Depth				
Channel	Disturbed Areas (Acres)			
	Intertidal (MHW to MLW)	Littoral Zone (MLW to 6ft MLW)	Sublittoral Zone(> 6ft to 15ft MLW)	Total Intertidal and Littoral
Ambrose	0.0	0.0	0.0	0.0
Anchorage	0.0	0.0	0.0	0.0
Bay Ridge/Red Hook	0.0	0.0	0.0	0.0
Port Jersey	0.0	0.0	12.35	0.0
Kill Van Kull	0.0	0.06	1.41	0.06
Arthur Kill to Howland Hook	0.0	3.23	3.22	3.23
Newark Bay	0.0	2.72	7.79	2.72
South Elizabeth	0.0	0.0	15.84	0.0
Elizabeth	0.0	0.25	1.42	0.25
Totals	0.0	6.26	42.03	6.26

7 MITIGATION OF IMPACTS

7.1 Environmental Mitigation Concepts

7.1 In accordance with the Council on Environmental Quality (CEQ) Regulations for Implementing NEPA (40 C.F.R. §1500-1508), and with paragraph 7-35 of USACE Engineering Regulation (ER) 1105-2-100 (USACE 1990, 1997), the planning of USACE-sponsored and other Federal projects must ensure that project-caused adverse environmental impacts (i.e., impacts to fish and wildlife resources) have been avoided or minimized to the extent practicable, and that remaining unavoidable significant adverse environmental impacts are compensated for to the extent justified. USACE regulations stipulate that the Recommended Plan must contain sufficient mitigation measures to ensure that the plan selected will have no more than negligible net adverse impacts on fish and wildlife resources, including impacts of the mitigation measures themselves. The USACE regulations also state that, "full credit shall be given to the beneficial aspects of an alternative plan, or project, before consideration is given to adding separable mitigation features." Regarding wetlands, however, the guidance contains very specific requirements that the District "ensure that adverse impacts to wetland resources are fully mitigated...as required to clearly demonstrate efforts made to meet the administrations goal of no net loss of wetlands."

7.2 The primary unavoidable environmental impacts (that require mitigation) associated with the Recommended Plan are disturbance and loss of littoral habitat. Mitigation for losses of littoral habitat are specifically required because the littoral zone is defined as wetland habitat in New York (Title 6 §661.2 (b) and (e) of the Official Codes of Rules and Regulations of New York State) and is protected in New Jersey under Coastal Area Facility Review Act (N.J.S.A 13:19-1 to 21) (CAFRA) regulations. No impacts to intertidal wetlands are expected to occur as a result of the proposed navigation channel improvements. Littoral zone areas that will be impacted were measured by planimetric analysis (of preliminary project construction drawings). Preliminary field confirmations of the impacted littoral zone areas were made during the field survey for the functional assessment of the impacted areas, described below.

7.3 Should the Recommended Plan be authorized, final measurements of actual areas impacted will be made during the project's detailed design phase. In order to ensure that all improvements in function or changes in area are adequately addressed by mitigation, additional functional assessments, if necessary, will be carried out prior to construction.

7.4 The mitigation plan presented herein was based in part on mitigation plans for other USACE-NYD channel improvement projects. Specifically, the mitigation plans adopted for the deepening of the Arthur Kill Channel and recommended for some portions of the New York Harbor Collection and Removal of Drift Project were used in the plan formulation process. The recommended mitigation plan was developed in consultation with state and Federal resource agencies through the New York and New Jersey Harbor Navigation Study Environmental Work Group.

7.5 USACE-NYD evaluated a variety of mitigation alternatives that might be used in the Harbor for this or other related projects. This evaluation included identification of potential

mitigation sites and, in some cases, conceptual designs for a number of alternatives that are not included in the Recommended Plan. The evaluation is described in detail in the Study's Mitigation Report. This section provides a summary of the Mitigation Report.

7.2 Potential Mitigation Measures

7.6 Mitigation concepts presented in (ER) 1105-2-100 to address environmental impacts include the following:

- **Avoidance**: avoiding the impact by not taking an action or part of an action
- **Minimization**: minimizing the impact by limiting the degree or magnitude of the action and its implementation
- **Restoration**: rectifying the impact by repairing, rehabilitating, or restoring the affected environment
- **Reduction**: reducing or eliminating the impact over time by preserving and maintaining operations during the life of the action
- **Compensation**: compensating for the impact by replacing or substituting for the affected resources or environments

7.7 Mitigation techniques applicable to the Recommended Plan for the mitigation concepts presented in (ER) 1105-2-100 are discussed below.

Avoidance Techniques

7.8 Environmental windows associated with dredging operations are time constraints placed on dredging or dredged material placement operations, so that sensitive biological resources or habitats may be protected from potentially detrimental effects of these operations. The concept of an operational "window" is based on the assumption that detrimental effects on fish and wildlife resources may be avoided if dredging and placement operations are restricted to periods when biological resources are least sensitive to disturbance (Dickerson et al. 1998). The concept is also applicable in the form of location constraints dictated by proximity to sensitive biological resources or habitat.

7.9 State and Federal resource agencies began requesting observance of environmental windows soon after passage of NEPA in 1969. The practice has since become commonplace, affecting most Federal dredging projects. About 80% of all civil works O&M dredging projects are subject to seasonal environmental windows. Technical justifications given by resource agencies for specific environmental windows or location constraints may be categorized as follows: physical disturbance of nesting and spawning activities, habitat destruction, detrimental effects of suspended sediments, turbidity, sedimentation, hydraulic entrainment, vessel strikes, barriers to migration, reduced water quality, and impediments to recreational activity (Reine et al. 1998a).

7.10 For the purpose of protecting migration, spawning, and nesting activities, many resource agencies restrict dredging operations during the spring and summer months (i.e., March through

September) (Reine et al. 1998b, Sanders and Killgore 1989). Resource agencies may also impose restrictions in winter and spring to protect striped bass, American shad, Atlantic tomcod (spawning), winter flounder (spawning and entrainment), and blue crab. Restrictions during summer and fall might be imposed to protect weakfish from turbidity and reduced DO; sea turtles from entrainment; and nesting plovers, terns, and herons from physical disturbance (Reine et al. 1998b).

7.11 A review of conditions attached to previous permits indicates that a dredging window in combination with a location constraint is normally applied in the vicinity of Shooters Island: dredging within 1,000 feet of Shooters Island from March 1 through August 31 is prohibited. This condition is likely to be applied to the proposed project. This and any other environmental windows or location constraints will be specified in the state and Federal permits and approvals.

Minimization Techniques

7.12 Minimization techniques generally involve design modifications to reduce or minimize a project's adverse effects. Such modifications might include project redesign to avoid environmentally sensitive areas, or the elimination of certain aspects of a project due to unmitigatible or unacceptable significant impacts. Minimization techniques were incorporated into the initial screening of the alternatives (Section 2), where some alternatives were eliminated.

Restoration Techniques

7.13 Restoration refers to the rectification of project impacts during or immediately following project implementation. Under the proposed project, restoration will be implemented to address any unexpected consequences of temporary project elements. Techniques may include replanting of damaged ground surfaces, removal of construction-related (i.e., temporary) structures, or repair of construction-related damage.

Reduction or Elimination Techniques

7.14 The Recommended Plan will incorporate design and operational modifications to reduce or eliminate adverse effects of the project. Some of these modifications will be specified in the conditions and requirements of the regulatory agencies (e.g., permits), while others may be employed in addition to agency requirements. Examples of such modifications include:

- Monitoring and observance of water quality conditions and standards
- Employment of fish-deterrent systems during blasting
- Monitoring of blasting operations to control impacts to adjacent structures and historic properties
- Scheduling of blasting to minimize impacts on navigation
- Coordination of all dredging activities with the U.S. Coast Guard and local harbor authorities, to avoid interference with commercial traffic
- Requiring the dredging contractor to file and maintain an Incident Response Plan to cover spills and accidents, as well as Trash and Debris Management Plans

- Having contingency plans to address equipment failures, project delays, and encounters with unexpected bottom materials
- Implementation of BMPs

Compensation Techniques

General

7.15 Mitigation protocols established by USACE and regulatory agencies consider compensation for resource impacts only after avoidance, minimization, restoration, and reduction techniques have been fully considered. The unavoidable impacts to protectable resources that are expected to remain after consideration of the first four techniques must then be offset by compensatory mitigation. Compensation measures may be in-kind or out-of-kind. In-kind compensation refers to the creation or restoration of the same habitat type as the disturbed habitat type and preferably takes place in the vicinity of the impacted area. Out-of-kind compensation, on the other hand, refers to the creation or restoration of a habitat type that is different from the disturbed habitat type. Examples of out-of-kind compensation for this project include: intertidal or upland wetland creation or restoration; mitigation banking; creation of upland bird and wildlife habitat; shoreline stabilization or enhancement; and island and nearshore creation or restoration. In-kind is preferred over out-of-kind compensation because it results in a more direct replacement of the lost resource. Out-of-kind compensation may be selected, however, if in-kind compensation is less feasible or uneconomical. A combination of in-kind and out-of-kind compensation techniques may be selected. In any case, the habitat value of the created or restored habitat should be at least equivalent to the value of the mitigation goal.

7.16 The Mitigation Report describes in detail the compensation techniques that were considered for mitigation of impacts from the Recommended Plan. Conceptual designs of compensation mitigation techniques are also presented in this report. The following sections provide a summary of these techniques.

Littoral Zone Creation or Restoration

7.17 Creation or restoration of littoral habitat is the only type of in-kind mitigation applicable to this mitigation plan. Littoral zone restoration/creation involves the improvement of existing littoral habitat (0 to 6 ft MLW) or the creation of this habitat from some other habitat type. Restoration involves the identification of some limiting factor at a particular littoral zone site and the rectification of that factor or factors to increase the value of the habitat for fish and wildlife. Creation of littoral habitat would involve either filling deeper-water areas with sediment, preferably from nearby dredging activities, or deepening upland or intertidal areas to 0 to 6 ft MLW. The creation of littoral zone should involve careful consideration of the value of the existing habitat compared to the value of the littoral zone that would be created. Only habitats that are already degraded should be considered for littoral zone creation.

Intertidal Wetlands Creation or Restoration

7.18 Creation or restoration of intertidal wetland habitat is a mitigation technique that is commonly used for dredging projects. Creation might include the conversion of less valuable upland habitat to intertidal marsh-creek systems by grading uplands to suitable intertidal elevations. Restoration might include altering drainage systems, widening existing channels, or excavating new channels to change or improve creek system hydrodynamics. Similar to littoral-zone creation, the creation of intertidal wetlands should involve careful consideration of the value of existing habitat as compared to the value of the intertidal habitat that would be created.

Shoreline Stabilization/Enhancement

7.19 Shorelines that are prone to erosion may be stabilized with riprap, underwater dikes, or other slope-protection devices. If underwater dikes are used, dredged fill material could be placed behind the structure to enhance subaqueous habitat for benthos, fish, and birds, thereby providing an additional ecological benefit from this technique. Shorelines can also be stabilized by planting supplemental vegetation (e.g., saltmarsh cordgrass) along the shoreline. Once established, the root structures of the planted vegetation trap sediments and dampen wave energy, thereby reducing erosion and scour along the shoreline.

Island and Nearshore Creation or Restoration

7.20 Island and nearshore creation or restoration could potentially incorporate all of the in-kind and out-of-kind mitigation options discussed above, with the unifying theme that the activities would take place in or around an island ecosystem. Island restoration/creation might involve creating or restoring intertidal wetlands on the island, creating or restoring littoral habitat adjacent to the island, stabilizing eroding shorelines on the island, creating or restoring upland habitat on the island, or combining any or all of these options. Since islands serve as valuable nesting and nursery areas for many wildlife species, the restoration or creation of island and nearshore habitats has the potential to greatly increase the habitat value of these ecosystems.

Other Mitigation Measures

7.21 Although only minimal compensatory mitigation is likely to be required under state or Federal wetland regulations, the project's sponsoring agency has made clear its willingness to work with regional resource agencies to identify and address resource enhancement opportunities in the New York and New Jersey Harbor area. This intent has been demonstrated in the Mitigation Report.

7.22 Given the large volume of dredged material (including sand and rock) to be removed for the proposed project, a number of opportunities present themselves for the beneficial use of this material. In the DMMP for the Port of New York and New Jersey (USACE 1999a), the following beneficial use applications are identified:

- Beach nourishment
- Restoration of borrow pits

- Treatment of wetlands
- Creation of wetland habitat
- Recontouring for shallow- water habitat
- Filling dead-end basins
- Creation of artificial reefs
- Creation of bird habitat
- Creation of shellfish habitat
- Creation of mud flats
- Creation of oyster habitat
- Creation of Submerged Aquatic Vegetation (SAV)
- Ocean remediation
- Landfill, brownfield, quarry, and mine remediation
- Upland habitat creation or restoration (particularly at remediated landfills)

7.23 A beneficial use plan is not synonymous with a mitigation plan; a beneficial use evaluation is required for all DMMPs (USACE 1999b). The list of beneficial use options contained in the DMMP nevertheless provided a starting point for determining some of the compensation techniques that were considered for the mitigation plan for this project. The DMMP also provides options for the placement of additional dredged materials not specifically allocated for the compensatory mitigation techniques identified in the recommended mitigation plan. Similar to the compensation techniques described above, the DMMP also considers the implications of modifying one aquatic habitat type to benefit another. The tradeoff requires evaluation within the NEPA framework as the project options and alternatives are evaluated.

7.24 Some of the beneficial uses for dredged material have already been identified as compensatory mitigation measures. However, these compensatory measures will not utilize all material that will be produced from deepening and maintenance of the channels. Beneficial use of this additional material will be a priority for this project. Because of this, additional beneficial uses that will be considered for the project are described in detail in the Mitigation Report. They are summarized below.

Beach Nourishment or Replenishment

7.25 The technique of beach nourishment or replenishment involves the placement of sand or gravel on or adjacent to an eroding beach, with the intention of providing temporary protection to the shoreline or replacing material lost by erosion processes.

7.26 In general terms, beach replenishment projects fall into three categories: improvement of recreational beaches, flood prevention, and erosion compensation or protection. Each type of project has different requirements in terms of material characteristics, frequency of future replenishment, and placement locations. For the recreational beach, sand can be used and placed over a wide intertidal area. For flood protection, coarse materials are preferred and are placed above the high-water contour. Finally, for erosion protection or compensation, fine to coarse material may be placed in the breaker zone. Due to the dynamics of shoreline processes and the vulnerability of the project location(s), beach replenishment is generally a temporary solution, and the application of additional material is usually required at regular intervals in the future. In

conditions of equal exposure, coarse material is generally applied to steeper and more stable beaches, while fine sands are more appropriate for public beaches, where shoreline gradients are normally low and wave conditions moderate.

7.27 Selection of candidate sites for beach nourishment requires a thorough understanding of shoreline conditions and the needs of the beach users or the waterfront community. A gravel beach may provide a stable shoreline with infrequent replenishment needed but may not be acceptable for recreational use. On the other hand, a fine sand beach in an active wave area will require frequent replenishment and may therefore be unsatisfactory to the project sponsors. In general, it is recommended that beach replenishment material should match the existing beach material as closely as possible in order to maintain similar slopes and match the natural conditions of the area.

Construction of Artificial Reefs

7.28 Artificial reefs are constructed to enhance or increase the productivity of hard-bottom marine habitats, to provide shoreline protection, to channel shoreline currents, and to create recreational fishing and sport diving opportunities in coastal waters. The reefs also provide additional habitat, refuge, and feeding areas for resident and migratory fish. This is accomplished by placing suitable long-lived, stable, and environmentally safe materials (usually steel, concrete, or rock) on a selected area of ocean bottom. Once the material is in place, it acts in the same way that naturally occurring rock outcrops do in providing the hard substrate necessary for the formation of a live-bottom reef community.

7.29 When properly designed and placed, and if constructed with an adequate quantity of stable and durable substrate, manmade reefs can be as productive as naturally occurring hard-bottom habitats, limited only by the life-span of the materials used.

Filling of Subaqueous Pits using Dredged Material

7.30 The DMMP discussion on beneficial uses (USACE 1999b) evaluates the benefits and concerns associated with the use of dredged materials to fill subaqueous borrow pits previously created by sand mining and construction activities. These pits, which have been excavated below the natural contours of the Harbor bottom, are without navigational significance.

7.31 Flow velocities in borrow pits are generally lower than flows in the surrounding undisturbed (shallower) areas. The reduced flows can result in an increase in the hydraulic residence times of the borrow pits relative to normal conditions, with a concomitant reduction in borrow pit water quality. Reduced flow velocities also result in increased sedimentation rates in the borrow pits compared to the undisturbed areas around the pits. The sediment that accumulates within the pits tends to be fine-grained mud and silts that exert a greater benthic oxygen demand than sand and can result in lower dissolved oxygen within a pit. Before any commitment is made to the filling of a borrow pit, the status of the pit and the site-specific benefits that would be attained by filling it must be determined. While a number of pits show evidence of having lower organism abundance than surrounding areas (Bokuniewicz 1986), others have been characterized as "preferable benthic habitats" (Cerrato et al. 1989).

7.32 In the "best-case" scenario described in the DMMP, the borrow pit should be relatively deep, below the wave zone, and have steep sides. A thick cap over the borrow pit should consist of clean material of greater particle size than the surrounding area. By optimizing these criteria, the report concludes, a filled borrow pit could provide a stable undisturbed containment area, where wave action, bioturbation, and tidal currents would not affect deposited materials.

7.33 USACE-NYD has characterized the candidate pits in the New York and New Jersey Harbor by volume, stability, sediment type, hydrodynamics, and benthic and fish communities.

7.3 Evaluation of Projected Impacts

7.34 Based on the results of hydrodynamic modeling, environmental evaluation, and planimetric analysis of the preliminary construction drawings, the potential environmental impacts related to the proposed navigation channel improvements have been assessed. They are described in Section 6.

7.35 As described in Section 6, habitat disturbance has been evaluated for intertidal (MHW to MLW) and littoral (MLW to a depth of 6 ft MLW) wetlands. A determination of disturbed wetlands within each of the defined areas is presented in Table 7.2-1. Based on sampling efforts and modeling, a preliminary assessment indicates that no impacts will occur to intertidal wetlands, but that 6.26 acres of littoral wetlands will be disturbed. Of this, approximately 4.7 acres will be disturbed in New Jersey, and 1.56 acres in New York.

7.36 USACE regulation (ER) 1105-2-100 (USACE 1990, 1997) requires that, following the determination of environmental quality changes related to implementation of the proposed project, the current and future conditions of the impacted indicator be determined. To address this requirement, a functional assessment technique was needed to determine the *value* of the littoral zone wetlands expected to be disturbed by the project. This habitat value is used to determine the type and amount of compensation required. Since no approved Habitat Evaluation Procedure (HEP) technique for the assessment of littoral zone wetlands was available, a functional assessment questionnaire was developed specifically for this project. Questions were derived from other assessment methods (mainly the Wetland Evaluation Technique [WET]) and from previously observed or documented wetland functions in the project area. The habitat values resulting from the functional assessment are expressed in Habitat Units (HUs).

7.37 In addition to assessing the value of the littoral habitat that would be disturbed as a result of the project, a purpose of the functional assessment is to predict the value to be gained by the compensatory mitigation options considered for the project. Since both in-kind (littoral zone) and out-of-kind (intertidal zone) compensation measures were considered, the functional assessment was developed to assess the value not only of littoral habitat, but also of intertidal habitat). The maximum total habitat value (in HUs) is the same for both intertidal and littoral habitat. This is based, in part, on Title 6, Part 661 of New York State Regulations, which state that "some...littoral zones are areas of extremely high biological productivity and are nearly or equally as important in this respect as intertidal marshes...." The equivalence of the maximum

total value for the two habitat types allows for a direct comparison between the value of the impacted areas and the value to be gained by compensatory mitigation.

7.38 The functional assessment for the littoral zone disturbance areas does not address the potential for sedimentation to return the bottom contours to pre-disturbance conditions. It was assumed that any areas of the littoral zone that would initially become deeper than 6 ft MLW as a result of dredging would not return to a depth of less than 6 ft MLW by natural sedimentation. In addition, although only a portion of the disturbed littoral zone would actually become deeper than 6 ft MLW, it was assumed that the entire area of the disturbed littoral zone would in fact become deeper than 6 ft MLW.

7.39 On 8, 9, and 10 September 1999, the identified littoral zone disturbance areas were examined around low tide, and a Functional Assessment Questionnaire was completed for each area. Details of the actual assessment methods are described in the Mitigation Report. Completion of the questionnaires resulted in a raw score being assigned to each area. This raw score for each location was then multiplied by its corresponding area (in acres) to obtain a value in HUs for each location. These values were then summed to obtain an overall value of 109.55 HUs for the littoral zone disturbances projected to result from the project. The habitat value of each of the disturbed areas is summarized in the table below:

Functional Assessment of Disturbed Littoral Zone Areas (0-6 ft MLW)

ASSESSMENT AREA	RAW SCORE	AREA (ac.)	HABITAT UNITS
Elizabeth Channel:			
Site 1 – Elizabeth Channel	13.9	0.35	4.87
Subtotal:			**4.87**
Newark Bay Channel:			
Site 1 – West Side of Newark Bay Channel, South Reach	16.7	2.62	43.75
Subtotal :			**43.75**
Elizabeth River:			
Site 1 – Mouth of the Elizabeth River	14.0	0.53	7.42
Subtotal:			**7.42**
Arthur Kill Channel to Howland Hook:			
Site 1 – South of Channel, Port Ivory East to Shooters Island Split	25.0	0.77	19.25
Site 2 – North of Channel, from Shooters Island Split East	18.1	0.90	16.29
Site 3 – South of Channel, East of Shooters Island Split	13.8	0.46	6.35
Site 4 – South of Channel, West of Port Ivory to Howland Hook	26.0	0.24	6.24
Site 5 – North of Channel, Opposite Shooters Island Split	16.2	0.12	1.94
Site 6 – North of Channel, East of Elizabeth Memorial Park	19.1	0.18	3.44
Subtotal:			**53.51**
TOTAL HABITAT UNITS:			**109.55**

7.4 Mitigation Planning

Objectives

7.40 The objective of the mitigation plan is to compensate for the unavoidable impacts to ecological resources that will remain after avoidance, minimization, reduction/elimination, and restoration techniques are fully considered and implemented to the extent possible. As discussed previously, USACE regulation (ER) 1105-2-100 states that full credit shall be given to the beneficial aspects of an alternative plan, or project, before consideration is given to adding separable mitigation features. However, regardless of such beneficial aspects, the guidelines contain very distinct requirements for wetlands. Specifically, the mitigation plan must ensure that adverse impacts to wetland resources are fully mitigated, and an effort must be made to meet the administration's goal of no net loss of wetlands.

7.41 The primary mitigation objective for this project, therefore, is to provide replacement for the loss of littoral zone habitat as a result of project implementation. This objective not only encompasses the goal required of replacing the 109.55 HUs calculated to be lost, but also includes a goal of providing no less than acre-for-acre compensation, and a general preference for in-kind over out-of-kind compensation.

7.42 After the compensation measures to mitigate projected loss of wetlands were selected, an evaluation was made as to whether additional mitigation might be required to compensate for other projected impacts, such as sublittoral zone disturbances, or impacts to Essential Fish Habitat. In compliance with USACE regulations, the beneficial aspects of the plan, such as beneficial uses of dredged materials, were given full credit in order to determine the need for additional mitigation.

Selection of Mitigation Sites

7.43 As discussed previously, the following compensation options were considered for mitigation of wetlands for this project:

- Littoral zone creation or restoration
- Intertidal wetlands creation or restoration
- Shoreline stabilization/enhancement
- Creation/restoration of island or nearshore habitat

7.44 Numerous potential mitigation sites exist in the study area. Environmental resource agencies and other groups have previously identified many of the sites as their preferred mitigation sites based on their agency or group-specific criteria. Other sites have also been identified in conjunction with mitigation plan development for other water resources projects in the Harbor region (USACE 1997a,b; USACE 1999c). The project team used the previously developed lists and some of its own criteria and observations to identify 7 littoral zone restoration/creation sites, 11 intertidal wetland restoration/creation sites, 8 shoreline stabilization/enhancement sites, and 7 island restoration sites as potential sites for the project.

7.45 Once the list of 33 potential mitigation sites was compiled, the sites were further evaluated for their applicability to this mitigation plan and for their potential for success. A variety of screening criteria were used to narrow down the list of potential mitigation sites to a smaller list of preferred sites to be carried through the habitat evaluations (functional assessments) and incremental cost analyses. These screening criteria included:

- Proximity to the project area
- Whether a site has already been selected for another project
- Potential for a significant increase in habitat value from restoration.

7.46 After the list of sites was narrowed down using the above three criteria, consideration was given to the equitability of distribution of resulting site locations between New York and New Jersey. It became evident that, on the basis of the first three screening criteria, a significantly greater number of sites was located in New York. Two large New Jersey sites (Marquis Creek and Cheesequake Marsh) that had initially been screened out for lack of proximity to the project area were therefore added to the list, creating a more balanced distribution of preferred mitigation sites between the two states. The table below lists the preferred mitigation sites that were retained as a result of the screening process:

List of Preferred Mitigation Sites

Type of Site	Site Name	Location	Estimated Size after Mitigation (acres)
Littoral Zone Restoration/ Creation	West New Brighton	Staten Island, NY	2.3
	Elm Park	Staten Island, NY	1.8
	Mariner's Harbor	Staten Island, NY	4.6
	Howland Hook	Staten Island, NY	8.3
	South of Goethals Bridge	Linden, NJ	3.0
	Veterans Park	Bayonne, NJ	1.0
Intertidal Wetland Restoration/ Creation	Old Place Creek	Staten Island, NY	50
	Woodbridge River	Woodbridge, NJ	16
	Cheesequake Marsh	Sayreville, NJ	125
	Marquis Creek	Old Bridge, NJ	50
Shoreline Stabilization	Old Place Creek	Staten Island, NY	9.2
Island Restoration	Shooters Island	North of Staten Island, NY	20

Functional Assessments of Mitigation Sites

7.47 In order to develop plan costs and establish the HU differential resulting from implementation of mitigation measures at each site, a baseline functional assessment was conducted for each of the preferred mitigation sites. The baseline functional assessment assisted in the identification of site conditions that could be improved by implementation of mitigation measures. The mitigation measures proposed for each site are listed in the table below. Details and conceptual designs for each site are provided in the Mitigation Report.

Mitigation Measures Proposed for Preferred Mitigation Sites

Type of Site	Site Name	Proposed Mitigation Measures
Littoral Zone Restoration/ Creation	West New Brighton	Drift removal; install dike and fill to create/stabilize littoral habitat; benthic substrate enhancement; shoreline revegetation
	Elm Park	Drift removal; install dike and fill to create/stabilize littoral habitat; repair shoreline structure; benthic substrate enhancement; shoreline revegetation
	Mariner's Harbor	Same as Elm Park
	Howland Hook	Same as Elm Park
	South of Goethals Bridge	Install dike and fill to create/stabilize littoral habitat; Remove piers (leave pilings for fish cover); shoreline plantings
	Veterans Park	Benthic substrate enhancement; install structure to protect area from wind/waves; shoreline plantings
Intertidal Wetland Restoration/ Creation	Old Place Creek	Improve existing & excavate new channels; remove existing dikes; *Phragmites* control; lower ground surface; improve adjacent uplands
	Woodbridge River	Excavate new channels; *Phragmites* control; improve adjacent uplands
	Cheesequake Marsh	Improve existing & excavate new channels; locall regrade soil piles; lower ground surface; *Phragmites* control
	Marquis Creek	Excavate new channels; *Phragmites* control; create public access; improve adjacent uplands
Shoreline Stabilization	Old Place Creek	Install riprap; install submerged dike and fill
Island Restoration	Shooters Island	Drift removal; install flow training dike and fill to create/stabilize littoral habitat; benthic substrate enhancement; shoreline revegetation

7.48 Another functional assessment for each of the preferred mitigation sites was then conducted. This second assessment assumed that the recommended mitigation measures were implemented and successful. The theoretical post-mitigation increase in HUs was obtained by subtracting the baseline HU value from the estimated post-mitigation HU value for each site. The results of the baseline and post-mitigation functional assessments for the preferred mitigation sites are presented in the table below:

Functional Assessment Results for Preferred Mitigation Sites					
Type of Site	Name/Location	Size (acres) After Mitigation	Before Mitigation Score (HUs)	After Mitigation Score (HUs)	Habitat Units Gained from Mitigation
Littoral Zone	West New Brighton	2.3	32.2	57.7	**25.5**
	Elm Park	1.8	36	56	**20**
	Mariner's Harbor	4.6	64.4	115.5	**51.1**
	Howland Hook	8.3	181.8	234.1	**52.3**
	So. of Goethals Bridge	3.0	22.6	62.7	**40.1**
	Veterans Park	1.0	18.1	28.2	**10.1**
Intertidal Wetlands	Old Place Creek	50	800	1,288	**488**
	Woodbridge River	16	286	330	**44**
	Cheesequake Marsh	125	1,944	2,340	**396**
	Marquis Creek	50	1,102.5	1,494.5	**392**
Shore Stabilization	Old Place Creek	0.45	0	11.9	**11.9**
Island Creation / Restoration	Shooters Island	20	394	586	**192**

Economic Analysis

7.49 Mitigation planning differs from traditional USACE planning studies, since mitigation outputs typically cannot be expressed in monetary terms. In practice, USACE mitigation studies often measure the ecosystem effects of alternative plans in terms of physical dimensions, population counts, or various habitat-based scores. To promote effective decision-making for environmental mitigation, USACE environmental planning has incorporated Cost Effectiveness/ Incremental Cost Analysis (CE/ICA) to compare relative costs and outputs of alternative mitigation plans.

7.50 CE/ICA generates information that supports sound financial investments by comparing costs and non-monetary outputs of alternative investment choices. CE/ICA is conducted in a series of steps that progressively identify alternatives that meet specified criteria and screen out those that do not. These analyses help determine whether additional environmental outputs for increasing levels of mitigation are worth the additional monetary cost. Although neither cost-effectiveness nor incremental cost analysis necessarily results in identification of a single "best" alternative, the analyses contribute to informed decision-making for environmental mitigation.

7.51 The USACE Institute for Water Resources (IWR) has developed a computer model, *IWR-PLAN*, to facilitate incorporation of CE/ICA into the environmental planning process. *IWR-PLAN* may be used to: (1) formulate alternative plans by evaluating potential combinations of mitigation measures and a variety of scales of individual measures; (2) perform cost-effectiveness analysis over the spectrum of potential mitigation plans; and (3) conduct incremental cost analysis on cost-effective plans. The *IWR-PLAN* software identifies the set of

the most cost-effective combinations of sites or plans, out of all the possible combinations of sites or plans, given the constraints imposed on the system by the programmer.

7.52 Constraints imposed upon the system for the Harbor navigation project were as follows:

- A total of at least 110 HUs must be gained by the mitigation plan. This constraint ensures that the mitigation plan creates more HUs than were impacted by the navigation project (109.55 HUs).

- The mitigation plan must offer at least 7 acres of mitigation. This constraint ensures that the mitigated acreage is at least as large as the impacted acreage (6.26 acres).

- At least 3 acres of littoral zone mitigation must be accomplished by the mitigation plan. This constraint ensures a minimum level of in-kind mitigation (approximately 50% of the impacted acreage).

- The ratio of mitigated acres in New Jersey to mitigated acres in New York must be between 2.4 and 3.6. This constraint maintains the parity with the ratio of impacted acres in New Jersey to impacted acres in New York (NJ/NY ratio = 3.0).

7.53 The results of the economic analysis indicate that the least cost plan includes the following mitigation sites:

- Woodbridge
- Mariner's Harbor
- South of Goethals Bridge

7.54 Table 7.4-1 provides the results of the incremental cost analysis, and Figure 7.4-1 illustrates the average annual incremental cost per additional habitat unit for the plans indicated in Table 7.4-1.

Recommended Mitigation Plan

Selection of the Recommended Compensation Plan

7.55 The plan that was selected as the recommended plan for compensating for 6.26 acres of disturbed littoral habitat is the same as the least cost plan. This plan, which includes the Woodbridge, Mariner's Harbor, and South of Goethals Bridge sites, provides for a total of 137.5 HUs and 18.6 acres of mitigation, of which 7.6 acres would be in-kind. An evaluation of the average annual incremental cost per additional habitat unit gained indicated that, of all the cost effective plans, the next cost effective plan after the least cost plan is one that includes a significantly greater number of habitat units (1316 HUs). However, this plan was not selected over the least cost plan due to a drastic increase in total cost and a relatively large incremental cost per additional habitat unit gained.

Description of the Recommended Compensation Plan

7.56 The mitigation measures to be performed at the three mitigation sites that are included in the recommended mitigation plan are indicated in the table below:

Recommended Mitigation Plan				
Site Name	**Type of Site**	**Mitigation Measures**	**Acres**	**HU Gain**
Woodbridge	Intertidal wetland restoration	Excavate new channels; *Phragmites* control; improve adjacent uplands	11	44
Mariner's Harbor	Littoral zone restoration	Drift removal; install dike and fill to create/stabilize littoral habitat; repair shoreline structure; benthic substrate enhancement; shoreline revegetation	4.6	51.1
South of Goethals Bridge	Littoral zone restoration/creation	Install dike and fill to create/stabilize littoral habitat; remove piers (leave pilings for fish cover); shoreline plantings	3	40.1

Conclusions

7.57 In compliance with USACE Engineering Regulation (ER) 1105-2-100, full credit will be given for the beneficial aspects of the project before consideration is given to adding separable mitigation features beyond those required for the wetlands disturbances. One such beneficial aspect of this project is the beneficial use of dredged materials that will be produced during channel construction. Although it is anticipated that dredged materials produced during construction will be used for the compensatory mitigation measures identified in the recommended mitigation plan, these mitigation measures will not utilize nearly the entire volume of dredged materials that will be produced. As described in Section 7.2, the remaining dredged materials will be utilized for a variety of additional beneficial uses, including beach nourishment/ replenishment, construction of artificial reefs, and filling of degraded subaqueous pits. It should also be noted, as discussed in Section 6, that the acreage estimates for the projected disturbances to littoral and sublittoral habitat are overestimated, since a portion of the 6.26 acres of disturbed littoral habitat will remain at a depth less than 6 ft below MLW, and a portion of the 42.03 acres of disturbed sublittoral habitat will remain at a depth of between 6 and 15 ft below MLW. Furthermore, a portion of the littoral habitat that *will* become deeper than 6 ft below MLW will actually become sublittoral habitat, thereby further decreasing the actual net acreage of sublittoral habitat that will be lost. Finally, since the number of acres included in the recommended mitigation plan (18.6 acres) is approximately three times the disturbed littoral wetland acreage, credit for this additional acreage must also be taken. It is anticipated that the benefits derived from an extra 12.34 acres of wetlands restoration and the beneficial uses of the large volume of additional dredged materials, in light of the fact that the true net loss of littoral and sublittoral habitat will actually be less than the estimated disturbed acreages, will outweigh the adverse effects of the non-wetland disturbances, such as impacts to Essential Fish Habitat and disturbances of sublittoral habitat, that are expected to result from the project.

7.5 Cultural Resources Mitigation Plan

7.58 Cultural resources investigations conducted for the New York and New Jersey Harbor Navigation Study and other navigation projects in the port have identified historic properties listed or eligible for listing on the National Register of Historic Places (NRHP) within the Area of Potential Effect (APE). The areas comprising the APE that will be impacted by project actions such as channel deepening are within and adjacent to the Ambrose, Arthur Kill, Kill Van Kull, Newark Bay, Port Jersey, and Bay Ridge Channels as well as in the Bay Ridge/Red Hook and Gravesend Anchorage Areas. Historic properties within the APE include abandoned vessels and shipwrecks, waterfront structures such as wharves and piers, historic structures and buildings, and submerged land surfaces, which may be sensitive for prehistoric materials and paleoenvironmental data. Within the vicinity of the APE are National Historic Landmark properties such as the Statue of Liberty and Ellis Island, and NRHP-eligible historic properties such as Bush Terminal and the Greenville Yards. Recommended project actions, including channel deepening, widening, and realignment, would be implemented through excavation and dredging techniques, preceded, in areas with unfractured rock, by blasting. All mitigation measures have been outlined in a Programmatic Agreement (PA). This draft of this document was reviewed by the both SHPOs and NYCPLC. The final version will be routed for signature.

Prehistoric Resources

7.59 Geomorphological studies were undertaken to identify locations within the APE that are potentially sensitive for prehistoric resources (Geoarchaeology Research Associates, Inc. 1999). On the basis of these evaluations, the mudflats at Port Jersey, Newark Bay, Anchorage Channel, and the sideslopes of the Kill Van Kull are anticipated to include submerged land surfaces that date to periods in prehistory (Paleoindian and early to mid-Archaic) for which there is a paucity of information in the New York and New Jersey region. The data retrieved from the Ambrose Channel to date have been inconclusive, and further borings are recommended. A survey conducted in connection with the DMMP provides further information on the sensitivity of the Harbor for submerged prehistoric resources (LaPorta, Sohl and Brewer 1999). The DMMP study indicated that within the New York and New Jersey Harbor Navigation Study APE, the Bay Ridge/Red Hook Channel is a sensitive location. Any data sets relating to human occupation and activities during these eras are therefore potentially eligible under Criterion D of the NRHP due to their capacity to provide scientific information on the life and culture of indigenous peoples before the advent of written records. Portions of these sensitive areas will be impacted by channel realignment or widening.

7.60 Mitigation of these impacts will consist of a data recovery program. In order to focus data sampling and interpretation, the sensitivity models developed in previous geomorphologic studies for the Harbor Navigation Study, DMMP, and other related projects (Wagner and Siegal 1996, LaPorta, Sohl and Brewer 1999, Geoarchaeology Research Associates, Inc. 1999) will be refined and calibrated using a limited number of specifically located borings. Recovered data will be entered into a Geographic Information System (GIS) to facilitate the correlation to known archaeological sites and resources as well as to aid in efficient project management over the life of the Harbor Navigation Study.

7.61 Sensitive portions of the Arthur Kill, just northeast of Shooters Island, were investigated in the autumn of 1999 as part of the Arthur Kill 40-41 ft channel deepening. No further work, therefore, will be required for prehistoric resources along this channel as part of the Harbor Navigation Study. Results of this investigation will be available in early 2000.

7.62 The South Elizabeth Channel will require further studies, in the form of borings and analyses.

Historic Resources

7.63 The APE includes many channels and shorelines previously inventoried for historic properties as part of other projects (Brouwer 1981, 1983; Flagg 1986; Henn 1985; Kardas and Larabee 1977, 1978, 1979, 1980, 1983, 1985a, 1985b; Louis Berger and Associates, Inc. 1983; HAER, n.d; Panamerican Consultants, Inc. 1991, 1999; Raber Associates, Inc. 1984, 1985a 1985b, 1985c, 1996a, 1996b, 1996c; Rockman and Rothschild 1979; Wegman Engineers 1983). In particular, channel widening may impact historic resources identified as eligible for the NRHP through surveys conducted for the USACE Collection and Removal of Drift Project. The potential for impacts to abandoned shipwrecks and waterfront structures is highest along the Kill Van Kull and Arthur Kill. A PA is already in place between USACE-NYD and both the New York and New Jersey State Historic Preservation Offices (SHPOs) regarding work in this area. The Bay Ridge channel also has potential for historic nearshore resources.

7.64 In order to locate buried shipwreck sites and abandoned vessels that may be affected by channel widening actions, remote sensing surveys will be conducted. The Mitigation Plan will include development of strategies for evaluating the NRHP eligibility of these resources and appropriate data recovery measures. Possible locations of buried historic properties include the mud flat areas near the Port Jersey, South Elizabeth, Ambrose and Anchorage Channels and possibly Newark Bay.

Monitoring Program

7.65 Detailed engineering and design documentation will define areas for which blasting is required as part of construction. Construction specifications will require that blasting be conducted according to BMPs to avoid vibration impacts to upland buildings and structures. To identify structures eligible for the NRHP, architectural surveys will be conducted for the upland areas adjacent to channel reaches where blasting will be conducted. To ensure that no impacts result from construction, these structures will be subject to monitoring during blasting. To date, the monitoring of blasting effects has been coordinated with the appropriate SHPO along the Kill Van Kull and part of Newark Bay.

INDEX

B

Beach nourishment or replenishment..... 6–7

C

Constraints on mitigation planning..... 15
Cultural resources mitigation plan.....17–18

D

DMMP.....6, 7, 8, 17
Dredging windows..... 2–3

E

Economic analysis 14–15
Environmental mitigation, concepts 1–8
  avoidance..... 2–3
  compensation..... 4–8
  minimization..... 3
  overview 1–2
  reduction or elimination..... 3–4
  restoration 3

F

Functional assessment..... 8–10

I

Intertidal wetlands, creation or restoration 5
Island and nearshore creation/ restoration 5

L

Littoral zone creation or restoration..... 4

M

Mitigation planning 10–15

P

Pits, subaqueous, filling..... 7–8

R

Reef construction..... 7

S

Shoreline stabilization/enhancement 5
Site selection and screening.....11–14

TABLE 7.2-1 Disturbed Areas By Depth		
	Disturbed Areas	
Channel	Intertidal Zone (MHW to MLW)	Littoral Zone (MLW to -6ft)
Ambrose	0.0	0.0
Anchorage	0.0	0.0
Bay Ridge & Red Hook	0.0	0.0
Port Jersey	0.0	0.0
Kill Van Kull	0.0	0.06
Arthur Kill to Howland Hook	0.0	3.23
Newark Bay	0.0	2.72
South Elizabeth	0.0	0.0
Port Elizabeth	0.0	0.25
Totals	0.0	6.26

TABLE 7.4-1 (Page 1 of 2)

Results of the Incremental Cost Analysis

ID #	Mitigation Sites	HUs Gained	Total Acres	In-Kind (Littoral) Acres	NJ/NY Acres Ratio	Average Annual Incr. Cost	Average Annual Incr. Cost/HU
1	E,J,L	137.5	18.6	7.6	3.0		
19	B,C,D,L	1316.1	176	3	2.8	$678,896	$576
23	B,C,D,E,L	1360.1	187	3	3.1	$743,187	$608
20	B,C,D,L,N	1326.2	177	4	2.8	$729,647	$614
21	B,C,D,J	1329.4	177.6	4.6	2.5	$733,813	$616
22	B,C,D,I,L	1337	177.8	4.8	2.7	$741,549	$618
24	B,C,D,E,L,N	1370.2	188	4	3.1	$793,938	$644
25	B,C,D,E,J	1373.4	188.6	4.6	2.7	$798,104	$646
26	B,C,D,E,I,L	1381	188.8	4.8	2.9	$805,840	$648
27	B,C,D,E,K	1384.8	192.3	8.3	2.5	$822,217	$659
28	B,C,D,E,I,L,N	1391.1	189.8	5.8	3.0	$856,591	$683
29	B,C,D,E,I,J	1394.3	190.4	6.4	2.6	$860,757	$685
31	B,C,D,E,J,L	1413.5	191.6	7.6	2.8	$878,062	$688
30	B,C,D,E,K,N	1394.9	193.3	9.3	2.6	$872,968	$694
32	B,C,D,E,K,L	1424.9	195.3	11.3	2.6	$902,175	$701
33	B,C,D,E,I,J,L	1434.4	193.4	9.4	2.7	$940,715	$725
34	B,C,D,E,K,L,N	1435	196.3	12.3	2.6	$952,926	$734
35	B,C,D,E,I,K,L	1445.8	197.1	13.1	2.5	$964,828	$737
36	B,C,D,E,H,K,L	1449.2	197.6	13.6	2.5	$1,007,680	$768
37	B,C,D,E,I,K,L,N	1455.9	198.1	14.1	2.5	$1,015,579	$770
38	B,C,D,E,H,I,J,L	1458.7	195.7	11.7	2.6	$1,046,220	$792
39	B,C,D,E,H,K,L,N	1459.3	198.6	14.6	2.5	$1,058,431	$801
40	B,C,D,E,H,I,K,L	1470.1	199.4	15.4	2.4	$1,070,333	$803
41	B,C,D,E,J,K,L,N	1488.4	200.9	16.9	2.4	$1,087,801	$805
42	B,C,D,E,H,I,K,L,M,N	1492.1	200.85	16.4	2.4	$1,245,748	$920

Table 7.4-1 (Page 2 of 2)

Results of the Incremental Cost Analysis

ID #	Mitigation Sites	HUs Gained	Total Acres	In-Kind (Littoral) Acres	NJ/NY Acres Ratio	Average Annual Incr. Cost	Average Annual Incr. Cost/HU
5	B,I,J,K	531.1	63.7	14.7	3.3	$384,246	$976
9	C,I,O	608.9	99.8	21.8	3.6	$461,696	$979
8	B,O	584	69	20	2.5	$441,508	$989
11	B,E,O	628	80	20	3.0	$505,799	$1,031
12	C,J,O	641.4	102.6	24.6	3.2	$533,918	$1,060
10	C,H,O	612.3	100.3	22.3	3.5	$504,548	$1,063
6	B,H,J,K	534.5	64.2	15.2	3.2	$427,098	$1,076
7	BIJKN	541.2	64.7	15.7	3.4	$434,997	$1,078
13	C,K,O	652.8	106.3	28.3	2.8	$558,031	$1,083
14	B,E,L,O	668.1	83	23	3.2	$585,757	$1,104
16	C,E,K,O	696.8	117.3	28.3	3.1	$622,322	$1,113
15	C,J,L,O	681.5	105.6	27.6	3.3	$613,876	$1,128
17	C,E,I,J,O	706.3	115.4	26.4	3.4	$660,862	$1,162
18	C,E,K,N,O	706.9	118.3	29.3	3.2	$673,073	$1,182
2	E,J,L,N	147.6	19.6	8.6	3.3	$50,751	$5,025
4	E,J,L,M,N	159.5	20.05	8.6	3.0	$175,415	$7,973
3	E,J,L,M	149.4	19.05	7.6	2.8	$124,664	$10,476

B = Marquis Creek, C = Cheesequake Marsh, D = Old Place Creek (intertidal), E = Woodbridge, H = West New Brighton, I = Elm Park, J = Mariner's Harbor, K = Howland Hook, L = South of Goethals Bridge, M = Old Place Creek (shoreline stabilization), N = Veterans Park, O = Shooters Island

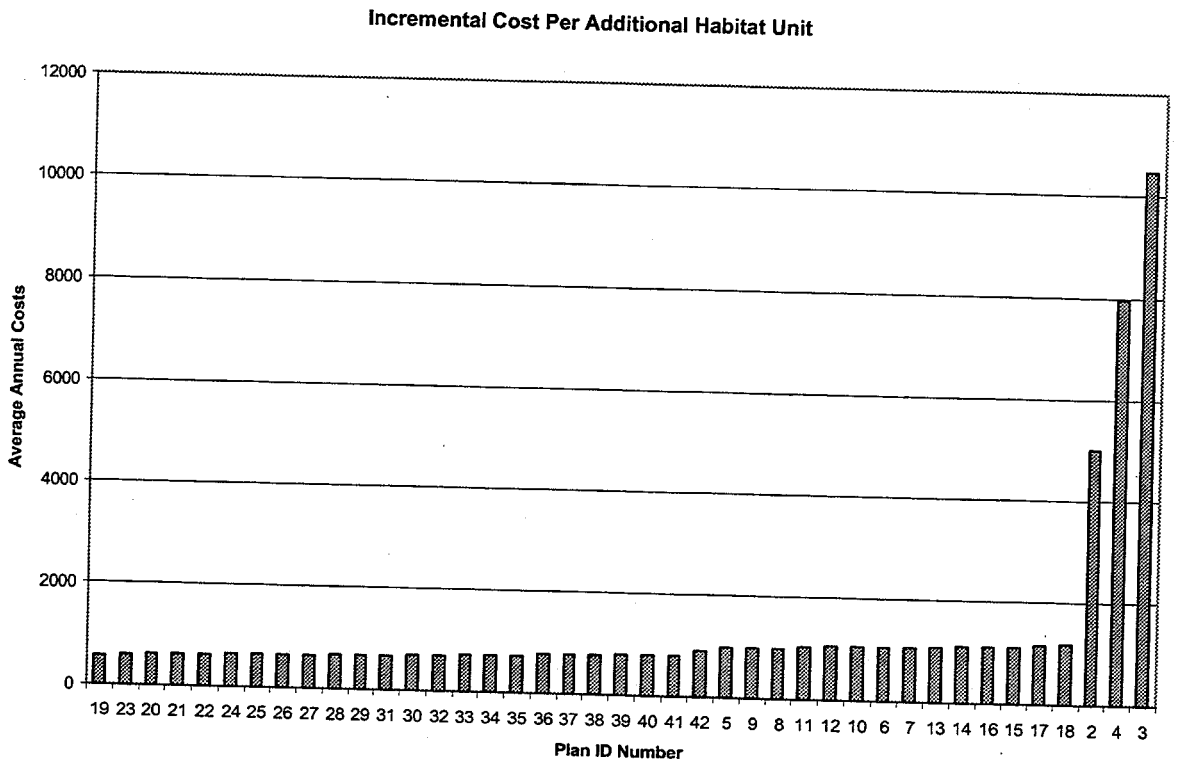


Figure 7.4-1 Incremental cost per additional habitat unit

8 REQUIREMENTS FOR PROJECT IMPLEMENTATION

8.1 Project Implementation

8.1 In developing the Recommended Plan for New York and New Jersey Harbor navigation channel improvements, the USACE-NYD evaluated a number of alternatives. The results of this analysis are presented earlier in this EIS and in the Main Report. The proposed project, which is the result of both economic and environmental screening, calls for the deepening of nine navigation channels to facilitate the movement of cargo through the New York and New Jersey Harbor. If the proposed project is authorized, the following may be required before the project can be implemented:

Non-Federal Sponsorship

8.2 The implementation of Federal projects requires a non-Federal partner. Currently, the states of New York and New Jersey, PANYNJ, and the City of New York are expected to act in concert as non-Federal project sponsors. The Main Report provides additional information on sponsorship requirements and on cost apportionment. Design and Project Cooperation Agreements must be executed among all parties prior to both the Pre-construction Engineering and Design (PED) phase and the construction phase.

Schedule for Design and Construction

8.3 Following completion of the feasibility phase, the District will enter the Pre-Construction and Engineering (PED) phase. Entry into this phase requires that a Design Agreement be executed with the projects non-Federal partner. The purpose of the PED phase is to conduct sufficient engineering design and environmental work necessary to prepare the first set of construction plans and specifications. The phase is expected to last from one to two and one half years, during which time project authorization is expected. The Project Cooperation Agreement will also be executed during the PED phase and marks the completion of that phase.

8.2 Management of Dredged Material

8.4 Deepening of the New York and New Jersey Harbor navigation channels will require the subsequent management of approximately 51 MCY of dredged material. A description of potential dredged material management alternatives is presented and discussed in the Port of New York and New Jersey DMMP and in Appendix B-1.5. The production of structural or nonstructural fill, manufactured soil or using, processing, or transferring dredged material in New Jersey requires an Acceptable Use Determination (AUD) from the NJDEP (NJDEP 1977). The AUD must be obtained prior to any activity using dredged material from the tidal waters of New Jersey and adjacent interstate waters.

8.3 Best Management Practices

8.5 Best Management Practices (BMPs) are procedures that minimize the potential for adverse environmental impacts from dredging and dredged material management operations, or reduce their

magnitude. BMPs for the proposed project, which will follow New Jersey and New York State guidelines, are likely to be included as permit conditions.

8.6 The following BMP summaries may be applicable to the dredging and placement operations of the selected alternative:

- ***Closed Environmental Dredge Bucket:*** The use of a closed environmental dredge bucket, applicable for the dredging of contaminated sediments, reduces the suspension of solids at the dredging site. A closed dredge bucket is required where a no-barge-overflow permit condition is in effect (see below).

- ***Dredging Practices:*** Certain procedures may be employed to minimize the creation and dispersal of suspended sediments when using a dredge in fine-grained or contaminated sediments. The following dredging practices are expected to be applicable for most Harbor sediments:

    - maximizing the size of the "bite" taken by the dredge bucket, thereby reducing the number of bites needed to dredge a particular volume of sediment;

    - keeping the hoist speed under 2 feet per second;

    - eliminating the hosing down or rinsing of sediments from the sides and gunwales of the barge while at the dredge site.

- ***Elimination of Barge-overflow:*** The elimination of barge-overflow reduces the creation and dispersal of suspended sediments when finer-grained sediments are dredged. Barge-overflow would not be permitted when the dredged material is contaminated at levels warranting concern (NJDEP 1997). A no-barge-overflow permit condition is possible for dredging of surficial sediments throughout the Harbor. In the Ambrose and Anchorage Channels, however, due primarily to the presence of sand and to low sediment contamination, the imposition of a no-barge-overflow condition is not anticipated. Nor is it likely that no-barge-overflow will be required for the dredging of deeper, previously undisturbed sediments or sand.

- ***Shunting:*** Decant water would be shunted to minimize resuspension of sediments in the upper water column. Diffusers would be employed to reduce the potential for additional disturbance of benthic sediments.

- ***Barge/Scow Type:*** The type of barge used would depend on the placement option selected. It is anticipated that barges or scows would be of solid hull construction or would be sealed, unless open-water placement is approved. Split-hull barges would be used only for the placement of suitable material at the HARS, for the creation of artificial reefs, or for HARS-unsuitable material in sub-channel placement cells, should that option be chosen.

- ***Point Placement:*** Strict navigational requirements designed to ensure point placement of dredged material at the HARS, at artificial reefs, or at subaqueous placement facilities are

anticipated. It is expected that such point placement would be accomplished by means of a Differential Global Positioning System (DGPS).

- ***Weather and Tide Restrictions:*** Dredging and dredged material placement operations may be restricted by severe weather or tidal conditions. High wind speeds and unusually high tidal ranges (such as those that occur during severe storms or during particular spring tides) may result in increased current in open-water placement sites, with consequent movement of suspended sediments away from the placement area. Permit conditions related to weather and tides are possible. It is likely that weather conditions severe enough to adversely affect placement operations would also curtail dredging.

- ***Silt Curtains:*** Silt curtains or turbidity barriers are vertical barriers designed to enclose or contain turbid water generated by a dredging operation. They are also used to protect adjacent critical resources, including sensitive wetlands and tributaries. The State of New York requires the use of silt curtains (where feasible) for dredging within the Arthur Kill and Upper and Lower New York Bays.

- ***Dredging Inspector:*** Onboard inspectors will be assigned to dredging and dredged material placement activities as required.

- ***Dredging (Environmental) Windows***: To avoid interference with anadromous or other migratory finfish, nesting shorebirds, overwintering waterfowl, and other fauna, dredging and dredged material placement operations may be limited to seasonal biological "windows" in some areas of New York and New Jersey Harbor

8.7 Other BMPs to be incorporated in the project include site safety procedures and operational schedules to minimize interference with shipping. All pertinent Occupational Safety and Health Administration safety regulations in 29 C.F.R. §1926 (Construction) will be followed, as will the General Industry Standards in 29 C.F.R. §1910.

Blasting Operations

8.8 Blasting would be restricted to channel-deepening operations in Port Jersey, the Kill Van Kull, portions of Newark Bay, and the Arthur Kill Channels, where rock will have to be removed. Blasting operations have the potential to impact both the biological and structural aspects of the area. The following steps may be employed to minimize or eliminate environmental or structural impacts related to blasting operations:

Protection of Fisheries

- ***Fish Exclusion Devices:*** The use of fish exclusion devices such as bubble curtains, startle devices, or strobe lights have demonstrated the ability to minimize the movement of fish through an active blasting area.

- ***Fish Location Devices:*** Systems such as sonar or hydroacoustics could be used to warn of the passage of fish schools.

- ***Blasting Delays and Stemming:*** Blasting could be conducted using inserted delays of a fraction of a second per hole. Another useful technique is stemming, in which fish mortality is reduced by placing a rock on top of the borehole to dampen the shock wave reaching the water column.

- ***Biological Windows:*** Blasting operations could be limited to periods of reduced fish activity.

Prevention of Structural Damage

- ***Pre-blast/Post-blast Surveys:*** Structural surveys could be conducted to determine the condition of nearby structures (e.g., historic locations and bridges) that might be affected by blasting activity.

- ***Seismographs:*** Seismographs could be placed around the blast site to determine the magnitude of the seismic forces generated by blasting. New Jersey allows a PPV of up to 2.0 in/sec in the vicinity of bridge piers and abutments and commercial structures, and up to 1.0 in/sec near residential structures. New York City has adopted a maximum allowable PPV of 0.5 in/sec for all designated historic structures.

8.4 Construction Monitoring and Management Plan

8.9 The purpose of the Monitoring and Management plan is to provide a database of selected environmental and operational parameters that would be used to determine whether project construction was in compliance with permit conditions.

8.10 The plan presented here establishes the objectives of the monitoring plan and general sampling protocols for the parameters that would be sampled. The detailed monitoring plan, including quality assurance/quality control procedures and reporting requirements, would be prepared after permit issuance, but before construction operations commenced.

8.11 The purpose of setting these objectives is to develop and implement a monitoring plan that accomplishes site inspection, that documents conformance to design standards, and that provides remedial action options if design standards/permit conditions are contravened. The objectives of this plan are to:

- Establish an organizational framework for management of the plan.

- Provide baseline information for physical, chemical, and biological conditions. The baseline database will include both existing information and data gathered during the project.

- Provide a general sampling protocol, as well as information required for operational management and long-term monitoring. The final monitoring plan, quality assurance/quality control procedures, and reporting requirements will be specified in the project-specific Federal and state permits.

8.12 The proposed monitoring program is planned as a series of monitoring tasks to be conducted during the project. The final monitoring program will be based on agreements among the regulatory agencies. The tasks considered for inclusion in the monitoring program should serve to ensure that design criteria are satisfied during dredging operations.

8.13 Existing information is considered sufficient to define pre-project conditions. The evaluation of monitoring data would involve a comparison with existing conditions or with a permit limit. Literature on the effects of dredging and dredged material placement on water quality and aquatic life is extensive. The evaluation of project effects and performance would be based primarily on the site-specific monitoring data.

Proposed Monitoring Program

8.14 The proposed monitoring program is divided into a series of tasks to be conducted during the project's three stages as follows:

- ***Pre-construction:*** The baseline information gathered for the preparation of this FEIS, in addition to ongoing studies and monitoring, will be available for evaluation of future monitoring data.

- ***Channel Deepening***: Channel deepening will be monitored by bathymetric surveys to confirm that channel side slope dimensions have been maintained, and to verify position.

- ***Placement of Dredged Material***: Monitoring during this stage would be directed toward the proper placement of dredged material and the possible water quality effects of the discharge of material from the barges/scows.

8.15 To gather the data needed for monitoring the environmental effects of this project, the following general sampling programs are proposed:

Bathymetry/Establishment of Dredge Position

8.16 Pre-dredging bathymetric surveys will be conducted to establish the existing bottom contours.

8.17 Bathymetric surveys will also be conducted during dredging operations to ensure adherence to design specifications and to confirm that dredging has been accomplished to a uniform depth.

8.18 During dredging operations, the dredge will require repositioning several times a day. Position can be verified by either of two methods, both of which satisfy the accuracy requirements of a Class 1 survey: (1) use of pre-established and surveyed range lines and reaches, or (2) Differential GPS.

Water Quality

8.19 Potential water quality changes associated with dredging activities are limited to the immediate vicinity of dredging operations (LMS 1997). Mechanical dredging operations may be expected to result in the temporary suspension of 3–5% of the total dredging quantity and an increase in Total Suspended Solids (TSS) readings in the area being dredged. Because chemical constituents are most frequently bound to these fine particles, increased TSS in the water column might indicate the movement of contaminated sediments to the surrounding environment. If required by resource agency permit conditions, TSS levels will be measured either gravimetrically or by means of turbidity meters placed upstream and downstream of dredging operations.

Biological Monitoring

8.20 Biological monitoring, if required by permit conditions, might consist of sampling to determine composition or density of benthic infauna. These data would later be used to establish the recolonization rate of the disturbed areas, and the functional use of the area by higher-trophic-level populations. Information would be obtained on the successional pattern of benthic populations through sequential sampling. Benthic data for the area would also provide a baseline for evaluating the recovery of the benthic community.

8.21 To provide a sound basis for comparison, sampling of the benthos should be carried out with the same gear employed in previous studies. To the extent possible, sampling in undisturbed areas of the channel to obtain a concurrent baseline should be carried out at stations sampled in previous studies.

8.22 Physical parameters would be monitored following construction to verify predictions of hydrodynamic modeling. Salinity, water temperature, DO, and surface water elevation measurements would be taken periodically throughout the project area for comparison with baseline conditions established during previous biological surveys. This would indicate to what extent these parameters may have changed, and if the changes coincided with modeling predictions.

INDEX

B

Bathymetry 5
Best Management Practices (BMPs) 1–4
Blasting operations 3–4
  prevention of structural damage..... 4
  protection of fisheries 3–4

D

Dredged material management 1

G

Global Positioning System (GPS), Differential 5

M

Monitoring and management of construction 4–6
  overview 4–5
  sampling programs..... 5–6
    bathymetric survey and Differential GPS 5–6
    biological monitoring..... 6
    water quality 6

S

Schedule for project design and construction 1
Sponsorship of project, non-Federal 1

9 STATE PERMITS AND APPROVALS

9.1 New York Permitting Program

9.1 NYSDEC approval will be administered under the Protection of Waters Permit/401 Water Quality Certificate program. This approval will cover dredging, decanting (if necessary), and placement management of dredged materials. Many of the Special Conditions dictating the means and timing of dredging, in addition to habitat protection measures, will be described in the NYSDEC permit. In water-related projects, operations may be limited to "windows" for the protection of spawning or wintering fish, breeding birds, or migrating sea turtles. An example of working window is the permit issued to USACE by NYSDEC Region 2 for the Phase II deepening of the Kill Van Kull Channel, which specified that "dredging and blasting is prohibited during the period of March 1–August 31 in an area within 1000 ft from the shoreline of Shooters Island (Special Condition 20)." The permit also specified that "dredging is prohibited during the period of November 15–May 31 in any portion of Contract Reach 3 determined through biological monitoring to harbor significant populations of blue crab or winter flounder (Special Condition 21)." Following a review of current biological information, the need for a dredging window in Kill Van Kull Contract Reach 3 was determined to be unwarranted (letter to Frank Santomauro from Charles de Quillfeldt dated 26 Aug 99). A detailed review of available New York and New Jersey Harbor data, including the data collected for this study, does not indicate the need for seasonal dredging windows. [The Kill Van Kull permit also specified the use of a sealed dredge bucket, a maximum hoist speed for the bucket, and environmental monitoring standards.]

9.2 Because several littoral zone areas (areas with water depths ranging from MLW to 6 ft MLW) regulated under the Tidal Wetlands Act are expected to be impacted by the project, approval under NYSDEC's Tidal Wetlands Program will also be required.

9.3 A pre-application meeting will be held with representatives of NYSDEC Region 2 to discuss the contents of and specific details for inclusion in the state permit application. A sediment sampling and analytical program for the portion of the project within New York State waters will be discussed and finalized at the pre-application meeting. The number of samples to be collected, the analytical parameters (based on agency guidance documents) to be measured, the expected dredge volumes, and the history of contamination in the areas to be dredged will be decided at this pre-application meeting.

9.4 The permit application will incorporate by reference the DEIS and the FEIS. Copies of both documents will be filed with NYSDEC before the filing of the permit application.

9.5 The Joint Application for Permit (#95-19-3) form will be submitted to NYSDEC for the proposed work. In addition to whatever materials may be requested by NYSDEC at the pre-application meeting, or by the resource agencies (NMFS, USFWS) during the application review process, the attachments to be included with the permit application will include the following:

- A narrative describing the dredging process, including turbidity control measures, vessel-loading procedures, staging of equipment, and dredged material management

measures. Details of the proposed blasting work will also be provided. Due to the variety of sediment types projected for removal, several dredged materials management scenarios will be described. Equipment staging and barge storage areas will also have to be identified.

- Location maps identifying the proposed dredge areas and dredged material placement management sites.

- Representative photographs of the proposed work areas, keyed to the location map.

- Bathymetric cross-sections and dredged-material volume calculations. It is possible that NYSDEC will request that the dredged-material volumes be broken down into estimated amounts to be removed by blasting, by clamshell, and by hydraulic dredge. It is also possible that the agency will request estimates by sediment type, i.e., by grain size and classification.

- Results of chemical testing of the proposed dredge material.

- A copy of the Coastal Zone Assessment Form and Consistency Statement submitted to NYSDOS and the New York City Office of City Planning.

- Plans for the handling and disposal of debris (piles, logs, metal items) recovered during the dredging work.

- For the tidal wetlands component, "project plans at a scale of 1 in. = 100 ft with a contour interval of 2 ft and showing the mean high water line (if the project is in the water) and/or the tidal wetlands boundary as delineated on the site by NYSDEC staff or an environmental consultant, or an accurate representation of the tidal wetland boundary as taken from the official (NYSDEC) tidal wetlands maps." Due to the age (20 years or more) of the NYSDEC Tidal Wetlands Maps, some site validation of the habitat type may be requested. The tidal wetland component also requires "the names of adjacent landowners" and "a statement of feasible alternatives." The FEIS alternatives analysis is expected to be sufficient.

- Environmental protection, restoration, and monitoring programs to be conducted concurrent with and following the dredging work.

9.6 After NYSDEC determines that the permit application is complete, the agency will commence its internal review. A Public Notice will be issued at the completion of the internal review; and public comments will be accepted for a period of thirty days. The need for a Public Hearing will be determined by NYSDEC, based on the nature and relevance of the comments received. A Coastal Zone Consistency concurrence request will be filed with NYSDOS. The New York State Coastal Zone Consistency Policy Statement is presented in Appendix B-1.7.

9.7 In 1982, in response to the New York State Waterfront Revitalization and Coastal Resources Act and the Federal Coastal Zone Management Act, the New York City Department

of City Planning adopted the Local Waterfront Revitalization Program (LWRP). The LWRP responds to concerns about inappropriate uses of the waterfront as well as deterioration of waterfront structures. Compliance with the LWRP is required for projects within the Coastal Zone. A revised LWRP, currently under public review, is likely to be adopted in 2000.

9.8 The New York City LWRP functions by requiring project sponsors to evaluate the consistency of their projects with a series of environmental policies and objectives designed to protect and enhance the waterfront. The Howland Hook Marine Terminal and the South Brooklyn Marine Terminal sites are located within the Coastal Zone boundaries established by the LWRP. The program has three primary goals: to promote water-dependent economic development, to protect natural resources, and to increase public access and recreational use of the waterfront. All discretionary actions within the project's boundaries must be reviewed for consistency with the 56 policy statements included in the LWRP, or with the ten policy statements included in the revised plan, if adopted. In 1994, consistent with the LWRP, the Department of City Planning published a Plan for the Staten Island Waterfront and a Plan for the Brooklyn Waterfront.

9.2 New Jersey Permitting Program

9.9 The proposed work within New Jersey-regulated waters will be governed by NJDEP's guidelines for management and regulation of dredging and dredged materials (NJDEP 1977). Also required will be a state water quality certification, compliance with the state's coastal zone management program, and permits issued by NJDEP's Office of Dredging and Sediment technology. In addition, the production of structural and nonstructural fill, manufactured soil or using, processing or transferring dredged materials in New Jersey requires an Acceptable Use Determination (AUD) from the NJDEP. The AUD for dredged material from the tidal waters of the State of New Jersey and adjacent interstate waters must be obtained prior to any dredging or dredged material management activities. The contents of the application package to NJDEP are expected to be largely the same as those described above for the New York State application. The Land Use Regulation Program Application Form (LURP #1, adopted 4/24/95) will be submitted with the requisite attachments. Because the channel deepening will require Federal approval, and will therefore be covered by the Sovereign Immunity afforded to the Federal government, other state approvals will not be required as long as compliance with state standards is demonstrated. The project must comply with all Federal laws, including Section 307 of the Federal Coastal Zone Management Act and Section 401 of the Federal Water Pollution Control Act (Clean Water Act). Special Conditions expected to be issued by the State of New Jersey are the same as or similar to those likely to be required by New York. Conditions required by the state in the permit issued to USACE for the Port Jersey channel deepening project included no-barge-overflow, use of a closed-clamshell bucket, no discharge of decant water, and a maximum bucket lift speed of 2 fps.

9.10 A description of the New Jersey Coastal Zone Management Program is provided in Section 1.2. The New Jersey Coastal Zone Consistency Policy Statement is presented in Appendix B-1.7.

INDEX

S

State permits and approvals, process 1–3
New Jersey 3
New York 1–3

Literature Cited

Section 1:

Betts, M.B. 1997. Municipal Support of Maritime Transport and Commerce 1870-1930s in The New York Waterfront, Evolution and Building Culture of the Port and Harbor, ed. Kevin Bone, 38-81, The Monacelli Press.

James, S.R., Jr., and S.K. Duncan. 1999. Final Report, Cultural Resources Survey, New York Harbor Collection and Removal of Drift Project, Arthur Kill, Richmond County, New York Reach; Arthur Kill, Union and Middlesex Counties, New Jersey Reach; and Kill Van Kull, Richmond County, New York Reach. Vol. 1. Prepared for the U.S. Army Corps of Engineers by Panamerican Consultants, Inc., January 1999.

Mysak, J., with J.Schiffer. 1997. Perpetual Motion: The Illustrated History of the Port Authority of New York & New Jersey. General Publishing Group, Los Angeles.

Raber, M.S, T.R. Flagg, G. Weinstein, E.A. Wiegand, and N. Brouwer. 1996. Final Report, Reconnaissance Cultural Resource Investigations, Arthur Kill New Jersey Reach, Union and Middlesex Counties, New Jersey, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District. Prepared for Frederick R. Harris, Inc., by Raber Associates, January 1996.

U. S. Army Corps of Engineers, New York District (USACE-NYD). 1997. Final Limited Reevaluation Report – Technical Support Documents – Kill Van Kull-Newark Bay Channels Phase II Deepening Project.

Section 2:

U.S. Army Corps of Engineers (USACE). 1999a. Alternative Formulation Briefing (AFB) Technical Memorandum. New York and New Jersey Harbor Navigation Study. June, 1999.60 Pp.

U.S. Army Corps of Engineers - New York District (USACE-NYD). 1999b. New York and New Jersey Harbor Navigation Study. Environmental Scoping Document.

Section 3:

Permanent International Association of Navigation Congresses (PIANC). 1997. Approach Channels: A Guide for Design. Final Report of the joint PIANC-International Association of Ports and Harbors, Working Group II-30. June 1997.

U.S. Army Corps of Engineers – New York District (USACE -NYD). 1999. Dredged Material Management Plan for the Port of New York and New Jersey. Implementation Report, Programmatic Environmental Impact Statement, and Technical Appendix. September 1999.

U.S. Army Corps of Engineers, New York District (USACE). 1996. Dredged Material Management Plan for the Port of New York and New Jersey, Interim Report, October.

U.S. Army Corps of Engineers (USACE). 1995. Hydraulic Design Guidance for Deep-Draft Navigation Projects. EM-1110-2-1613. 31 August 1995.

URS Greiner Woodward Clyde Federal Services (WCFS). 1999. Update of Blasting Analysis: New Jersey – New York Harbor. Prepared for the U. S. Army Corps of Engineers, New York District. July 1999.

Woodward Clyde Federal Services (WCFS). 1997. Final Report – Blast Evaluation for Deepening the Kill Van Kull and Arthur Kill New Jersey and New York. Prepared for the U. S. Army Corps of Engineers, New York District.

Section 4:

U.S. Army Corps of Engineers (USACE). 1997. Final Limited Reevaluation Report and Final Environmental Assessment and Finding of No Significant Impact. Kill Van Kull-Newark Bay Channels Phase II Deepening Project. December 1997.

U.S. Army Corps of Engineers (USACE). 1998. Limited Reevaluation Report and Final Environmental Assessment and Finding of No Significant Impact and Pertinent Correspondence. Port Jersey Channel Federal Navigation (Deepening) Project, Bayonne, NJ. January 1998.

Section 5:

Able, K.W., A.L. Studholme and J.P. Manderson. 1995. Habitat quality in the New York/New Jersey Harbor Estuary: An evaluation of pier effects on fishes. Final Report to the Hudson River Foundation. December 1995.

American Ornithologists' Union. 1983. Checklist of North American birds, 6th ed. Am. Ornithologists' Union, Washington, D.C.

Anderson, B.H. 1972. Some uncommon avian records for central Florida. Florida Nat. 45(6):192. *In* Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Andrle, R.F., and J.R. Carroll. 1988. The Atlas of Breeding Birds in New York State. Cornell University Press. 550 pp.

Atwood, J.L., and D.E. Minsky. 1983. Least tern foraging ecology at three major California breeding colonies. Western Birds 14(2):57-72.

Atwood, J.L., R.A. Erickson, P.R. Kelly, and P. Unit. 1979. California least tern census and nesting survey, 1978. Endangered Wildlife Program E-W-2, Nongame Wildl. Invest., California Dept. Fish Game, Job V-2.13, Job Final Report (July 1979). v. p. *In* Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Baker, P.K. and R. Mann. 1991. Soft Shell Clam. *In* S.L. Funderburk, J.A. Mihursky, S.J. Jordan, and D. Riley (eds.). Habitat Requirements for Chesapeake Bay Living Resources.

Baskerville, C. 1994. Bedrock and Engineering Geologic Maps of New York County and Parts of Kings and Queens Counties, New York, and Parts of Bergen and Hudson Counties, New Jersey. Department of the Interior, U. S. Geological Survey. Miscellaneous Investigations Map I-2306, scale 1:24:000.

Barclay, J.S. and D.F. Squires. 1991. Wildlife Habitats and Populations in the New York/New Jersey Estuary. The University of Connecticut, Department of Natural Resource Management and Engineering and the Marine Sciences Institute. Storrs, Connecticut.

Batutis, M. Jr., and R. Scardamalia. 1985. Official Population Projection for NYS Counties 1980-2010.

Bauersfeld, W.R., E. W. Moshinsky, and C.E. Gurney. 1994. Water Resources Data-New Jersey, Water Year 1994: Volume 1. Surface-Water Data. U.S. Geological Survey (USGS) Water-Data Report NJ-94. Prepared in Cooperation with the New Jersey Department of Environmental Protection and Other Agencies.

Bellrose, F.C. 1980. Ducks, Geese, and Swans of North America. Harrisburg, PA: Stackpole Books. 540 pp.

Bent, A.C. 1963. Life histories of North American gulls and terns. Dover Public., Inc., NY.

Birnbaum, C. 1996 Protecting Cultural Landscapes: Planning, Treatment, and Management of Historic Landscapes. *Preservation Briefs* 36. Washington D.C.: Government Printing Office.

Birnbaum, C. ed. 1995. The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Properties. U.S. Department of the Interior, Washington D.C.

Bleakney, J.S. 1965. Reports of Marine Turtles from New England and Eastern Canada. Canadian Field Nat. 79:120-128.

Blumberg, A.F. and D.W. Pritchard. 1997. Estimates of the Transport Through the East River, New York. Journal of Geophysical Research. 102 (C3).

Bosakowski, T. 1986. Short-eared owl winter roosting strategies. Am. Birds 40:237-240.

Botton, M.L. 1995. Horseshoe Crab. Pages 51-58. *In* Living Resources of the Delaware Estuary. The Delaware Estuary Program.

Brongersma, L.D. 1972. European Atlantic Turtles. Zool. Verhandl. 121:1-318.

Brouwer, N. 1983. Survey of Cultural Resources in the Form of Derelict Ships and Barges in Area II (Completion) of Shooters Island, New Jersey, New York Harbor Collection and Removal of Drift Project.

Brouwer, N. 1985. Text: Recordings of Selected Barges Lying at Edgewater, New Jersey, Supplement to: Survey of Cultural Resources in the Form of Derelict Ships, Hudson River Shoreline of Edgewater, New Jersey (April 1984), New York Harbor Collection and Removal of Drift Project.

Brown, L. 1979. Grasses: An Identification Guide. Sponsored by the Roger Tory Peterson Institute. Houghton Mifflin Company.

Buckley, P.A and F.G. Buckley. 1981. The endangered status of North American roseate terns. Col. Waterbirds 4:166-173.

Bull, J. 1974. Birds of New York State. Comstock Publishing Associates, a division of Cornell University Press. 703 pp.

Bull, J. 1985. Birds of New York State. Comstock Publishing Associates, Cornell University Press, Ithaca, NY.

Bureau of Economic Analysis. 1999. http://www.bea.doc.gov

Burke, V.J. 1990. Seasonal Ecology of Kemps Ridley (Lepidochelys kempi) and Loggerhead (Caretta caretta) Sea Turtles in Long Island, New York. M. A. Thesis State College at Buffalo, N.Y.

Burke, V.J., S.J. Morreale, P. Logan and E. Standora. 1992. Diet of Green Turtles (Chelonia mydas) in the Waters of Long Island, N.Y. In Proceedings of the Eleventh Annual Workshop of Sea Turtle Conservation and Biology.

Cadwell, D.H. 1989. Surficial Geologic Map of New York, Lower Hudson Sheet. New York State Museum Geological Survey, Map and Chart Series No. 40, scale 1:250,000.

Carr, A. 1980. Some Problems of Sea Turtle Ecology. Amer. Zool. 20:489-498.

Carr, A. 1986. New perspecitves on the pelagic stage of sea turtle development. NOAA Technical Memorandum. NMFS-SEFC-190.

Carreker, R.G. 1985. Habitat Suitability Index Models: Least Tern. USF&W Biological Report 82/10. 103 29 pp.

Carrswell, L.D. 1976. Appraisal of Water Resources in the Hackensack River Basin, New Jersey. U.S. Geological Survey Water-Resources Investigations 76-74, 68pp.

Cerrato, R.M. 1985. New Bay benthos data letter report for May 1985. Appendix C in Newark Bay/Kill Van Kull Navigation Project final supplement to the final environmental impact statement. Appendices.

Cerrato, R.M. H.L. Bokuniewicz, M.H. Wiggins. 1989. A spatial and seasonal study of the benthic fauna of the lower Bay of NY Harbor. Marine Sciences Research Center Special Report 84. State University of New York at Stony Brook, NY.

Chezik, 1985. Newark Bay benthos data letter report for August 1985. Appendix C. in Newark Bay/Kill Van Kull Navigation Project Final supplement to the final environmental impact statement. Appendices.

Citeno, E. 1999. The Boating Almanac. The Boating Almanac Inc. Sayville, NY

Clark, K.E. 1995. Osprey. Pages 395 - 400 In L.E. Dove, and R.M. Nyman, eds. Living Resources of the Delaware Estuary. The Delaware Estuary Program.

Clark, K.E. and C.D. Jenkins. 1993. Status of Ospreys nesting in New Jersey, 1984 through 1993. Cited in L.E. Dove, and R.M. Nyman, eds. 1995. Living Resources of the Delaware Estuary. The Delaware Estuary Program.

Clark, R.C. 1975. A field study of the short-eared owl in North America. Wildl. Monogr. 47:1-67.

Coch, N.K. 1986. Sediment characteristics and facies distributions in the Hudson system. Northeastern Geology. 8:109-129.

Collard, S.B. and L.H. Ogren. 1990. Dispersal Scenarios for Pelagic Post-hatchling Sea Turtles. Bull. Mar. Sci. 47(1):23-243

Collins, C.T., K.E. Bender, and D.D. Rypka. 1979. Report on the feeding and nesting habits of the California least tern in the Santa Ana River marsh area, Orange County, California. UAACE, Los Angeles District (DACW09-79-C-008). 30 PP. In. Carreker 1985.

Collins, H.H., Jr. 1981. Compete field guide to North American wildlife. Eastern edition. Harper & Row, New York, NY. 714 pp.

Connor, P.F. 1988. Pied-billed grebe, *Podilymbus podiceps*. Pages 28-29 In Andrle, R.F. and J.R. Carroll, Eds. The atlas of breeding birds in New York State. Cornell Univ. Press, Ithaca, NY. 551 Pp.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Biological Services Program, U.S. Fish and Wildlife Service. December 1979.

Crawford, D.W., N.L. Bonnevie, C.A. Gillis, And R.J. Wenning. 1994. Historical Changes in the Ecological Health of the Newark Bay Estuary, New Jersey. Ecotoxicology And Environmental Safety 29 (1994):276-303.

Custer, T.W., and R.G. Osborn. 1978. Feeding habitat use by colonially-breeding herons, egrets, and ibises in North Carolina. The Auk. 95:733-743.

Dadswell, Michael J., Bruce D.Taubert, Thomas S. Squiers, Donald Marchette, and Jack Buckley. 1984. Synopsis of biological Data on Shornose Sturgeon, *Acipenser brevirostum* LeSueur 1818. NOAA Techinical Report NMFS 14:53p.

DeGraaf, R.M. and D.D. Rudis. 1986. New England wildlife: habitat, natural history, and distribution. Gen. Tech. Rep. NE-108. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station. 491 p.

Dolphins. 1999a. http://library.advanced.org/17963/genus – Tursiops.html.

Dolphins. 1999b. http://library.advanced.ort/17963/genus – Delphinus.html

Dorr, D.K. 1976. Least tern, *Sterna albifrons*, nesting habitat in Maine and its relevance to the Critical Areas Program. Maine State Planning Office Report 11. 21 pp. *In* Carreker (1985) Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Dovel, W.L. 1992. Movements of immature striped bass in the Hudson Estuary. *In* C.L. Smith, Ed. Estuarine Research in the 1980s. The Hudson River Environmental Society Seventh Symposium on Hudson River Ecology. 276-300

Downing, R.L. 1973. A preliminary nesting survey of least terns and black skimmers in the east. Am. Birds 27(6):946-949.

Drake, A.A., Jr., R.A. Volkert, D.H. Monteverde, G.C. Herman, H.F. Houghton, R.A. Parker, and R.F. Dalton. 1996. Bedrock Geologic Map of Northern New Jersey, Department of the Interior, U. S. Geological Survey, Miscellaneous Investigations Map I-2540, scale 1:100,000.

Duedall, I.W., H.B. O'Connors, R.E. Wilson, And J.H. Parker. 1979. The Lower Bay Complex: Mesa New York Bight Atlas Monograph 29, New York Sea Grant.

Eaton, E.H. 1910. Birds of New York, Port 1. Cited in Andrle and Carroll [eds.] (1988), The Atlas of Breeding Birds New York State. Cornell University Press.

Eaton, S.W. 1988. American bittern, *Botaurus lentiginosus*. Pages 32-33 in R.F. Andrle, and J.R. Carroll (eds.), The Atlas of Breeding Birds in New York State. Cornell University Press.

Edwards and Kelsey Engineers, Inc. 1999. Strategic Plan for the Redevelopment of the Port of New York, Task8-Draft. Environmental Screening Technical Memorandum. Prepared for the NYC Economic Development Corporation.

Ehrlich, P.R., D.S. Dobkin and D. Wheye. 1988. The birder's handbook. Simon and Schuster, Inc., New York. 222(4):72-78.

Ellison, B. (ed.). 1999. Reed's Nautical Almanac. North American East Coast 1999. Thomas Reed Publications, Inc. Boston, MA.

Engebretsen, J. E. 1982. New York Harbor and Adjacent Channels Study: Shipwreck inventory.

Erwin, R.M. 1978. Coloniality in terns: the role of social feeding. Condor 80(2):211-215.

Fay, C.W., Neves, R.J., and G.B. Pardue. 1983. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic) – Bay Scallop. U.S. Fish & Wildlife Service Biological Report 82 (11.12). U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS. Technical Report EL-84-2.

Federal Register. 1999. 64 FR 46542.

Ferguson, J. 1986. Preliminary Assessment of Cultural Resources Sensitivity for the Lower NewYork Bay, New York and New Jersey.

Figley, W. 1988. New Jersey's Recreational and Commercial Fishing Grounds of Raritan Bay, Sandy Hook Bay and Delaware Bay. Prepared for the New Jersey Department of Environmental Protection. Technical Series 88-1. 39 pp.

Fisk, E.J. 1975. Least tern: beleaguered, opportunistic, and roof-nesting. Am. Birds 29(1):15-16.

Forbes, M.R.L., H.P. Barkhouse And P.C. Smith. 1989. Nest-site selection by pied-billed grebes (*Podilymbus Podiceps*). Ornis. Scan. 20: 2019-2023.

Frederic R. Harris, Inc. 1997. New York Harbor Collection and removal of Drift Project Kill Van Kull, New York Reach. Preliminary Working Draft. November, 1997.

Gahagan & Bryant Associates, Inc. 1997. Dredging analysis and cost estimate for the Kill Van Kull channel and southern Newark Bay with Elizabeth channel. Report prepared for the Port Authority. April 1997.

Gardner J.D. and W. Riess. 1990. Remote Sensing Survey of the Borrow Area for the Atlantic Coast of New York City beach Erosion Control Project, Rockaway Inlet to Norton point: Coney Island, New York. On file, U.S. Army Corps of Engineers, New York District.

Geoarcheology Research Associates. 1999. A Geomorphological and Archaeological Assessment of the New York and New Jersey Harbor Navigation Channels.

Geospatial & Statistical Data Center. 1999. http://fisher.lib.virginia.edu

Gibbs, J.P. And S.M. Melvin. 1992a. Pied-billed grebe, *Podilymbus podiceps*. Pages 31-49 In K.J. Schneider And D.M. Pence, Eds. Migratory nongame birds of management concern in the northeast. U.S. Dept. Inter., Fish And Wildl. Serv., Newton Corner, MA. 400 Pp.

Gibbs, J.P. and S.M. Melvin. 1992b. American bittern, *Botaurus lentiginosus*. Pages 51-69 in K.J. Schneider and D.M. Pence, eds. Migratory nongame birds of management concern in the northeast. U.S. Dept. Inter., Fish and Wildl. Serv., Newton Corner, MA. 400 pp.

Gilbert, C.R. 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight) – Atlantic and shortnose sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL-82-4. 28p.

Gill, Frank B. 1990. Ornithology, W.H. Freemam and Co. New York.

Gleason, H. A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. 2nd ed. Bronx: New York Botanical Garden. 910 p.

Greeley, J.R. 1937. Fishes of the area with annotated list. Pp. 45-104 in Biological Survey of the Lower Hudson Watershed. 26th Annual Rept. NY Conservation Dept.(Suppl.)

Grosslein, M.D. and T.R. Azarovitz. 1982. Marine EcoSystem Analysis (MESA) Program. MESA New York bight Program. Fish Distribution. MESA New York Bight Atlas Monoraph 15. New York Sea Grant Institute. Albany, NY. 182 pp.

Grunchy,C.G. and B. Parker. 1980. *Acipenser brevirosrtrum* Lesueur, shortnose sturgeon. P.38. *In* D.S. Lee, et al. Atlas of North American freshwater fishes. North Carolina State Museum of Natural History, Raleigh.

Harbor Estuary Program (HEP). 1996. New York–New Jersey Harbor Estuary Program Including the Bight Restoration Plan. Final Comprehensive Conservation and Management Plan. March 1996.

Harbor Herons Report (HHR), The. 1990. A Strategy for Preserving a Unique Urban Wildlife Habitat and Wetland Resource in Northwestern Staten Island. Prepared by the Trust for Public Land in conjunction with the New York City Audubon Society.

Hardy, J.W. 1957. The least tern in the Mississippi Valley. Publ. Mus. Michigan State Univ. Biol. Ser. 1(1):1-60. *In* Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Harrison, H.H. 1975. A field guide to birds' nests of 285 species found breeding in the U.S. east of the Mississippi River. Houghton Mifflin Co., Boston.

Hartgen Archaeological Associates, Inc. 1996. Cultural Resources/Section 106 Compliance of the Environmental Impact Statement for the Newark Bay Confined Disposal Facility (NBCDF), Essex County, New Jersey.

Hays, H. 1984. The vole that soared. Nat. Hist. 93(5):7-16.

Hendrickson, J.R. 1980. The Ecological Strategies of Sea Turtles. Amer. Zool. 20:597-608.

Henn, R. 1985. Preliminary Assessment of Cultural Resources, Port Jersey, Hudson County, New Jersey.

Hill, J., Fowler, D.L., and M.J. Van Den Avyle. 1989. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic) – Blue Crab. U.S. Fish & Wildlife Service Biological Report 82 (11.100). U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS. Technical Report EL-82-4.

Howe, M.A., R.B. Clapp, and J.S. Weske. 1978. Marine and Coastal Birds. New York Sea Grant Institute. MESA N.Y. Bight Atlas Monograph 31. 87 pp.

Hudson River Watertrail Guide, The. 1999. http://www.enviroweb.org

Hydroqual, Inc. 1991. "The Transport through the East River for Data and Three Dimensional Hydrodynamic Modeling", report prepared for the Management Committee, Long Island Sound Estuary Study and the New England Interstate Water Pollution control commission.

Jackson, J.A., and B.J.S. Jackson. 1985. Status, dispersion, and population changes of the least tern in coastal Mississippi. Colonial Waterbirds. 8(1):54-62.

Jay, D.A. and M.J. Bowman. 1975. The Physical Oceanography and Water Quality of New York Harbor and Western Long Island Sound. Technical Report 23. Marine Sciences Research Center, State University of New York at Stony Brook.

Jernigan, L.R., J. Parnell, and T. Quay. 1978. Nesting habitats and breeding populations of the least tern (*Sterna alifrons antillarum*) in North Carolina. Natls. Oceanic Atmos. Admin., Sea Grant Publ. UNC-SG-78-07. 39 pp. *In* Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Kardas, S. and E. Larrabee. 1985. Historic American Building Survey/Historic American Engineering Record Level Recordation at the Ships Graveyards at Shooters Island Staten Island, Richmond County, New York and Bayonne - Elizabeth, Hudson and Union Counties, New Jersey.

Kennedy, V.S. 1991. Eastern Oyster. *In* S.L. Funderburk, J.A. Mihursky, S.J. Jordan, and D. Riley (eds.). Habitat Requirements for Chesapeake Bay Living Resources.

Kerlinger, P. 1999. The New York City Audubon Society Harbor Ecosystem Study: Nesting Population of Herons, Egrets, Ibis, gulls, and Other Birds, 1999. Prepared for New York City Audubon Society.

Killam Associates. 1998. The Upland Portion Harbor Navigation Study, Phase II, Existing Environmental Conditions Data Report, Final.

Kiviat, E. 1998. Where are all the reptiles and amphibians of the Hudson River? Part 2. News from Hudsonia 13(3):1-7.

Klemens, M. 1993. Reptiles and amphibians of Connecticut. Connecticut Department of Environmental Protection.

Korpimaki, E., and K. Norrdahl. 1991. Numerical and functional responses of kestrels, short-eared owls, and long-eared owls to vole densities. Cited in L.E. Dove, and R.M. Nuyman, eds. 1995. Living Resources of the Delaware Estuary. The Delaware Estuary program.

Krouse, J.S. 1979. Distribution and Catch Composition of Jonah Crab, *Cancer borealis*, and Rock Crab, *Cancer irroratus*, Near Boothbay Harbor, Maine. Fishery Bulletin. 77(3):685-693.

Kushlan, J.A. 1978. Feeding behavior of North American herons. In A. Sprunt, IV, J.C. Ogden, and S. Winckler, eds. Wading Birds. Nat. Aud. Soc. Rept. No. 7. pp. 249-297.

Kushlan, J.A. 1976. The feeding behavior of North American herons. The Auk 93:86-94.

LaPorta, P. C., L. E. Sohl and M. C. Brewer. 1999. Cultural Resource Assessment of Proposed Dredged Material Management Alternative Sites in the New York Harbor-Apex, Affecting the Coastal Areas of New York, Queens, Kings and Richmond Counties in New York and Bergen, Hudson, Middlesex and Monmouth Counties in New Jersey. On file, US Army Corps of Engineers, New York District.

Latham, R. 1969. Sea Turtles Recorded in the Southold Township Region of Long Island. Engelhardtia 1:7.

Lawler, Matusky & Skelly Engineers, LLP. 1990. Review of New York Harbor Aquatic Data Applicable to the Atlantic Basin. Draft Report. Prepared for the Port Authority of New York & New Jersey.

Lawler, Matusky & Skelly Engineers LLP (LMS). 1996. Biological survey of Newark Bay shoal areas and adjacent Kill Van Kull and Arthur Kill Channels. Prepared for the Port Authority of New York and New Jersey.

Lawler, Matusky & Skelly Engineers (LMS). 1987. Preliminary draft environmental impact statement, River Walk. Prepared on behalf of Related Properties, Inc., for the City of New York Environmental Quality Review.

Lawler, Matusky & Skelly Engineers (LMS). 1984a. Westway mitigation studies - Phase IIIa. Winter 1983-1984 Vol. I.

Lawler, Matusky & Skelly Engineers (LMS). 1984b. Description of existing water quality, aquatic biology, terrestrial ecology, and infrastructure at Hoboken Waterfront

development site. Prepared for the Port Authority of New York and New Jersey. Economic Development Dept.

Lazell, J.D. Jr. 1980. New England Waters: Critical habitat for Marine Turtles. Copeia 1980:290-295.

Lerman, M. 1986. Marine Biology: Environment, Diversity, and Ecology.Benjamin/Cummings Publishing Co. Menlo Park, CA. 534 pp.

Lewis and Kummel. 1912. Geologic Map of New Jersey. Revised by H.B. Kummel, 1931 and M.E. Johnson, 1950, New Jersey Department of Conservation and Economic Development, Atlas Sheet No. 40.

Long, D. and W. Figley. 1982. New Jersey's Recreational and Commercial Ocean Fishing Grounds. New Jersey Department of Environmental Protection, Bureau of Marine Fisheries.

Lyttle, P. T. and J.B. Epstein. 1987. Geologic Map of the Newark 1° x 2° Quadrangle, New Jersey, Pennsylvania, and New York, Department of the Interior. U. S. Geological Survey. Miscellaneous Investigations Map I-1715, scale 1:250,000.

MacKenzie, C. and J.R. Moring. 1985. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic) – American Lobster. U.S. Fish and Wildlife Service Biological Report 82 (11.33). U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS. Technical Report IL-82-4.

MacKenzie, C.L. 1990. History of the fishes of Raritan Bay, New York and New Jersey. Marine Fisheries Review, Vol. 52, No. 4. 45 pp.

Madison,D.M. 1997. The emigration in radio-implanted spotted salamanders, *Ambystoma maculatum*. Journal of Herpetology 31:542-552

Martin, D.M., T.Morto, T. Dobrzynski, and B. Valentine. 1996. Estuaries on the edge: The vital link between land and sea. Report by American Oceans Campaign. 297 pages.

Massey, B.W. 1971. A breeding study of the California least tern. Proc. Linnean. Soc. New York. 72:1-24.

Matthews, J.R. And C.J. Moseley. 1990. The official world wildlife fund guide to endangered species of North America, Vol. 2. Beacham Publ. Inc., Washington, D.C. Pp. 703-705.

MBGnet. 1999a. **http://mbgnet.mobot.org/MBGnet/salt/whale/minke.htm**

MBGnet. 1999b. **http://mbgnet.mobot.org/MBGnet/salt/whale/blue.htm**

MBGnet. 1999c. **http://mbgnet.mobot.org/MBGnet/salt/whale/humpback.htm**

MBGnet. 1999d. **http://mbgnet.mobot.org/MBGnet/salt/whale/sperm.htm**

McClelland, L.F., JT. Keller, G.P. Keller, and R.Z. Melnick n.d. Guidelines for Evaluating and Documenting Rural Historic Districts. National Register Bulletin 30. U.S. Department of the Interior, National Park Service. Washington D.C.: Government Printing Office.

Melnick, R Z. 1984. Cultural Landscapes: Rural Historic Districts in the National Park System. Washington D.C.: National Park Service, U.S. Department of the Interior.

Melvin, S.M., D. Smith, D. Holt, and G.R. Tate. 1989. Small owls. Cited in L.E. Dove, and R.M. Nuyman, eds. 1995. Living Resources of the Delaware Estuary. The Delaware Estuary program.

Meylan, A. 1986. The Riddle of the Ridleys. Nat. Hist. 95:90-96.

Meylan, A. and S. Sardove. 1986. Cold-Stunning in Long Island Sound, New York. Marine Turtle Newsl. 37:7-8.

Mid-Atlantic Fishery Management Council (MAFMC). 1998a. Amendment 12 to the Atlantic Surfclam and Ocean Quahog Fishery Management Plan. In cooperation with the National Marine Fisheries Service and the New England Fishery Management Council. October 1998.

Mid-Atlantic Fishery Management Council (MAFMC). 1998b. Amendment 8 to the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. In cooperation with the National Marine Fisheries Service and the New England Fishery Management Council. August. 1998.

Miller, R.E., D.W. Campbell, and P.J. Lunsford. 1980. Comparison of sampling devices for the juvenile blue crab, *Callinectes sapidus*. Fish. Bull. 78(1):196-198.

Miller, H.J. and S.R. James. 1992. "Proposed 30" Liberty Pipeline from Morgan, New Jersey Across Raritan Bay, Lower New York Bay and the Atlantic Ocean to Edgemere, New York. Final Report. 3 Volumes.

Millikin, M.R. and A.B. Williams. 1984. Synopsis of biological data on the blue crab, *Callinectes sapidus*. NOAA Tech. Rep. NMFS 1. FAO Fisheries Synopsis 138.

Mitchell, R. and Shevieak, C. 1983. Rare Plants of New York State. Bulletin No. 445. New York State Museum. The University of the State of New York. The State Education Department, Albany, NY 12230.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands. Van Nostrand, New York. 721pp.

Moffat & Nichol Engineers. 1998. Marine Terminal Planning, Final Report. Prepared for the Port Authority of New York and New Jersey.

Morreale, S.J. and V.J. Burke. 1997. Conservation and Biology of Sea Turtles in the Northeastern United States. *In* Tyning, T.F. (Ed.), Status and Conservation of Turtles of the Northeastern United States. Massachusettes Audubon Society, Lincoln, MA. Pp 41-46.

Morreale, S.J.,A.B. Meylan, S.S. Sadove, and E.A. Standora. 1992. Annual Occurrence and Winter Mortality of Marine Turtles in New York Waters. J. Herpetol. 26:301-308.

Morreale, S.J. and E.A. Standora. 1998. Occurrence, Movement and Behavior of the Kemp's Ridley and Other Sea Turtles in New York Waters. Ann. Rept. To New York State Department of Environemtnal Conservation, Return a Gilt to Wildlife Program. Apr. 1988-Apr. 1989.

Morreale, S.J. and E.A. Standora. 1994. Habitat Use and Feeding Activity of Juvenile Kemp's Ridleys in Inshore Waters of the Northeastern United States. In Proceedings of the Eleventh Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Mem. NMFS-SEFSC-302 pp 75-77.

Moseley, L.J. 1976. Behavior and communication in the least tern (*Sterna albifrons*). Ph.D. Diss., Univ., North Carolina, Chapel Hill. 164 pp. *In* Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Mullen, D.M. and J.R. Moring. 1986. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic) – Sea Scallop. U.S. Fish & Wildlife Service Biological Report 82 (11.67). U.S. Army

Corps of Engineers, Waterways Experiment Station, Vicksburg, MS. Technical Report EL-82-4.

Murphy, R.C. 1916. Long Island Turtles. Copeia 34:56-60.

National Marine Fisheries Service (NMFS). 1999a. Guide to Essential Fish Habitat Designations in the Northeastern United States Vol. III: Connecticut and New York. NOAA/NMFS Habitat Conservation Division. Gloucester, MA. March.

National Marine Fisheries Service (NMFS). 1999b. Personal Communication. Email from Karen Greene Dated September 1, 1999.

National Marine Fisheries Service (NMFS). 1994. Results of a Biological and Hydrographical Characterization of Newark Bay, New Jersey; May 1993 – April 1994.

National Oceanic and Atmospheric Administration (NOAA). 1998a. Tidal Current Tables, Atlantic Coast of North America. International Marine, Camden, ME.

National Oceanic and Atmospheric Administration (NOAA). 1998b. Tide Tables, East Coast of North and South America, including Greenland. ProStar Press, Annapolis, MD.

Nemickas, B. 1976. Geology and Ground-Water Resources of Union County, New Jersey. U.S. Geological Survey Water-Resources Investigations 76-73, 103p.

New England Fishery Management Council (NEFMC). 1998. Essential Fish Habitat Amendments to the Northeast Multispecies, Atlantic Sea Scallop, Monkfish, Atlantic Salmon, and Proposed Atlantic Herring Fishery Management Plans Vol. 1 and 2. October.

Newell, R.E. 1989. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North and Mid-Atlantic) – Blue Mussel. U.S. Fish & Wildlife Service Biological Report 82 (11.102). U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg MS. Technical Report EL-82-4.

New Jersey Department of Environmental Protection (NJDEP). New Jersey Administrative Code (N.J.A.C.) Title 7

New Jersey Boat Ramps. 1999. http://marinfosvc.com/ramps.htm

New Jersey Department of Environmental Protection. 1999. The New Jersey Natural Heritage Database.

New Jersey Department of Environmental Protection. 1998. New Jersey Air Quality Report, ambient air monitoring data – annual. Bureau of Air Monitoring.

New Jersey Department of Environmental Protection. 1998b. New Jersey Natural Heritage Database 1998.

New Jersey Department of Environmental Protection (NJDEP). 1982. New Jersey's Recreational and Commercial Ocean Fishing Grounds. Division of Fish, Game and Wildlife. Marine Fisheries Administration. Bureau of Marine Fisheries.

New York City Department of Environmental Protection (NYCDEP). 1993. New York Harbor Water Quality Survey 1991-1992.

New York State Department of Environmental Conservation. 1999. Database, Breeding Birds in the New York City Area. Received from Jim Daley, NYSDEC, Habitat Inventory Unit

New York State Department of Environmental Conservation (NYSDEC) 1998. NY Natural Heritage Program Database, 19 March, 1998.

New York State Department of Environmental Conservation (NYSDEC). 1994a. Species Dossier – Common Tern.

New York State Department of Environmental Conservation (NYSDEC). 1994b. Species Dossier – Northern Harrier.

New York State Department of Environmental Conservation (NYSDEC). 1993a. Species Dossiers- Spotted salamander (*Ambystoma maculatum*).

New York State Department of Environmental Conservation (NYSDEC). 1993b. Species Dossiers- Diamondback terrapin (*Malaclemys t. terrapin*)

New York State Department of Environmental Conservation (NYSDEC). 1993c. Species Dossiers- Eastern mud turtle (*Kinosternon s. subrubrum*)

New York State Department of Environmental Conservation (NYSDEC). 1993d. Species Dossiers- Southern leopard frog (*Rana u. utricularia*)

New York State Department of Environmental Conservation (NYSDEC). 1993e. Species Dossiers- Spotted turtle (*Clemmys gutata*)

New York State Department of Environmental Conservation (NYSDEC). 1993f. Species Dossiers- Eastern box turtle (*Terrapene c. carolina*)

New York State Department of Environmental Conservation (NYSDEC). 1993g. Species Dossiers - Black racers (*Coluber c. constrictor*)

New York State Department of Environmental Conservation (NYSDEC). 1993h. Species Dossiers - Eastern spadefoot toad (*Scaphiopus h. holbrookii*)

New York State Department of Environmental Conservation (NYSDEC). 1993i. Species Dossiers - Pied-billed grebe (*Podilymbus podiceps*)

New York State Department of Environmental Conservation (NYSDEC). 1993j. Species Dossiers - Roseate tern (*Sterna dougallii*)

New York State Department of Environmental Conservation (NYSDEC). 1993k. Species Dossiers - Black skimmer (*Rynchops niger*)

New York State Department of Environmental Conservation (NYSDEC). 1993l. Species Dossiers – American bittern *(Botauris lentiginosus)*

New York State Parks (NYS Parks). 1999. http://nysparks.state.ny.us/cgibin/cgiwrap/nysparks

New York/New Jersey Harbor Partnership. 1998. New York Harbor DMMP Aquatic Placement Options, Sub-channel Placement and CAD Cells Design. Draft Report Prepared for U. S. Army Corps of Engineers, New York District. November.

Nichols, T.C. 1995. Diving Ducks. Pages 353-358 In C.E. Dove and R.M. Nyman (eds.) Living Resources of the Delaware Estuary. The Delaware Estuary Program.

Northern Waterway Guide, 1999. From Delaware to the Canadian Border.

Nowak, T.A., Jr. and W. Riess. 1989. Final Report Archaeological Survey, East Bank and Lower Bay Areas, New York Harbor, New York. On file, U.S. Army Corps of Engineers, New York District.

Odum, E.P. 1971. Fundamentals of Ecology, 3rd Edition. W.B.Saunders Company. 574 pages.



Oey. L.Y., Mellor, G.L. and R.I. Hires. 1985. "A Three-Dimensional Simulation of the Hudson-Raritan Estuary. Part 1, Description of the Model and Model Simulations" *Journal of Physical Oceanography,* 15 (12).

Ogren, L.H. 1989. Distribution of Juvenile and Subadult Kemp's Ridley Turtles: Preliminary Results from 1984-1987 Surveys. *In* Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. Texas A&M Publication TAMU-SG-89-105 pp 116-123.

Palmer, R.S. (ed). 1962. Handbook of North American Birds, Vol. 1, Loons Through Flamingos. American Ornithologists Union and New York State Museum and Science Service. 567 pp.

Panamerican Consultants, Inc. 1999. Cultural Resources Survey, New York Harbor Collection Removal of Drift Project, Arthur Kill, New York Reach, Arthur Kill, New Jersey and Kill Van Kull, New York Reach, Final Report. 3 Volumes.

Parsons, K.C. 1994. Wildlife habitats on Shooters Island, New York Harbor: characterization study and management recommendations. Prepared for New York District U.S. Army Corps of Engineers.

Pearce, J.B., D.J. Radosh, J.V. Caracciolo, and F.W. Steimle, Jr. 1981. Marine EcoSystem Analysis (MESA) Program. MESA New York bight Program. Benthic Fauna. MESA New York Bight Atlas Monoraph 14. New York Sea Grant Institute. Albany, NY. 79 pp.

Peterson, D.M. 1988. Least tern *Sterna antillarium.* Pp 182 to 183, Roseate Tern Pp. 176-177, and Yellow –crowned hight heron P. 52-53, *In* Andrle, R.F. and J.R. Carroll (eds.), The Atlas of Breeding Birds in New York State. Cornell University Press.

Peterson, J.M.C. 1988b. Barred Owl (*Strix varia*). In R.F. Andrle and J.R. Carroll, eds. 1988. The Atlas of Breeding Birds in New York State. Ithaca: Cornell University Press. 551 pp.

Peterson, D.M, T.S. Litwin, D.C. MacLean and R.A. Lent. 1985. Long Island colonial waterbird and piping plover survey. Cornell Univ. Lab. Of Ornith. Seatuck Res. Program, Islip, New York.

Poole, A. 1989. Ospreys: A natural and unnatural history. Cambridge Univ. Press, Cambridge.

Port Authority of New York and New Jersey (PANY/NJ). 1996. Newark Bay Confined Disposal Facility (NBCDF), subsurface and laboratory investigation report. Report prepared by the Engineering Department.

Port Authority of New York and New Jersey (PANY/NJ). 1994. Staten Island Bridge Program, Goethals Bridge Expansion Subsurface Investigation and Foundation Study. Stage II – Phase I Interim Report.

Raber Associates, Inc. 1996a. Reconnaissance Cultural Resource Investigations, Arthur Kill New Jersey Reach, Union and Middlesex Counties, New Jersey, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Raber Associates, Inc. 1996b. Reconnaissance Cultural Resource Investigations, Arthur Kill New York Reach, Richmond County, new York, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Raber Associates, Inc. 1996c. Reconnaissance Cultural Resource Investigations, Kill Van Kull, new York reach, Richmond County, New York, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Raber Associates, Inc. 1985. Cultural Resources Investigations in Brooklyn reach II; New York Harbor Collection and Removal of Drift Project. On file, US Army Corps of Engineers. New York District.

Raber Associates, Inc. 1984. Cultural Resources Investigations in Brooklyn Reach I; New York Harbor Collection and Removal of Drift Project. On file, US Army Corps of Engineers, New York District.

Reschke, C. 1990. Ecological Communities of New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Latham, NY. March 1990.

Riess, W.C. 1994 Beach Erosion Control Project Atlantic Coast of New York, Rockaway Inlet to Norton Point, Underwater Inspections of Remote Sensing Targets. On file, U.S. Army Corps of Engineers, New York District.

Riess, W. C. 1993. Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York, Section 934 Study, Borrow Areas 1A and B Remote Sensing Survey. On file, U.S. Army Corps of Engineers, New York District.

Roegner, G.C. and R. Mann. 1991. Hard Clam. *In* S.L. Funderburk, J.A. Mihursky, S.J. Jordan, and D. Riley (eds.). Habitat Requirements for Chesapeake Bay Living Resources.

Safina, C. 1985. Tern conservation and restoration - 1985 Report. Nat. Aud. Soc. Scully Sanctuary, Islip, New York.

Safina, C. 1981. The effects of human disturbance on reproductive success in the black skimmer R*ynchops niger*. The Scully Preserve, Nat. Aud. Soc., Islip, NY.

Sadove, S. and P. Cardinale. 1993. Species Composition and Distribution of Marine Mammals and Sea Turtles in the New York Bight. Final Report to United States Fish and Wildlife Service Southern New England – New York bight Coastal Estuaries project Okeanos Ocean Research foundation, Inc. Hampton Bays, New York.

Schaffner, L.C. and R.J. Diaz. 1988. Distribution and abundance of overwintering blue crabs, *Callinectes sapidus*, in the lower Chesapeake Bay. Estuaries 11:68-72.

Seifert, D. J. 1995. Defining Boundaries for National Register Properties. National Register Bulletin 21. U.S. Department of the Interior, National Park Service. Washington D.C.; Government Printing Office.

Shoop, C.R. 1980. Sea Turtles in the Northeast. Maritimes 24:9-11.

Shoop, C.R. and R.D. Kenney. 1992. Seasonal Distribution and Abundances of Loggerhead and Leatherback Sea Turtles in Waters of the Northeastern United States. Herp. Monogr. 1992(6):43-67.

Smith, G.A., and J.M. Ryan. 1978. Annotated checklist of the birds of Oswego County and northern Cayuga County, N.Y. Rise Creek Biological Field Station Bulletin No. 5. Oswego, New York. *In* Andrle and Carroll (1988), The Atlas of Breeding Birds in New York State. Cornell University Press. 550 pp.

Snyder, N. and H. Snyder. 1997. Raptors: North American Birds of Prey. Voyageur Press, Inc. Stillwater, MN.

Spendelow, J.A. 1982. An analysis of temporal vegetation in, and the effects of habitual modification on the reproductive success of roseate terns. Col. Waterbirds 5:19-31.

Spitzer, P.R., R.W. Risebrough, W.W. Walker II, R. Hernandez, A. Poole, D. Puleston, and I.C.T. Nisbet. 1978. Productivity of ospreys in Connecticut-Long island increases as DDE residues decline. Science 202:333-335.

Stanford, S.D. 1996. Engineering and Environmental Geology of the Surficial Materials of the Hackensack Meadowlands and Adjacent Areas, New Jersey and New York. Association of Engineering Geologists. 39th Annual Meeting. pp. D-1 – D-20, September.

Stanley, J.G. and M.A. Sellers. 1986. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic) – American Oyster. U.S. Fish & Wildlife Service Biological Report 82 (11.65). U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS. Technical Report EL-82-4.

Stanley, J.G. 1985. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic) – Hard Clam. U.S. Fish & Wildlife Service Biological Report 82 (11.41). U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg MS. Technical Report EL-82-4.

Staples, J.C. 1998. Letter Dated 11 December 1998 From USFWS.

Steidl, R.J., C.R. Griffin, and L.J. Niles. 1991. Differential reproductive success of ospreys in New Jersey. J. Wildl. Manage. 55:266-272.

Stewart, R.E. 1958. Distribution of the black duck. U.S. Fish Wildlife. Serv., Circ. 51. 8 pp.

Stone, S.L., T.A. Lowery, J.D. Field, S.H. Jury, D.M. Delson, M.E. Monaco, C.D. Williams and L. Andreason. 1994. Distribution and abundance of fishes and invertebrates in Mid-Atlantic estuaries. ELMR Rep. No. 12. NOAA/NOS Strategic Environmental Assessments.

Stott, R.S., and D.P. Olson. 1973. Food-habitat relationship of sea ducks on the New Hampshire coastline. Ecology 54:996-1007.

Sulkin, S.D. and W.F. Van Heukelem. 1986. Variability in the length of the megalopal stage and its consequence to dispersal and recruitment in the portunid crab *Callinectes sapidus* Rathbun. Cited in Van Heukelem, W.F. 1991. Blue Crab. *In* S.L. Funderburk, J.A. Mihursky, S.J. Jordan, D. Riley (eds.). Habitat Requirements for Chesapeake Bay Living Resources.

Sullivan, Kevin J. 1991. Fish and Wildlife Populations and Habitat Status and Trends in the New York Bight.

Suszkowski, D.J. 1978. Sedimentology of Newark Bay, New Jersey An Urban Esturarine Bay. Dissertation – University of Delaware.

Sutton, P. 1995. Short-eared owl. Pages 409-414. In L.E. Dove, and R.M. Nuyman, eds. Living Resources of the Delaware Estuary. The Delaware Estuary program.

Tagatz, ME. 1968. Biology of the blue crab, *Callinectes sapidus* Rathbun. Cited in Hill, J., D.L. Fowler, and M.J. Van Den Avyle. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic) – blue crab. U.S. Fish and Wildlife Service Biological Report 82(11.100). U.S. Army Corps of Engineers, Waterways Experiment Station. Vicksburg, MS. Technical Report EL-82-4.

Terres, J.K. 1980. The Audubon Society Encyclopedia of North American Birds. New York: Alfred A. Knopf. 1109 pp.

Texas Instruments (TI). 1976. Liberty State Park ecological study. Prepared for the Port Authority of New York and New Jersey.

Thompson, B.C. 1982. Distribution, colony characteristics, and population status of least tern breeding on the Texas coast. Ph.D. Dissertation. Texas A&M University. College Station. 150 pp. *In* Carreker 1985.

Tiner, Jr., R.W. 1985. Wetlands of New Jersey. National Wetlands Inventory. U.S.Fish and Wildlife Service. July 1985.

Tompkins, I.R. 1959. Life history notes on the least tern. Wilson Bull. 71(4):313-322.

TQD, 1999. http://tqd.advanced.org/2946/finwhale.htm

United States Coast Guard. (USCG). 1995. Goethals Bridge Modernization and Capacity Enhancement Project. Draft Environmental Impact Statement, Section 4(f) statement.

Union County Soil Conservation Service. 1991. Draft Soil Survey of Union County.

URS Greiner Woodward Clyde. 1998. Geotechnical Investigation and Test Digs; Arthur Kill. Prepared for the U.S. Army Corps of Engineers, New York District. December.

U.S. Army Corps of Engineers – New York District (USACE-NYD). 1999a. New York and New Jersey Harbor Navigation Study. Baseline Biological Reconnaissance Survey.

U.S. Army Corps of Engineers - New York District (USACE-NYD). 1999b. New York and New Jersey Harbor Navigation Study. Environmental Scoping Document.

U.S. Army Corps of Engineers - New York District (USACE-NYD), 1999c Personal Communication Between Ben Baker, USACE, and Mala Ciancia, URSGWC, re. Geology in Project Area, May 12.

U.S. Army Corps of Engineers – New York District (USACE-NYD). 1999d. Biological Assessment for Threatened and Endangered Species in the Port of NY/NJ. Draft. June 3, 1999.

U.S. Army Corps of Engineers – New York District (USACE-NYD) 1998. Existing Biological Data for the New York and New Jersey Harbor: 1998

U.S. Army Corps of Engineers – New York District (USACE-NYD) 1997a. Final Environmental Impact Statement on the Newark Bay Confined Disposal Facility.

U.S. Army Corps of Engineers – New York District (USACE-NYD) 1997b. Final Limited Reevaluation Report and

Final Environmental Assessment and Finding of No Significant Impact: Kill Van Kull-Newark Bay Channels Phase II Deepening Project, New York District, New York, NY.

U.S. Army Corps of Engineers – New York District (USACE – NYD). 1994a. Raritan Bay Anchorages – Deep-Draft Navigation Reconnaissance Study, Volume I and II. New York District. March 1994.

U.S. Army Corps of Engineers – New York District (USACE-NYD). 1987. Newark Bay/Kill Van Kull Navigation Project. Final Supplement to the final Environmental Impact Statement. Appendices. January 1987.

U.S. Army Corps of Engineers (USACE). 1986. Arthur Kill Channel – Howland Hook Marine Terminal, Staten island, New York, Feasibility Report. Navigation Study on Improvements to existing Federal Navigation Channels. Main Report and Environmental Impact Statement. Final Report, March 1986.

U.S. Census Bureau. 1999. http://www.census.gov

U.S. Bureau of the Census. 1994. County & City Data Book: 1994. Washington, DC 1994.



U.S. Environmental Protection Agency. 1997. Supplement to the Environmental Impact Statement on the New York Dredged material Disposal Site Designation for the Designation of the Historic Area Remediation Site (HARS) in the New York bight Apex. May 1997. Prepared by EPA Region 2.

U.S. Fish and Wildlife Service (USFWS). 1999. New York and New Jersey Harbor Navigation Study. Ecological Services Region 5, Pleasantville, New Jersey. 34 p.

U.S. Fish and Wildlife Service (USFWS). 1998a. Assessment of the Dredged Material Management Plan for the Port of New York and New Jersey. Draft Fish and Wildlife Coordination Act Section 2(b) Report.

U.S. Fish and Wildlife Service (USFWS). 1998b. Correspondence dated April 16, 1998.

U.S. Fish and Wildlife Service (USFWS) 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. U.S. Fish and Wildlife Service southern New England – New York Bight Coastal Ecosystems Program Charlestown, Rhode Island, November 1997.

U.S. Fish and Wildlife Service (USFWS). 1993. Perth Amboy and Sandy Hook Dredging Reconnaissance: Fish and Wildlife Resources and Contaminants Study for General Anchorage #44 Raritan Bay East Reach Channel and New York Mud Dump Ocean Disposal Site – Final Planning Aid Report.

U.S. Fish and Wildlife Service (USFWS). 1989. Roseate tern recovery plan northeast population. USFWS, Newton Corner, MA. 78 Pp.

U.S. Fish and Wildlife Service (USFWS). 1988. National List of Plant Species that Occur in Wetlands: Northeast (Region 1). Biological Report 88(26.1) May 1988.

U.S. Fish and Wildlife Service (USFWS). 1986. Planning Aid Report to the U.S. Army Corps of Engineers

U.S. Geological Survey (USGS). 1994. Water Resources Data New Jersey Water Year 1994. Volume 1. Surface-Water Data. U.S. Geological Survey Water-Data Report NJ-94-1.

Van Engel, W.A. 1958. The Blue Crab and its Fishery in Chesapeake Bay. Part 1. Reproduction, Early Development, Growth, and Migration. Commer. Fish. Rev. 20(6):6-17.



Van Heukelem, W.F. 1991. Blue Crab. *In* S.L. Funderburk, J.A. Mihursky, S.J. Jordan, and D. Riley (eds.). Habitat Requirements for Chesapeake Bay Living Resources.

Wakeman, T.H., E. Knoesel, P. Dunlop, and L. Knutson. 1996. Dredged Material Disposal in Subaqueous Pits. Northeastern Geology and Environmental Sciences, 8(4):286-291.

Weiss, H. M. 1995. Marine animals of southern New England and New York. State Geological and Natural History Survey of Connecticut.

Wilbur, S.R. 1974. The literature of the California least tern. U.S. Dep. Int., Washington, DC. Bur. Sport Fish. Wildl. Spec. Sci. Rep. Wildl. 175. 18 pp.

Wilk, .J., R.A. Pikanowski, D.G. McMillan, and E.M. MacHaffie. 1998. Seasonal distribution and abundance of 26 species of fish and megainvertebrates collected in the Hudson-Raritan Estuary, January 1992 – December 1997. Northeast Fish. Sci. Cent. Ref.Doc. 98-10; 145 p.

Will, R. and L.J. Houston. 1992. Fish distribution survey of Newark Bay, May 1987-April 1988. In: Estuarine Research in the 1980's (C. Lavett Smith, ed). The Hudson river Environmental Society, Seventh Annual symposium on Hudson River Ecology.

Willard, D.E. 1977. The feeding ecology and behavior of five species of herons in southeastern New Jersey. The Condor 79:462-470.

Wilson, K.A. and K.W. Able. 1992. Blue Crab (*Callinectes sapidus*) habitat utilization and survival in the Hudson River. Final report to the Hudson River Foundation. August 1992.

Wilson, K.A., K.W. Able, and K.L. Heck, Jr. 1990. Habitat use by juvenile blue crabs: a comparison among habitats in southern New Jersey. Bulletin of Marine Science. 46(1):105-114.

Wolcott, T.G. and A.H. Hines. 1990. Ultrasonic Telemetry of Small-Scale Movements and Microhabitat Selection by Molting Blue Crabs (*Callinectes sapidus*). Cited in Van Heukelem, W.F. 1991. Blue Crab. *In* S.L. Funderburk, J.A. Mihursky, S.J. Jordan, D. Riley (eds.). Habitat Requirements for Chesapeake Bay Living Resources.

Woodhead, P.M.J. 1991. Inventory and Assessment of Habitat and Fish Resources and Assessment of Information on Toxic Effects in the New York-New Jersey Harbor Estuary. A report to the New York-New Jersey Harbor Estuary Program concerning

work in tasks 3.2,5.1, and 5.3. U.S. Environmental Protection Agency, Region 2, New York, New York. 217 pp.

Woodhead, P.M.J., S.S. McCafferty, and M.A. O'Hare. 1987. Assessments of the fish community of the lower Hudson-Raritan Estuary Complex.

Woodward-Clyde Federal Services (WCFS). 1998a. SPT Boring Investigation of the Gravesend, New York, and Stapleton Anchorages. Final Report prepared for the U.S. Army Corps of Engineers, New York District. June, 1998.

Woodward-Clyde Federal Services (WCFS). 1998b. Vibracore Investigation of the Gravesend, New York, and Stapleton Anchorages and Ambrose Channel. Final Report prepared for the U. S. Army Corps of Engineers, New York District. June, 1998.

Workforce New Jersey Public Information Network. 1999. http://wnjpin.state.nj.us

Section 6:

Able, K.W. and F.P. Fahay. 1998. The first year in the life of estuarine fishes in the Middle Atlantic Bight. Rutgers Univ. Press, New Brunswick, NJ 400 p.

Able, K.W., R.E. Matheson, W.W. Morse, M.P. Fahay and G. Shepherd. 1990. Patterns of summer flounder Paralichthys dentatus early life history in the Mid-Atlantic Bight and New Jersey estuaries. Fishery Bulletin 88:1-12.

Able, K.W., D. A. Witting, R.S. McBride, R.A. Rountree, and K.J. Smith. 1996. Fishes of polyhaline estuarine shores in Great Bay – Little Egg Harbor, New Jersey: a case study of seasonal and habitat influences. *in* K.F. Nordstrom and C.T. Roman (eds.) Estuarine shores: Evolution, environments and human alterations. Wiley, Chichester, England.

Anthony, V.C. 1982. Atlantic Herring, *Clupea harengus harengus*. MESA (Mar. Ecosyst. Anal.) N.Y. Bight Atlas Monogr. 15:63-65.

Berg, D.L. and J.S. Levinton. 1985. The biology of the Hudson-Raritan estuary, with emphasis on fishes. NOAA Tech. Mem. NOS OMA 16. 170 pp.

Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish. Wildl. Serv. Bull. 53. 577 p.

Bopp, R.F., M.L. Gross, H. Tong, H.J. Simpson, S.J. Manson, B.L. Deck, and F.C. Moser. 1991. A major incident of dioxin contamination: Sediments of New Jersey Estuaries. Environ. Science and Technology, Vol. 25, No. 5.

Briggs, P.T. and J.S. O'Connor. 1971. Comparison of shore-zone fishes over naturally vegetated and sand-filled bottoms in Great South Bay. New York Fish and Game Journal 18(1):15-41.

Buckley, J. 1989. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic)-winter flounder. U.S. Fish and Wildlife Service, Coastal Ecology Group, Waterways Experiment Station, Vicksburg, MS. (NTIS) 21 pages.

Chang, S. 1998. Essential Fish Habitat Source Document: Windowpane flounder, *Scophthalmus aquosus* (Mitchell), Life History and Habitat Characteristics. National Marine Fisheries Service, Highlands, New Jersey.

Chiarella, L.A. and D.O. Conover. 1990. Spawning season and first-year growth of adult bluefish from the New York Bight. Transactions of the American Fisheries Society 119:455-462.

Coch, N.K. 1986. Sediment characteristics and facies distributions in the Hudson system. Northeastern Geology. 8:109-129.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service. FWS/OBS-79/31. 103p.

Croker, R.A. 1965. Planktonic fish eggs and larvae of Sandy Hook Estuary. Ches. Sci. 6:92-95.

Custer, T.W. and R.G. Osborn. 1978. Feeding habitat used by colonially-breeding herons, egrets, and ibises in North Carolina. Auk. 95:733-743.

Ferraro, S.P. 1980. Daily time of spawning of 12 fishes in the Peconic Bay, New York. Fishery Bulletin 78:455-464.

Hare, J.A. and R.K. Cowen. 1993. Ecological and evolutionary implications of the larval transport and reproductive strategy of bluefish *Pomatomous saltatrix*. Marine Ecological Progress Series 98(1 and 2):1-16.

Howe, A. B., P. G. Coates, and D. E. Pierce. 1976. Winter flounder estuarine year-

class abundance, mortality, and recruitment. Trans. Amer. Fish. Soc. 105(6):647-657.

Howell, P., A. Howe, M. Gibson, S. Ayvazian. 1992. Fishery Management Plan for inshore stocks of winter flounder, *Pleuronectes americanus*. Fisheries Management Report of the Atlantic States Fisheries Commission, No. 21. 138 p

Interstate Sanitation Commission. 1998. Annual Report.

Klein-MacPhee, G. 1978. Synopsis of biological data for the winter flounder, *Pseudopleuronectes americanus* (Walbaum). NOAA Technical Report NMFS Circular 414. FAO Fisheries Synopsis No. 117. 43 pages.

Lawler, Matusky & Skelly Engineers (LMS). 1984. Description of existing water quality, aquatic biology, terrestrial ecology, and infrastructure at Hoboken Waterfront development site. Prepared for the Port Authority of New York and New Jersey. Economic Development Dept.

Lawler, Matusky & Skelly Engineers LLP (LMS). 1997. Water quality monitoring of Howland Hook Dredge Operation. Project No. 712-001.

Lawler, Matusky & Skelly Engineers (LMS). 1993. Arthur Kill Impingement and Entrainment Monitoring Report, September 1991–September 1992. Prepared for Consolidated Edison Co. of New York, Inc. New York, New York.

Lawler, Matusky & Skelly Engineers (LMS). 1994. World Trade Center Impingement and Entrainment Report, March 1991–February 1993. Prepared for the Port Authority of New York and New Jersey, New York, New York.

Lawler, Matusky & Skelly Engineers LLP (LMS). 1996. Biological survey of Newark Bay shoal areas and adjacent Kill Van Kull and Arthur Kill channels. Prepared for the Port Authority of New York and New Jersey.

Long, E.R., D.A. Wolfe, K.J. Scott, G.B. Thursby, E.A. Stern, C. Peven, and T. Schwartz. 1995. Magnitude and extent of sediment toxicity in the Hudson Raritan Estuary. National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NOSORCA 88.

McBride, R.S. and D.O. Conover. 1993. Recruitment of young-of-year bluefish *Pomatomous saltatrix* to the New York Bight: variation in abundance and growth of spring- and summer-spawned cohorts. Marine Ecological Progress Series 78(3):205-216.

MAFMC (Mid-Atlantic Fisheries Management Council). 1998. Amendment 12 to the summer flounder, scup, and black sea bass fishery management plan. October 1998. 398 pp. + append.

MAFMC (Mid-Atlantic Fisheries Management Council). 1996. Amendment 9 to the summer flounder fishery management plan: fishery management plan and draft environmental impact statement for the black sea bass fishery. Dover, DE. 152 p. + append.

Morse, W.W. 1978. Biological and fisheries data on scup, *Stenotomus chrysops* (Linnaeus). Sandy Hook Lab. Tech. Rept. No. 14 (NEFSC). 41 pp.

Morse, W.W. and K.W. Able. 1995. Distribution and life history of windowpane, *Scophthalmus aquosus*, off the northeastern United States. U.S. Fishery Bulletin 93:675-693.

Mid-Atlantic Fishery Management Council (MAFMC). 1998. Amendment 8 to the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan, August 1998. NOAA Award No. NA57FC0002.

Mueller, J.A., T.A. Gerrish, and M.C. Casey. 1982. Contaminated inputs to the Hudson-Raritan Estuary. NOAA Technical Memorandum OMPA-21, 446 pp.

National Marine Fisheries Service (NMFS). 1999. Personal Communication. Email from Karen Greene Dated September 1, 1999.

National Marine Fisheries Service. 1998. Essential Fish Habitat: New Marine Fish Habitat conservation Mandate for Federal Agencies. December 1998.

National Marine Fisheries Service. 1994. Results of a biological and hydrological characterization of Newark Bay, New Jersey, May 1993-April 1994.

Neuman, M.J. and K.W. Able. 1998. Experimental evidence of sediment preference by early life history stages of windowpane, (*Scophthalmus aquosus*). Journal of Sea Research.

New York City Department of Environmental Protection. 1999. New York Harbor Water Quality Survey 1999.

Olsen, C.R., I.L. Larsen, R.H. Brewster, N.H. Cutshall, R.F. Bopp, and H.J. Simpson. 1984. A geochemical assessment of sedimentation and contaminant distributions in

the Hudson-Raritan Estuary. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN. NOAA Technical Report NOS OMS 2. 101 pp.

Packer, D.B. and S.J. Griesbach. 1998. Draft Essential Fish Habitat Source Document: Summer flounder, *Paralichthys dentatus*, Life History and Habitat Characteristics. National Marine Fisheries Service, Highlands, NJ.

Pacheco, A.L. 1983. Seasonal occurrence of finfish and larger invertebrates at three sites in lower New York Harbor, 1981-1982. NOAA Sandy Hook Laboratory. Final Report to NY District Corps of Engineers. Support Agreement NYD82-88(C).

Parish and Weiner, Inc. 1989. River Walk Draft Environmental Impact Statement, Prepared for: The Related Companies Inc.

Pearcy, W.G. 1962. Ecology of an estuarine population of winter flounder, *Pseudopleuronectes americanus* (Walbaum). Parts I-IV. Bull. Bingham. Oceanogr. Collect. 18(1):5-78.

Reid, R., L. Cargnelli, S. Griesbach and D. Packer. 1998. Essential Fish Habitat Source Document: Atlantic Herring, Clupea harengus L., Life History and Habitat Characteristics. National Marine Fisheries Service, Highlands, NJ.

Rose, K. A., J. A. Tyler, R. C. Chambers, G. Klein-MacPhee, and D. J. Danila. 1996. Simulating winter flounder population dynamics using coupled individual-based young-of-the-year and age-structured adult models. Canadian Journal of Fisheries and Aquatic Science. 53:1071-1091.

Schoelkopf, R.C. and E. Stetzar. 1995. Diamondback terrapin. Pp. 299-304 *In* L.E. Dove and R.M. Nyman (eds.) Living Resources of the Delaware Estuary. The Delaware Estuary Program.

Sisson, R.T. 1974. The growth and movements of scup (*Stenotomus chrysops*) in Narragansett Bay, Rhode Island and along the Atlantic coast. Cited in Able, K.W. and F.P. Fahay. 1998. The first year in the life of estuarine fishes in the Middle Atlantic Bight. Rutgers Univ. Press, New Brunswick, NJ 400 p.

Sindermann, C.J. 1979. Status of northwest Atlantic herring stocks of concern to the United States. NMFS Sandy Hook Lab. Tech. Ser. Rep. 23. 449 p.

Steimle, F. W. Morse, P. Berrien and D. Johnson. 1998. Essential Fish Habitat Source Document: Red Hake, Urophycis chuss, Life History and Habitat Characteristics. National Marine Fisheries Service, Highlands, New Jersey.



Squibb, K.S., J.M. O'Connor, and T.J. Kneip. 1991. New York/New Jersey Harbor Estuary Program. Module 3.1: Toxics Characterization Report. Institute of Environmental Medicine, New York University Medical Center, Tuxedo, NY, 188 pp.

Squires, D.F. 1992. Quantifying anthropogenic shoreline modification of the Hudson River and Estuary from European Contact to Modern Time. Coastal Management. Vol. 20, pp. 343-354.

Stone, S.L., T.A. Lowery, J.D. Field, S.H. Jury, D.M. Nelson, M.E. Monaco, C.D. Williams, and L. Andreason. 1994. Distribution and Abundance of Fishes and Invertebrates in the Mid-Atlantic Estuaries. ELMR Rep. No. 12. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD. 280 p.

Szedlmayer, S.T. and K.W. Able. 1996. Patterns of seasonal availability and habitat use by fishes and decapod crustaceans in a southern New Jersey estuary. Estuaries 19(3).

Topp, R. W. 1968. An estimate of fecundity of the winter flounder, *Pseudopleuronectes americanus*. Jour. Fish. Res. Board Canada. 25(6):1299-1302.

U.S. Army Corps of Engineers – New York District (USACE-NYD). 1999a. Dredged Material Management Plan for the Port of New York and New Jersey. Implementation Report. September, 1999.

US Army Corps of Engineers – New York District (USACE-NYD). 1999b. New York and New Jersey Harbor Navigation Study. Existing Biological Data for the New York and New Jersey Harbor:1998.

US Army Corps of Engineers – New York District (USACE-NYD). 1999c. New York and New Jersey Harbor Navigation Study. Baseline Biological Reconnaissance Survey.

U. S. Army Corps of Engineers – New York District (USACE-NYD). 1999d. Biological Assessment for Threatened and Endangered Species in the Port of NY/NJ. July 1999. 36pages.

U.S. Army Corps of Engineers (USACE). 1982. Navigation and navigable waters; chapter II, regulatory programs of the corps of Engineers, Vol 47, No. 138, p.31810

U. S. Fish and Wildlife Service (USFWS). 1999. Draft Fish and Wildlife Coordination Act Section 2(b) Report New York and New Jersey harbor Navigation Study August 1999. 34 pages plus Appendices.

U.S. Fish and Wildlife Service (USFWS). 1997. Biological Opinion on the Effects of Channel Deepening Activities within the Arthur Kill, Kill Van Kull, and Newark Bay Channels, New York and New Jersey, on the Peregrine Falcon.

Section 7:

Bokuniewicz. 1986. Subaqueous Borrow Pits as Fine-Grain Sediment Traps. Ltr (1 Aug 1986) Plan Div. NYD. 2pp.

Brouwer, N. 1981. Survey of Cultural Resources in the Form of Derelict Ships and Barges Area I of Shooters Island, New Jersey and New York Harbor Collection and Removal of Drift Project.

Brouwer, N. 1983. Survey of Cultural Resources in the Form of Derelict Ships and Barges in Area II (Completion) of Shooters Island, New Jersey, New York Harbor Collection and Removal of Drift Project.

Cerrato, R.M. H.L. Bokuniewicz, M.H. Wiggins. 1989. A spatial and seasonal study of the benthic fauna of the lower Bay of NY Harbor. Marine Sciences Research Center Special Report 84. State University of New York at Stony Brook, NY.

Dickerson, D.D., K.J. Reine and D.G. Clarke. 1998. Economic impacts of environmental windows associated with dredging operations. DOER Technical Notes Collection (TN DOER-E3), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/dots/doer

Flagg, T. 1986. Documentation for Determination of Eligibility for Bush Terminal, Brooklyn, New York.

Geoarcheology Research Associates. 1999. A Geomorphological and Archaeological Assessment of the New York and New Jersey Harbor Navigation Channels.

Historic American Engineering Record (HAER). No Date.

HAER No. NY-147: West 55th Street and West 56th Street Piers (Piers 95 and 96, North River)

HAER No. NY-201: Bush Terminal Company (Bush Terminal)

HAER No. NY 201a: Bush Terminal Company Pier 7 (Bush Terminal: Pier 7)
HAER No. NY-201b: Bush Terminal Company Pier 5 (Bush Terminal: Pier 5)
HAER No. NY-202: Brooklyn Army Terminal Supply Base (Brooklyn Military Ocean Terminal) (Brooklyn Army Terminal)
HAER No. NY-203: South Brooklyn Freight Terminal: 29th Street Pier (Isbrantsen Pier)

Henn, R. 1985. Preliminary Assessment of Cultural Resources, Port Jersey, Hudson County, New Jersey.

Kardas, S. and E. Larrabee. 1977. Cultural Resource Reconnaissance Northeast Shore, Staten Island, New York Harbor Collection and Removal of Drift Project.

Kardas, S. and E. Larrabee. 1978. Cultural Resource Reconnaissance Jersey City Reach New York Harbor Collection and Removal of Drift Project.

Kardas, S. and E. Larrabee. 1979. Information Recording (Task I Survey) Greenville Yards Jersey City, New Jersey.

Kardas, S. and E. Larrabee. 1980. Cultural Resources Reconnaissance New York Harbor Collection and Removal of Drift Area of Elizabeth, Union County, New Jersey.

Kardas, S. and E. Larrabee. 1983. Cultural History Recording of the Greenville Yard Jersey City, Hudson County, New Jersey.

Kardas, S. and E. Larrabee. 1985a. Cultural Resource Reconnaissance New York Harbor Collection and Removal of Drift Project Bayonne Reach, Hudson County, New Jersey. Volumes I and II

Kardas, S. and E. Larrabee. 1985b. Historic American Building Survey/Historic American Engineering Record Level Recordation at the Ships Graveyards at Shooters Island Staten Island, Richmond County, New York and Bayonne - Elizabeth, Hudson and Union Counties, New Jersey.

LaPorta, P. C., L. E. Sohl and M. C. Brewer. 1999. Cultural Resource Assessment of Proposed Dredged Material Management Alternative Sites in the New York Harbor-Apex, Affecting the Coastal Areas of New York, Queens, Kings and Richmond Counties in New York and Bergen, Hudson, Middlesex and Monmouth Counties in New Jersey. On file, US Army Corps of Engineers, New York District.

Louis Berger and Associates, Inc. 1983. Supplementary Cultural Resource Reconnaissance, Stapleton, Staten Island Reach, New York Harbor Collection and Removal of Drift.

Panamerican Consultants, Inc. 1991. Underwater Inspection of the Seven Port Johnson Sailing Vessels, Bayonne Reach, New York Harbor Collection and Removal of Drift Project, Hudson County, New Jersey.

Panamerican Consultants, Inc. 1999. Cultural Resources Survey, New York Harbor Collection Removal of Drift Project, Arthur Kill, New York Reach, Arthur Kill, New Jersey and Kill Van Kull, New York Reach, Final Report. 3 Volumes.

Raber Associates, Inc. 1996a. Reconnaissance Cultural Resource Investigations, Arthur Kill New Jersey Reach, Union and Middlesex Counties, New Jersey, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Raber Associates, Inc. 1996b. Reconnaissance Cultural Resource Investigations, Arthur Kill New York Reach, Richmond County, new York, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, new York District.

Raber Associates, Inc. 1996c. Reconnaissance Cultural Resource Investigations, Kill Van Kull, new York reach, Richmond County, New York, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Raber Associates, Inc. 1985a. Cultural Resources Investigations in Brooklyn reach II; New York Harbor Collection and Removal of Drift Project. On file, US Army Corps of Engineers. New York District.

Raber Associates, Inc. 1985b. Documentation for Determination of Eligibility for Bush Terminal Brooklyn, Kings County, New York.

Raber Associates, Inc. 1985c. Todd Shipyards, Erie Basin Addendum To: Cultural Resources Investigations in Brooklyn Reach I, New York Harbor Collection and Removal of Drift Project.

Raber Associates, Inc. 1984. Cultural Resources Investigations in Brooklyn Reach I; New York Harbor Collection and Removal of Drift Project. On file, US Army Corps of Engineers, New York District.

Reine, K. and D. Clarke. 1998a. Entrainment by hydraulic dredges—A review of potential impacts. DOER Technical Notes Collection (TN DOER-E1), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/dots/doer

Reine, K. J., D. D. Dickerson and D. G. Clarke. 1998b. Environmental windows associated with dredging operations. DOER Technical Notes Collection (TN DOER-E2), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/dots/doer

Rockman, D. DiZerega and N. Rothschild. 1979. A Preliminary Assessment of Cultural Resources On Shooters Island, Richmond County, New York and Hudson and Union Counties, New Jersey.

Sanders, L. and J. Killgore. 1989. Seasonal restrictions on dredging operations in freshwater systems. Environmental Effects of Dredging, Technical Notes (EEDP-01-16), U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

United States Army Corps of Engineers (USACE). 1990, 1997. Policy and Planning – Guidance for Conducting Civil Works Planning Studies. Publication Number: ER 1105-2-100. 28 December 1990.

United States Army Corps of Engineers (USACE). 1987. Beneficial Use of Dredged Material. USACE No. EM0111-2-5026. June 1987.

United States Army Corps of Engineers (USACE). 1997a. New York Harbor Collection and Removal of Drift Project: Kill Van Kull, New York Reach. Limited Reevaluation Report. Preliminary Working Draft. November 7, 1997.

United States Army Corps of Engineers (USACE). 1997b. New York Harbor Collection and Removal of Drift Project: Arthur Kill, New Jersey Reach. Limited Reevaluation Report. Preliminary Working Draft. October 6, 1997.

U.S. Army Corps of Engineers – New York District (USACE -NYD). 1999a. Dredged Material Management Plan for the Port of New York and New Jersey. Implementation Report, Programmatic Environmental Impact Statement, and Technical Appendix. September 1999.

United States Army Corps of Engineers (USACE). 1999b. Beneficial Uses of Dredged Material for Habitat Creation, Enhancement, and Restoration in the NY/NJ Harbor (Draft). February, 1999.



United States Army Corps of Engineers (USACE). 1999c. Draft Conceptual Mitigation Plan: Arthur Kill-Howland Hook Federal Navigation Channel Deepening and Realignment Project. Prepared for USACE by Northern Ecological Associates, Inc. Contract Number DACW51-97-D-0010, Delivery Order 0051. June 18, 1999.

Wagner, D.P., PhD. and P.E. Siegel, PhD. 1997. A Geomorphological and Archaeological Analysis of the Arthur Kill - Howland Hook Marine Terminal Channel, Richmond County, New York and Union County, New Jersey. On file, U.S. Army Corps of Engineers, New York District.

Wegman Engineers. 1983. New York Harbor Collection and Removal of Drift Jersey City Reach: Evaluation of Piers 20, 21 and 22.

Section 8:

Lawler, Matusky & Skelly Engineers LLP (LMS). 1997. Water quality monitoring of Howland Hook Dredge Operation. Project No. 712-001.

New Jersey Department of Environmental Protection (NJDEP). 1997. The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters. October 1997.

Section 9:

New Jersey Department of Environmental Protection (NJDEP). 1997. The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters. October 1997.

Bibliography

Allee, King, Rosen & Fleming, Inc. 1994. Staten Island Bridges Program – Modernization and Capacity Enhancement Project,Historic Resources Survey, City of Elizabeth, Union County.

Alpine Ocean Seismic Survey, Inc. And Panamerican Consultants, Inc. 1992. "Proposed 30" Liberty Pipeline from Morgan, New Jersey Across Raritan Bay, Lower New York Bay and the Atlantic Ocean to Edgemere, New York (2 volumes).

Alpine Ocean Seismic Survey, Inc.and Panamerican Consultants Inc. n.d., Final report "Proposed Junction Platform Near Edgemere, New York." Hazard and Archaeological Survey, Phase 2 - Liberty Pipeline, Offshore New York.

American Ornithologists' Union. 1983. Checklist of North American birds, 6th ed. Am. Ornithologists' Union, Washington, D.C.

Anderson, B.H. 1972. Some uncommon avian records for central Florida. Florida Nat. 45(6):192. *In* Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Andrle, R.F., and J.R. Carroll. 1988. The Atlas of Breeding Birds in New York State. Cornell University Press. 550 pp.

Atwood, J.L., and D.E. Minsky. 1983. Least tern foraging ecology at three major California breeding colonies. Western Birds 14(2):57-72.

Atwood, J.L., R.A. Erickson, P.R. Kelly, and P. Unitt. 1979. California least tern census and nesting survey, 1978. Endangered Wildlife Program E-W-2, Nongame Wildl. Invest., California Dept. Fish Game, Job V-2.13, Job Final Report (July 1979). v. p. *In* Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Austin, O.L. 1948. Predation by the common rat (*Rattus norvegicus*) in Cape Cod colonies of nesting terns. Bird Banding 19:60-65.

Barclay, J.S. and D.F. Squires. 1991. Wildlife Habitats and Populations in the New York/New Jersey Estuary,. The University of Connecticut, Department of Natural Resource Management and Engineering and the Marine Sciences Institute. Storrs, Connecticut.

Bauersfeld, W.R., E.W. Moshinsky, and C.E. Gurney. 1994. Water Resources Data - New Jersey, Water Year 1994: Volume 1. Surface-Water Data. U.S. Geological Survey (USGS) Water-Data Report NJ-94-?. Prepared In Cooperation With The New Jersey Department Of Environmental Protection And Other Agencies.

Baystate Environmental Consultants, Inc. 1993. Cultural Resources Survey for Base Closure and Realignment, Redevelopment and Reuse of Excess Property at Naval Weapons Station New York, Brooklyn, New York.

Bent, A.C. 1923. Life Histories of North American Wildfowl. Vol. I and II. New York: Dover Publications, Inc. 685 pp.

Bokuniewicz, H. 1996. "Building the Turbidity Maximum in the Hudson River Estuary", Special Report No. 115 (96-06), Marine Sciences Research Center, State University of New York, Stony Brook.

Brouwer, N. 1976. Reconnaissance of Marine Archeological Remains in Priority Area I, Liberty State Park; U.S. Army Corps of Engineers Drift Removal Project.

Brouwer, N. 1977. Survey of Cultural Resources in the Form of Derelict Ships and Boats: Priority Area 2 of Liberty State Park New York Harbor Collection and Removal of Drift Project (20 Supplement S1).

Brouwer, N. 1977. Survey of Cultural Resources in the Form of Derelict Ships and Boats: Priority 3 Area of Liberty State Park New York Harbor Collection and Removal of Drift Project (20 Supplement S2).

Brouwer, N. 1977. Survey of Cultural Resources in the Form of Derelict Ships and Boats: Priority 4 Area of Liberty State Park New York Harbor Collection and Removal of Drift Project (20 Supplement S3).

Brouwer, N. 1981. Survey of Cultural Resources in the Form of Derelict Ships and Barges Area I of Shooters Island, New Jersey New York Harbor Collection and Removal of Drift Project.

Brouwer, N. 1983. Survey of Cultural Resources in the Form of Derelict Ships and Barges in Area II (Completion) of Shooters Island, New Jersey, New York Harbor Collection and Removal of Drift Project.

Brouwer, N. 1984. Survey of Cultural Resources in the From of Derelict Ships and Barges, Hudson River Shoreline of Edgewater, New jersey New York Harbor Collection and Removal of Drift Project.

Brouwer, N. 1985. Text: Recording of Selected Barges lying at Edgewater, New Jersey, Supplement to: Survey of Cultural Resources in the Form of Derelict Ships, Hudson River Shoreline of Edgewater, New Jersey (April 1984), New York Harbor Collection and Removal of Drift Project.

Brown, L. 1979. Grasses: An Identification Guide. Sponsored by the Roger Tory Peterson Institute. Houghton Mifflin Company.

Buckley, P.A. and F.G. Buckley. 1981. The endangered status of North American roseate terns. Col. Waterbirds 4:166-173.

Buckley, P.A. and F.G. Buckley. 1980. Populations and colony-site trends of Long Island waterbirds for 5 years in the mid-1970's. Transactions of the Linnaean Soc. of New York 9:23-56.

Bull, J. 1974. Birds of New York State. Comstock Publishing Associates, a division of Cornell University Press. 703 pp.

Bull, J. 1985. Birds of New York State. Comstock Publishing Associates, Cornell Universtiy Press, Ithaca, NY.

Bull, J., Jr. 1964. Birds of the New York City area. Harper and Row, New York.

Carreker, R.G. 1985. Habitat Suitability Index Models: Least Tern. USF&W Biological Report 82/10. 103 29 pp.

Connor, P.F. 1988. Pied-billed grebe, *Podilymbus podiceps*. Pages 28-29 in Andrle, R.F.and J.R. Carroll, eds. The atlas of breeding birds in New York State. Cornell Univ. Press, Ithaca, NY. 551 pp.

Cook, A. 1957. Man, Marshes, and Ducks. New York State Conservationist 11(5):12-13.

Coyne, J.S. Drucker, A. Haskell and N. Krieg. 1977. New York Waterfront: A Preliminary Study of (Still) Existing Structures.

Cox L.J. Jr. 1993. Archaeological Assessment of the Long Slip Canal, Hoboken and Jersey City, Hudson County, New Jersey.

Cox, J.L. 1998. Magnetic & Acoustic Remote Sensing Survey Field Support for Dredged Material Management Alternatives NY/NJ Harbor. Submitted to Dames & Moore. On file, .S. Army Corps of Engineers, New York District.

Cruickshank, A.D. 1942. Birds around New York City. The American Museum of Natural History. Handbook Series no. 13, NY.

Cultural Resource Consulting Group, The. 1996. Phase 1B Cultural Resource Survey. Proposed Federal Aviation Administration Terminal Doppler Weather Radar Facility, USCG Air Station Brooklyn, Borough of Brooklyn, Kings County, New York.

Dadswell, M.J., B.D.Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological Data on Shornose Sturgeon, *Acipenser brevirostum* LeSueur 1818. NOAA Techinical Report NMFS 14:53p.

Documentation Provided to Assistant Commissioner Helen Fenske Assistant State Historic Preservation Officer Department of Environmental Protection , State of New Jersey.

Dolphins, 1999. http://library.advanced.org/17963/genus-Tursiops.html.

Dolphins, 1999. http://library.advanced.org/17963/genus-Delphinus.html.

Dorr, D.K. 1976. Least tern, *Sterna albifrons*, nesting habitat in Maine and its relevance to the Critical Areas Program. Maine State Planning Office Report 11. 21 pp. In Carreker. 1985. Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Dovel, W.L. 1992. Movements of immature striped bass in the Hudson Estuary. In C.L. Smith, Ed. Estuarine Research in the 1980s. The Hudson River Environmental Society Seventh Symposium on Hudson River Ecology. 276-300.

Downing, R.L. 1973. A preliminary nesting survey of least terns and black skimmers in the east. Am. Birds 27(6):946-949.

Drobbin, L. 1993. Request for Determination of Eligibility for Long Slip Canal, Hoboken and Jersey City, Hudson County, New Jersey.

Eaton, E.H. 1910. Birds of New York, part 1. Univ. of the State of New York, Albany.

Eaton, S.W. 1988. American bittern, *Botaurus lentiginosus*. Pages 32-33 in R.F. Andrle and J.R. Carroll, eds. The atlas of breeding birds in New York State. Cornell Univ. Press, Ithaca, NY. 551 pp.

Ebasco Environmental. 1990. Preliminary Evaluation of the Archaeological Potential of the Staten Island Portion of the Linden Cogeneration Project.

Edwards and Kelsey Engineers, Inc. 1999. Strategic Plan for the Redevelopment of the Port of New York, Task 8 – Draft Environmental Screening Technical memorandum. Prepared for the NYC Economic Development Corporation.

Ehrlich, P.R., D.S. Dobkin and D. Wheye. 1988. The birder's handbook. Simon and Schuster, Inc., New York.

Eisenberg, L. 1987. Preliminary Assessment of Cultural Resources Arthur Kill Extension Howland Hook to Tufts Point.

Engebretson, J.E. 1982. New York Harbor and Adjacent Channels Study: Shipwreck Inventory.

Erwin, R.M. 1978. Coloniality in terns: the role of social feeding. Condor 80(2):211-215.

Erwin, R.M. 1979. Coastal waterbird colonies: Cape Elizabeth, Maine to Virginia. FWS/OBS-79/10. U.S. Fish and Wildlife Service, Office of Biol. Services. Washington, D.C.

Erwin, R.M., and C.E. Korschgen. 1979. Coastal waterbird colonies: Maine to Virgina, An atlas showing colony locations and species composition. U.S. Fish and Wildlife Service, Biological Services Program, FWS/OBS-79/08.

Fay, C.W., Neves, R.J., and G.B. Pardue. 1986. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic) – Softshell Clam. U.S. Fish & Wildlife Service Biological Report 82 (11.68). U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS. Technical Report EL-82-4.

Federal Highways Administration. 1983. Building-Structure Inventory Forms Westway Project

Ferguson, J. 1986. Preliminary Assessment of Cultural Resources Sensitivity for the Lower New York Bay, New York and New Jersey.

Fisk, E.J. 1975. Least tern: beleaguered, opportunistic, and roof-nesting. Am. Birds 29(1):15-16.

Fittipaldi, J.A. 1980. Urban Park and Recreation Recovery Program 1980 City of Elizabeth, Union County Dowd Playfield, Arabella Miller/Mack Plaza.

Flagg, T. 1986. Documentation for Determination of Eligibility for Bush Terminal, Brooklyn, New York.

Flagg, T. 1991. Cultural Resource Survey, Newark Bay Site: Main Parcel and Pier Parcel, Staten Island New York, New York City Long Range Sludge Management Plan GEIS III.

Flagg, T., G. Weinstein and N. Brower. 1991. Reconnaissance of Marine Cultural Resources at the Newark Bay Site, Staten Island. New York City Long Range Sludge Management, GEIS III, New York City Department of Environmental Protection.

Flagg, T., G. Weinstein and N. Brower. 1992 Reconnaissance of Marine Cultural Resources at the Newark Bay Site, Staten Island,New York. New York, New York City Long Range Sludge Management Plan GEIS III.

Florio, P. 1982. Erie Lackawanna Terminal Historic Structures Report, Hoboken, New Jersey.

Forbes, M.R.L., H.P. Barkhouse and P.C. Smith. 1989. Nest-site selection bypied-billed grebes (*Podilymbus podiceps*). Ornis. Scan. 20: 2019-2023.

Geismar, J.H. And S.J. Oberon. 1992. Stage 1A Cultural Resources Survey Documentary Study and Assessment of Potential Impact, Proposed Navy Yard Cogeneration Facility, Borough of Brooklyn, Kings County, New York.

Geismar, J.H. 1993, Bayonne Extension, Archaeological Study for the Hudson-Bergen Light Rail System.

Geismar, J.H., Ph.D. 1996. Archaeological Evaluation (Stage 1A Documentary Study), Former Naval Station (NAVSTA), New York, Navy Yard Annex Site, Brooklyn, New York.

Geoarcheology Research Associates. 1998. A Geomorphological and Archaeological Assessment of the New York and New Jersey Harbor Navigation Channels.

Gibbs, J.P. and S.M. Melvin. 1992. American bittern, *Botaurus lentiginosus*. Pages 51-69 in K.J. Schneider and D.M. Pence, eds. Migratory nongame birds of management concern in the northeast. U.S. Dept. Inter., Fish and Wildl. Serv., Newton Corner, MA.

Gibbs, J.P. and S.M. Melvin. 1992. Pied-billed grebe, *Podilymbus podiceps*. Pages 31-49 in K.J. Schneider and D.M. Pence, eds. Migratory nongame birds of management concern in the Northeast. U.S. Dept. Inter., Fish and Wildl. Serv., Newton Corner, MA. 400 pp.

Gilbert, C.R. 1989. Species profiles: Lofe histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight) – Atlantic and shortnose sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL-82-4. 28p.

Golden, M.R., C. Ricioppo, R. Leopold and D V. Tierce. 1990. Report of the National Park Service. Unpubl. report.

Gorham, S.W., and D.E. McAllister. 1974. The shortnose sturgeon *(Acipenser brevirostrum)* in the Saint John River, New Brunswick, Canada, a rare and possibly endangered species. Syllogeus No. 5, National Museum of Canada, Ottawa.

Greeley, J.R. 1937. Fishes of the area with annotated list. Pp. 45-104 in Biological Survey of the Lower Hudson Watershed. 26th Annual Rept. NY Conservation Dept.(Suppl.).

Griscom, L. 1923. The birds of the New York City region. The American Museum of Natural History. Handbook series no. 9, NY.

Greenhouse Consultants, Inc. 1990. Stage I/II Historical and Archaeological Investigations of Richmond Terrace, Borough of Staten Island, New York.

Harbor Estuary Program. 1999. National Estuary Program Profiles: NY-NJ Harbor. http://earth1.epa.gov/OWOW/estuaries/hep/htm.

Hardy, J.W. 1957. The least tern in the Mississippi Valley. Publ. Mus. Michigan State Univ. Biol. Ser. 1(1):1-60. In Carreker. 1985. Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Harris, W. 1980. Historic Background Study of Block 74W. Prepared for Office of Economic Development.

Harris R. Frederic Inc. and Wallace, Roberts & Todd. 1991. North Terminal Bulkhead and Walkway, Liberty State Park, Jersey City, New Jersey.

Harrison, P. 1985. Seabirds: an identification guide. Houghton Mifflin Co., Boston.

Hartgen Archaeological Associates, Inc. 1987. Literature Review and Cultural Resource Inventory of the Charles B. Poletti Power Project, Astoria Queens, County, New York. Prepared for the New York Power Authority.

Hartgen Archaeological Associates, Inc. 1995. Report of Archaeological Potential for Goethals Bridge Expansion, Staten Island Bridges Program, Richmond County, New York and Union County, New Jersey.

Hartgen Archaeological Associates, Inc. Cultural Resources/Section 106 Compliance of the Environmental Impact Statement for the Newark Bay Confined Disposal Facility (NBCDF), Essex County, New Jersey.

Hays, H. 1984. The vole that soared. Nat. Hist. 93(5):7-16.

Henn, R. 1985. Preliminary Assessment of Cultural Resources, Port Jersey, Hudson County, New Jersey.

Heritage Studies 1982. Cultural Resource Survey for the Caven Point Waterfront Development, Jersey City, Hudson County, New Jersey.

Historic American Engineering Record (HAER). No Date.

HAER No. NY-147: West 55th Street and West 56th Street Piers (Piers 95 and 96, North River).
HAER No. NY-201: Bush Terminal Company (Bush Terminal).
HAER No. NY 201a: Bush Terminal Company Pier 7 (Bush Terminal:

Pier 7).
HAER No. NY-201b: Bush Terminal Company Pier 5 (Bush Terminal: Pier 5).
HAER No. NY-202: Brooklyn Army Terminal Supply Base (Brooklyn Military Ocean Terminal) (Brooklyn Army Terminal).
HAER No. NY-203: South Brooklyn Freight Terminal: 29th Street Pier (Isbrantsen Pier).

Historic Conservation and Interpretation. 1980. Photographic Recording and Architectural Description of the Standing Structures, Pier 19 Liberty State Park, Jersey City, New Jersey.

Historic Conservation and Interpretation. 1983. Westside Highway Cultural Resource Survey Archeological Work Program: Cultural Resources Research.

Historical Perspectives, Inc. n.d. Archaeological Monitoring: Soil and Foundation testing at the Empire Stores,Brooklyn, Kings County, N.Y.

Historical Perspectives Inc. 1982. Empire Stores Report: Archaeological Monitoring for Two Trees Management Company,Brooklyn, Kings County, New York.

Historical Perspectives Inc. 1996. Charleston Retail Center, Veterans Road West, Staten Island, Phase 1A Archaeological Assessment.

Hunter Research Inc. (Richard Porter, Richard Hunter and Diana Zakalak) 1991. A Cultural Resource Assessment for the North Terminal Walkway and Bulkhead Liberty State Park, City of Jersey City, Hudson County, New Jersey.

Hunter Research, Inc. Ellis Island Archaeological Investigations, Statue of Liberty-Ellis Island Foundation, National Park Service.

Hyrdoqual, Inc. 1991. "The Transport through the East River from Data and Three Dimensional Hydrodynamic Modelling", report prepared for the Management Committee, Long Island Sound Estuary Study and the New England Interstate Water Pollution Control Commission.

Jackson, J.A., and B.J.S. Jackson. 1985. Status, dispersion, and population changes of the least tern in coastal Mississippi. Colonial Waterbirds. 8(1):54-62.

Jacobsen, J. 1961. 1961 Archaeological Research Near Burial Ridge, Tottenville.

James, S. 1987. An Underwater Archaeological Inspection of Four Sites Identified as Shipwrecks U.S. Dike, Union County, New Jersey.

James, S. 1987. An Underwater Cultural Resources Survey and Determination of Eligibility of Five Shipwrecks U.S. Dike, Arthur Kill Channel Union County, New Jersey.

Jernigan, L.R., J. Parnell, and T. Quay. 1978. Nesting habitats and breeding populations of the least tern (*Sterna alifrons antillarum*) in North Carolina. Natls. Oceanic Atmos. Admin., Sea Grant Publ. UNC-SG-78-07. 39 pp. In Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Johnson, B.H. and T.M. Pachure. 1999. Estimating dredging sediment resuspension sources. DOER Technical Notes Collection (TN DOER-E6), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/dots/doer.

Kardas, S. and E. Larrabee. 1976. A Preliminary Archaeological Reconnaissance for Cultural Resources, Kill Van Kull and Newark Bay Channel Dredging Project.

Kardas, S. and E. Larrabee. 1976. Prehistoric and Historic Archaeological Reconnaissance for Cultural Resources: Priority Area I Liberty Park, New York Harbor Collection and Removal of Drift.

Kardas, S. and E. Larrabee. 1976. Report of Archeological Resources Probability and Significance and Recommendations for Protection, Ferry Slip and Approach Channel, Ellis Island.

Kardas, S. and E. Larrabee. 1976. Survey for Prehistoric and Historic Archaeological Sites and Historic Sites and Structures. Route 169 and Route 440 from the Bayonne Bridge in Bayonne to the Vicinity of Bayview Avenue in Jersey City. Hudson County, New Jersey.

Kardas, S. and E. Larrabee. 1977. Cultural Resource Reconnaissance East River Reach, New York Harbor Collection and Removal of Drift Project.

Kardas, S. and E. Larrabee. 1977. Cultural Resource Reconnaissance Northeast Shore, Staten Island, New York Harbor Collection and Removal of Drift Project.

Kardas, S. and E. Larrabee. 1978. Cultural Resource Reconnaissance Jersey City Reach New York Harbor Collection and Removal of Drift Project.

Kardas, S. and E. Larrabee. 1979. Cultural Resources Survey Exchange Place and Pavonia Avenue Ferries, Jersey City, New Jersey.

Kardas, S. and E. Larrabee. 1979. Information Recording (Task I Survey) Greenville Yards Jersey City, New Jersey.

Kardas, S. and E. Larrabee. 1980. Cultural Resources Reconnaissance New York Harbor Collection and Removal of Drift Area of Elizabeth, Union County, New Jersey.

Kardas, S. and E. Larrabee. 1982. Archaeological Reconnaissance of the Foreign Trade Zone Project at Howland Hook, Staten Island, New York.

Kardas, S. and E. Larrabee. 1982. Cultural Resource Reconnaissance of Hackensack River Tidal Barrier, Hudson County, New Jersey

Kardas, S. and E. Larrabee. 1983. Cultural History Recording of the Greenville Yard Jersey City, Hudson County, New Jersey.

Kardas, S. and E. Larrabee. 1985. Cultural Resource Reconnaissance New York Harbor Collection and Removal of Drift Project Bayonne Reach, Hudson County, New Jersey. Volumes I and II.

Kardas, S. and E. Larrabee. 1985. Historic American Building Survey/Historic American Engineering Record Level Recordation at the Ships Graveyards at Shooters Island Staten Island, Richmond County, New York and Bayonne - Elizabeth, Hudson and Union Counties, New Jersey.

Kardas, S. and E. Larrabee n.d. Survey for Prehistoric and Historic Archaeological Sites and Historic Sites and Structures, Routes 169 and 440, Bayonne, and Jersey City, New Jersey

Kelly, M.W. 1993. A Review of the Geologic, Physiographic, and Historic Development of New Jersey as it Pertains of Bayonne Peninsula.

Killam Associates. 1998. The Upland Portion Harbor Navigation Study, Phase II, Existing Environmental Conditions Data Report, Final.

Kopper, J.S. 1978. Cultural Resources Reconnaissance Gowanus Creek Channel Brooklyn, New York.

Kraft, H.C. 1979. Cultural Resources Survey of the Hudson County Utilities Authority Facilities Plan-Area III from Hoboken to Guttenberg, Hudson County, New Jersey.

Kushland, J.A. 1978. Feeding ecology of wading birds. Pages 249-297 in A. Sprunt, IV, J.C. Ogden, and S. Winckler, eds. Wading Birds. Nat. Aud. Res. Rept. No. 7.

LaPorta, P.C., L E. Sohl and M.C. Brewer. 1998. Cultural Resource Assessment of Proposed Dredged Material Management Alternative Sites in the New York Harbor-Apex, Affecting the Coastal Areas of New York, Queens, Kings and Richmond Counties in New York and Bergen, Hudson, Middlesex and Monmouth Counties in New Jersey. On file, U.S. Army Corps of Engineers, New York District.

Larrabee and Kardas. 1976. Survey of the *Newton*. 1976. Cultural Resources Survey of Priority Area I of Liberty Harbor Based on Recommendations of Reconnaissance.

Loucks, B.A. and K. Kogut. 1985. The peregrine returns. NYS Conservationist. March-April.

Louis Berger & Associates, Inc., The Cultural Resources Group. 1983. Environmental Technical Report Analysis of Cultural Resources Newport City Development Site, Jersey City, New Jersey.

Louis Berger and Associates, Inc. 1983. Supplementary Cultural Resource Reconnaissance Stapleton, Staten Island Reach, New York Harbor Collection and Removal of Drift.

Louis Berger and Associates, Inc. 1985. Potential for Submerged Archaeological Resources in the Proposed Dredging Area: Surface Action Group, Stapleton, Staten Island, New York.

Louis Berger & Associates, Inc., The Cultural Resource Group. 1986. Assessment of Cultural Resource Potential Harsimus Cove South Development Jersey City, New Jersey.

Louis Berger & Associates, Inc., The Cultural Resource Group. 1990. Phase I, Historical and Archaeological Survey, Liberty Pipeline Project, Borough of Richmond, New York, New York.

MAAR Associates, Inc. 1986. Howland Hook Marine Terminal Expansion Cultural Resources Reconnaissance.

Marshall, S. and N.J. Brouwer. 1981. Cultural Resources Reconnaissance Hoboken to North Bergen Reach, New York Harbor Collection and Removal of Drift Volumes I and II.

Massey, B.W. 1971. A breeding study of the California least tern. Proc. Linnean. Soc. New York. 72:1-24.

Mathews, J.R. and C.J. Moseley. 1990. The official World Wildlife Fund guide to endangered species of North America, vol. 2. Beacham Publ. Inc., Washington, D.C. pp. 703-705.

Mitchell, R. and Shevieak, C. 1983. Rare Plants of New York State. Bulletin No. 445. New York State Museum. The University of the State of New York. The State Education Department, Albany, NY 12230.

Miller, Peter, Robert A. Brooks and Associates. 1977. Cultural Resources Reconnaissance Borough of Carteret Sewer Facility , Carteret, Middlesex County, New Jersey.

Moseley, L.J. 1976. Behavior and communication in the least tern (*Sterna albifrons*). Ph.D. Diss., Univ., North Carolina, Chapel Hill. 164 pp. *In* Carreker (1985), Habitat Suitability Index Models. USF&WS Biological Report 82/10.

Mueser Rutledge Consulting Engineers. 1985. Inspection Analysis, Survey and Subsurface Exploration of U.S. Dike of Junction of Newark Bay and Arthur Kill Channel, New York.

Nadareski, C.A. 1996. Pers. commun. regarding peregrine falcon use of Goethals and Bayonne bridges for nesting.

National Oceanic and Atmospheric Administration (NOAA). 1983. New York Harbor Chart Number 12327. Washington, D.C.: U.S. Department Of Commerce, National Ocean Service, Coast And Geodetic Survey.

National Park Service, North Atlantic Regional Office. 1995. Cultural Resources Report for Fort Wadsworth, Staten Island, New York.

New England Fishery Management Council (NEFMC). 1998. Essential Fish Habitat Amendments to the Northeast Multispecies, Atlantic Sea Scallop, Monkfish, Atlantic salmon, and Proposed Atlantic Herring Fishery Management Plans Vol. 1 and 2. October.

New Jersey's Audubon Society's Nature Notes, Checklist of New Jersey Birds http://www.nj.com/audubon/genlmenu/cklist.html.

New Jersey Department of Environmental Protection (NJDEP). 1990. Hazardous Waste Program Update.

New Jersey Department of Environmental Protection (NJDEP). 1999. The New Jersey Natural Heritage Database.

New York State Department of Environmental Conservation (NYSDEC). 1994. Species Dossier – Northern Harrier.

New York State Department of Environmental Conservation (NYSDEC). 1994. Species Dossier – Common Tern.

New York State Department of Environmental Conservation (NYSDEC). 1999. NY Natural Heritage Program Database, 19 March, 1998.

Newrirth, J., J.M. Harmon and R.C. Grubb. 1991. Stage 1A Cultural Resources Survey Combined Sewer Overflow Planning Study, City of Bayonne, Hudson County, New Jersey.

Nichols, W.D. 1968. Special Report No. 28, Ground water resources of Essex County, New Jersey. Prepared for the State of New Jersey Department of Conservation and Economic Development.

Nisbet, I.C.T. 1989. The roseate tern. In W.C. Chandler, L. Labate, and C. Wille, eds. The Audubon Wildlife Report 1989/1990. Academic Press, Inc., New York. 400 pp.

Nisbet, I.C.T. 1984. Migration and winter quarters of North American roseate terns a shown by banding recoveries. J. Field Ornith. 55:1-17.

Nisbet, I.C.T. 1981. Biol. characters of the roseate tern (*Sterna dougallii*). Unpubl. report to the U.S. Fish and Wildl. Serv., Office of End. Species. Massachusetts Audubon Soc., Lincoln, MA.

Nisbet, I.C.T. 1980. Status and trends of the roseate tern (*Sterna dougallii*) in North America and the Caribbean. Unpubl. report to the U.S. Fish and Wildl. Serv., Office of End. Species. Massachusetts Audubon Soc., Lincoln, MA.

Nisbet, I.C.T. 1973. Terns in Massachusetts: Present status and historical trends. Bird Banding 44:27-55.

Panamerican Consultants, Inc. 1991. Underwater Inspection of the Seven Port Johnson Sailing Vessels, Bayonne Reach, New York Harbor Collection and Removal of Drift Project Hudson County, New Jersey.

Panamerican Consultants, Inc. 1999. Cultural Resources Survey, New York Harbor Collection and Removal of Drift Project, Arthur Kill, New York Reach, Arthur Kill, New Jersey Reach and Kill Van Kull, New York Reach. Final Report. 3 Volumes.

Parsons, K.C. 1990. The Harbor Herons Report; A Strategy for Preserving a Unique Urban Wildlife habitat and Wetland Resource in the northwestern Staten Island. The Trust for Public Land in Conjunction with the New York City Audubon Society.

Parsons, K.C. 1994. Wildlife habitats on Shooters Island, New York Harbor: Characterization Study and Management Recommendations, Draft Report. Manomet

Observatory for Conservation Sciences. Prepared for the Corps of Engineers (COE) New York District, New York, NY.

Peterson, R.T. 1980. Peterson Field Guide: Eastern Birds, Fourth Edition, Houghton Mifflin Company, Boston, MA.

Peterson, D.M. 1988. Black skimmer, *Rynchops niger*. pp 186-187. In R.F. Andrle and J.R. Carroll, eds. The atlas of breeding birds in New York State. Cornell Univ. Press, Ithaca, NY.

Peterson, D.M. 1988. Least tern *Sterna antillarium*. pp 182-183. In Andrle, R.F. and J.R. Carroll. eds. The Atlas of Breeding Birds in New York State. Cornell University Press.

Peterson, D.M. 1988. Roseate tern, *Sterna dougallii*. pp 176-177. In R.F. Andrle and J.R. Carroll, eds. The atlas of breeding birds in New York State. Cornell Univ. Press, Ithaca, NY.

Peterson, D.M. 1988. Yellow-crowned night heron. pp 52-53. In R.F. Andrle and J.R. Carroll, eds. The atlas of breeding birds in New York State. Cornell Univ. Press, Ithaca, NY.

Peterson, D.M., T.S. Litwin, D.C. MacLean and R.A. Lent. 1985. 1985 Long Island colonial waterbird and piping plover survey. Cornell Univ. Lab. of Ornith., Seatuck Res. Program, Islip, New York.

Pickman, A. 1988. Stage II Archaeological Survey, Woodvale-by-the-Sea, Tax Lots 188, 184, and 181,Block 8005, Tottenville, Staten Island, New York (NYSDEC Application No. 20-87-0128).

Public Archaeology Laboratory, Inc., The. 1996. Phase IA Archaeological Assessment of the Governors Island National Historic Landmark District, Governors Island, New York. Prepared for the US Coast Guard.

Raber Associates, Inc. 1984. Cultural Resources Investigations Hoboken - North Bergen, New Jersey Reach, New York Harbor Collection and Removal of Drift Project.

Raber Associates, Inc. 1984. Cultural Resources Investigations in Brooklyn Reach I: New York Harbor Collection and Removal of Drift Project.

Raber Associates, Inc. 1984. Cultural Resources Reconnaissance Edgewater, New Jersey Reach: New York Harbor Collection and Removal of Drift Project.

Raber Associates, Inc. 1984. Survey Level Study and Documentation for Determination of Eligibility for Spencer Kellogg and Sons, Inc. Pier and Transit Shed Borough of

Edgewater, Bergen County, New Jersey.

Raber Associates, Inc. 1985. Cultural Resources Investigations in Brooklyn Reach II: New York Harbor Collection and Removal of Drift Project.

Raber Associates, Inc. 1985. Documentation for Determination of Eligibility for Bush Terminal Brooklyn, Kings County, New York.

Raber Associates, Inc. 1985. Todd Shipyards, Erie Basin Addendum To: Cultural Resources Investigations in Brooklyn Reach I, New York Harbor Collection and Removal of Drift Project.

Raber. Michael and Thomas Flagg. 1986. Assessment of Cultural Resources in the Lincoln Harbor Development Site, Township of Weehawken and City of Hoboken, Hudson County, New Jersey.

Raber Associates. 1986. Assessment of Cultural Resources in the Lincoln Harbor Development Site, Township of Weehawken and City of Hoboken, Hudson County, New Jersey.

Raber Associates, Inc. 1986. Cultural Resources Reconnaissance of the Manhattan Upper West Side Reach: New York Harbor Collection and Removal of Drift Project.

Raber Associates, Inc. 1986. Survey Level Study for Determination of Significance and Management Recommendations: 31st Street Pier, Brooklyn, New York Brooklyn Reach II New York Harbor Collection and Removal of Drift Project.

Raber Associates, Inc. 1996. Reconnaissance Cultural Resource Investigations, Arthur Kill New Jersey Reach, Union and Middlesex Counties, New Jersey, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Raber Associates, Inc. 1996. Reconnaissance Cultural Resource Investigations, Arthur Kill New York Reach, Richmond County, New York, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Raber Associates, Inc. 1996. Reconnaissance Cultural Resource Investigations, Kill Van Kull, New York Reach, Richmond County, New York, New York Harbor Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Rakos, L. 1996. Preliminary Assessment of Cultural Resource Sensitivity and Scoping Document for Additional Cultural Resources Studies in Connection with the New York Harbor Apex Region Dredged Material Management Plan (DMMP), New York and New Jersey. On file, U.S. Army Corps of Engineers, New York District, NY.

Richard Grubb & Associates, Inc. 1993. Interim Report Upon the Combined Sewer Overflow Planning Study for Planning Area III. City of Hoboken, Township of Weehawken, Union City, Town of West New York, Town of Guttenberg, Township of North Bergen (East). Volume III., Stage 1A Cultural Resources Survey.

Rockman, D. DiZerega and N. Rothschild. 1979. A Preliminary Assessment of Cultural Resources On Shooters Island, Richmond County, New York and Hudson and Union Counties, New Jersey.

Rothe Partnership, P.C., The, 1986. Historic Site Analysis for Waterfront development Permit, Grant Marina (Hoboken Shipyard) Hudson Street Hoboken, New Jersey.

Rubertone, P. 1974 Inventory and Assessment of Archaeological Potential of Distrigas Property, Rossville, S.I., N.Y. Final Report. Staten island Institute of Arts and Sciences.

Rubinson, Dr. K.S. 1989 Documentary Study and Field Survey Totten's Landing Project. Tottenville, Staten Island. NYSDEC Application Number 20-85-0948.

Rutsch, E.S. 1977. Cultural Resources Reconnaissance Liberty State Park.

Rutsch, E., M. Gimigliano, R.J. Leo and B.H. Morrell. 1977. Stage 1A Cultural Resource Survey for the Hudson County Sewerage Authority. 201Wastewater Facility Plan-District II Bayonne, Hudson County, New Jersey.

Rutsch, E., and R.J. Leo, Jr. 1977. Stage IB Cultural Resource Survey for the Hudson County Sewerage Authority, 201Wastewater Facility Plan-District I Jersey City, North Bergen, Secaucus, and Kearny.

Rutsch, E. and H.J. Githens. 1980. Stage 1B Cultural Resources Survey of the Hudson County Sewerage Authority's Proposed Sewerage Treatment Facilities at the Jersey City East Treatment Plant, Jersey City, Hudson County, New Jersey.

Rutsch, E., H.J. Githens and M. Spozarsky. 1980. Industrial Archaeological Recording of the Central Railroad of New Jersey Engine Terminal at Communipaw, Jersey City, Hudson County, New Jersey.

Rutsch , E., B. Morrell and P. Condell. 1987. Infield Cultural Resource Survey of the Portside Tract, Jersey City, Hudson County, New Jersey.

Rutsch, E. and P. Condell. 1986. Stage 1A Documentary Cultural Resources Survey of the Proposed Portside Tract, Jersey City, Hudson County, New Jersey.

Safina, C. 1981. The effects of human disturbance on reproductive success in the black skimmer *Rynchops niger*. The Scully Preserve, Nat. Aud. Soc., Isl Solecki, Ralph S.,

PhD. 1977, Stage I Archaeological Survey, Fulton Street (Cadman Plaza West), Furman Street to east of Front Street, Atlantic Avenue, Furman Street and Joralemon Street (west of Columbia Street), Main and Plymouth Street, Howard Alley to Pearl Street. Contract 1A, Red Hook Water Pollution Control Project, Brooklyn, New York.

Safina, C. and J. Burger. 1983. Effects of human disturbance on reproductive success in the black skimmer. Condor 85:165-171.

Safina, C. 1985. Tern conservation and restoration – 1985 report. Nat. Aud. Soc. Scully Sanctuary, Islip, New York.

Schuldenrein, J. and D.M. Thieme. 1996. Staten Island Bridges Program – Modernization and Capacity Enhancement Project Phase 1B Geomorphological Analysis. Final Report of Field Investigations.

Siebenheller, N. 1981. Breeding Birds of Staten Island, 1881-1981, including Shooters Island, Prall's Island, Hoffman and Swinburne Islands. Staten Island Institute of Arts & Sciences. Staten Island, New York.

Spendelow, J.A. 1982. An analysis of temporal vegetation in, and the effects of habitual modification on the reproductive success of roseate terns. Col. Waterbirds 5:19-31.

Solecki, R.S., PhD. 1978. Stage 2 Archaeological Survey, The Archaeology and History of the Empire Stores, 2 –14 Main Street, Brooklyn, Contract 1A, Red Hook Water Pollution Control Project, Brooklyn, New York.

Staples, J.C. 1998. Letter dated 11 December 1998 from USF&WS.

Stanford, S.D. 1996. Engineering and Environmental Geology of the Surficial Materials of the Hackensack Meadowlands and Adjacent Areas, New Jersey and New York. Association of Engineering Geologists, 39th Annual Meeting, pp. D-1 – D-20, September.

Stone, S.L., T.A. Lowery, J.D. Field, S.H. Jury, D.M. Delson, M.E. Monaco, C.D. Williams and L. Andreason. 1994. Distribution and abundance of fishes and invertebrates in Mid-Atlantic estuaries. ELMR Rep. No. 12. NOAA/NOS Strategic Environmental Assessments.

Thompson, B.C. 1982. Distribution, colony characteristics, and population status of least tern breeding on the Texas coast. Ph.D. Dissertation. Texas A&M University. College Station. 150 pp. In Carreker 1985.

Tompkins, I.R. 1959. Life history notes on the least tern. Wilson Bull. 71(4):313-322.



Wegman Engineers. 1982. Evaluation of Rehabilitation of Waterfront Structures at Hoboken Terminal.

U.S. Army Corps of Engineers and U.S. Coast Guard. n.d. Cultural Resource Investigation for the New Jersey Turnpike Widening Project: Interchange 11 to US Route 46.

U.S. Army Corps of Engineers (USACE). 1994. Raritan Bay Anchorages - Deep-Draft Navigation Reconnaissance Study, Volume I and II. New York District. March 1994.

U.S. Army Corps of Engineers, New York District (USACE-NYD). 1999. Dredged Material Management Plan for the Port of New York and New Jersey.

U.S. Army Corps of Engineers -New York District (USACE-NYD). 1999. New York and New Jersey Harbor Navigation Study. Environmental Scoping Document.

U. S. Army Corps of Engineers, New York District (USACE-NYD). 1999. Personal Communication Between Ben Baker, USACE, and Mala Ciancia, URSGWC, re. Geology in Project Area, May 12.

U.S. Environmental Protection Agency (EPA). 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. U.S. Environmental Protection Agency. Prepared by Bolt, Beranek, and Newman. December 1971.

U.S. Fish and Wildlife Service (USFWS). 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. U.S. Fish and Wildlife Service southern New England – New York Bight Coastal Ecosystems Program Charlestown, Rhode Island, November 1997.

U.S. Fish and Wildlife Service. 1989. Roseate tern recovery plan Northeast population. USFWS, Newton Corner, MA. 78 pp.

U.S. Fish and Wildlife Service (USFWS). 1988. National List of Plant Species that Occur in Wetlands: Northeast (Region 1). Biological Report 88(26.1) May 1988.

U.S. Fish and Wildlife Service (USFWS). 1988. Draft recovery plan for the Northeast roseate tern. Unpubl. draft report. USFWS. Newton Corner, MA. 72 pp.

U.S. Fish and Wildlife Service (USFWS). 1989. "Recovery plan for Roseate Tern *(Sterna dougallii)* northeastern population." U.S. Fish and Wildlife Service, Newton Corner, MA.

U.S. Fish and Wildlife Service (USFWS). 1998. Assessment of the dredged material management plan for the port of New York and New Jersey. Draft Fish and Wildlife Coordination Act Section 2(b) Report.

URS Greiner Woodward Clyde. 1998. Geotechnical Investigation and Test Digs; Arthur Kill. Prepared for the U. S. Army Corps of Engineers, New York District. December.

Wagner, D. and P. Siegel. 1996. A Geomorphological and Archeological Analysis of the Arthur Kill-Howland Hook Marine Terminal Channel, Richmond County, New York and Union County, New Jersey.

Wilbur, S.R. 1974. The literature of the California least tern. U.S. Dep. Int., Washington, Bur. Sport Fish. Wildl. Spec. Sci. Rep. Wildl. 175. 18 pp.York, Albany.

Wilk, S.J., R.A. Pikanowski, D.G. McMillan, and E.M. MacHaffie. 1998. Seasonal distribution and abundance of 26 species of fish and megainvertebrates collected in the Hudson-Raritan Estuary, January 1992 – December 1997. Northeast Fish. Sci. Cent. Ref. Doc. 98-10; 145 pp.

Wegman Engineers. 1983. New York Harbor Collection and Removal of Drift Jersey City Reach: Evaluation of Piers 20, 21 and 22.

Woodhead, P.M.J. 1991. Inventory and Assessment of Habitat and Fish Resources and Assessment of Information on Toxic Effects in the New York/New Jersey Harbor Estuary. New York/New Jersey Harbor Estuary Program. Marine Sciences Research Center, State University of New York, Stony Brook, New York.

LIST OF PREPARERS

Final Environmental Impact Statement Prepared By:

U.S. Army Corps of Engineers – New York District		
Name	**Title**	**Role in FEIS Preparation**
Jenine Gallo	Wildlife Biologist	EIS Coordinator, Project Biologist
Roselle Henn	Section Chief	Team Leader
Lynn Rakos	Archeologist	Cultural Resource Analysis
Judy Rugg	Biologist	FWCAR and CZM Coordinator
Thomas J. Shea, III	Civil Engineer	Project Manager
Thomas J. Hodson	Economist	Economic Studies
Steven Weinberg	Civil Engineer	Engineering Studies
Seung Baek	Civil Engineer	Engineering Studies

Information Supplied By:

New York and New Jersey Harbor Partnership (A Joint Venture of Lawler, Matusky, & Skelly Engineers LLP and Moffatt & Nichol Engineers)		
Name	**Title**	**Role in FEIS Preparation**
John Headland	Project Manager, Principal	Task Leader, Section Author
Susan Metzger	Principal, Aquatic Biologist	Project Manager, Section Author, Reviewer
Karim A. Abood	Partner	Quality Control/Quality Assurance
Tom Mac Allen	Vice President	Quality Control
Jerry Diamantides	Senior Economist	Section Author
Dennis Suler	Environmental Specialist	Section Author, Task Leader
Patricia McNeal	Project Engineer	Task Leader, Navigation Planning
John Matousek	Aquatic Biologist	Task Leader, Section Author, Reviewer

GLOSSARY OF ACRONYMS AND TERMS

ACRONYMS

AAQS	Ambient Air Quality Standards
AFB	Alternative Formulation Briefing
AHPA	Archaeological and Historic Preservation Act
APE	Area of Potential Effect
BCR	Benefit Cost Ratio
BEA	Bureau of Economic Analysis
BMP	Best Management Practices
BNB	Bayonne-Newark Bay
BOD	Biochemical Oxygen Demand
BRAC	Base Realignment and Closure
CAFRA	Costal Area Review Act
CARP	Containment Assessment and Reduction Program
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
C.F.R.	Code of Federal Regulations
CO	Carbon Monoxide
COHS	Coefficent of Haze
CPDP	Comprehensive Port Development Plan
CPUE	Catch-Per-Unit Effort
CSO	Combined Sewer Overflow
CWA	Clean Water Act
CZM	Coastal Zone Management
dBA	Decibels
DDT	Dichlorodiphenyltrichloroethane
DEIS	Draft Environmental Impact Statement
DGPS	Differential Global Positioning System
DMMP	Dredged Material Management Plan
DO	Dissolved Oxygen
DSEIS	Draft Supplemental Environmental Impact Statement
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIF	Environmental Investment Form
EIS	Environmental Impact Statement
ELMR	Estuarine Living Marine Resource
EQ	Environmental Quality
ER	Engineering Regulation
ESA	Endangered Species Act
EWG	Environmental Work Group

FC	Formerly Connected Tidal water
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Authority
FMC	Fisheries Management Council
FMP	Fishery Management Plans
FPS	Foot Per Second
FWCAR	Fish and Wildlife Coordination Act Report
GIS	Geographic Information Systems
GNF	General Navigation Features
GPS	Global Positioning System
GRA	Geoarchaeology Research Associates
HAER	Historic American Engineering Record
HAPC	Habitat Areas of Particular Concern
HARS	Historic Area Remediation Site
HEP	Harbor Estuary Program
HM	High Marsh or Saltmeadow
HTRW	Hazardous, Toxic and Radioactive Waste
IM	Intertidal Marsh
K_{oc}	Organic Carbon Partition Coefficent
K_{ow}	Octanol Water Partition Coefficent
LERRD	Lands, Easements, Rights-of-Way, Relocations, and Dredged Material Disposal Areas
LRR	Limited Reevaluation Report
LWRP	Local Waterfront Revitalization Program
LZ	Littoral Zone
MAFMC	Mid-Atlantic Fisheries Management Council
MARMAP	Marine Resources Monitoring, Assessment and Prediction
MHW	Mean High Water
MLW	Mean Low Water
MOA	Memorandum of Agreement
MOTBY	Military Ocean Terminal at Bayonne
MPRSA	Marine Protection, Research and Sanctuaries Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAAQS	National Ambient Air Quality Standards
NBCDF	Newark Bay Confined Disposal Facility
NEAT	Northeastern Automarine Terminal
NED	National Economic Development
NEFMC	New England Fisheries Management Council
NEPA	National Environmental Policy Act
NHL	National Historical Landmark
NHPA	National Historic Preservation Act
NJDEP	New Jersey Department of Environmental Protection

NM	National Monument
NMFS	National Marine Fisheries Service
NO	Nitric Oxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	Nitrogen Oxide
NPL	Noise Pollution Level
NRC	National Research Council
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NYCEDC	New York City Economic Development Corporation
NYCLPC	New York City Landmarks Preservation Commission
NYCRR	New York Code of Rules and Regulations
NYD	New York Division
NYNJHNS	New York New Jersey Harbor Navigation Study
NYSDEC	New York State Department of Environmental Conservation
NYSDS	New York State Department of State
O&M	Operation and Maintenance
O_3	Ozone
ORCA	Ocean Resources Conservation and Assessment
OSE	Other Social Effects
PAH	Polycyclic Aromatic Hydrocarbon
PANYNJ	Port Authority of New York and New Jersey
Pb	Lead
PCB	Polychlorinated Biphenyl
PCI	Panamerican Consultants, Inc.
PDEIS	Preliminary Draft Environmental Impact Statement
PED	Preconstruction Engineering and Design
PEIS	Programmatic Environmental Impact Statement
PM-10	Inhalable Particulates
Ppm	Parts Per Million
Ppt	Parts per thousand
PPV	Peak Particle Velocity
PSI	Pollutant Standards Index
RED	Regional Economic Development
ROD	Record of Decision
RQD	Rock Quality Designation
SAV	Submerged Aquatic Vegetation
SEA	Strategic Environmental Assessment
SEQRA	State Environmental Quality Review Act
SHPO	State Historic Preservation Office
SI&A	Supervision Inspection and Administration
SO_2	Sulfur Dioxide

SO_x	Sulfur Oxides
SPC	Sub-channel Placement Cell
SPDES	State Pollutant Discharge Elimination System
SPT	Standard Penetration Test
SS	Smoke Shade
STP	Sewage Treatment Plant
TES	Threatened and Endangered Species
TEU	Twenty-Ft Equivalent Units
TL	Total Length
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USACE-NJD	U.S. Army Corps of Engineers - New Jersey Division
USACE-NYD	U.S. Army Corps of Engineers - New York Division
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UST	Underground Storage Tank
VTC	Vessel Traffic Center
VTSNY	Vessel Traffic Service in New York
WRDA	Water Resources Development Act
WRP	Waterfront Revitalization Program
2,3,7,8-TCDD	2,3,7,8 – Tetrachlorodibenzodioxin
2,3,7,8-TCDF	2,3,7,8 - Tetrachlorodibenzofuran

GLOSSARY OF ACRONYMS AND TERMS

TERMS

Abiotic	Non-living.
Adsorption	The process by which ions or molecules present in one phase tend to condense and concentrate on the surface of another phase.
Aesthetics	Related to any perceptible (visual, noise, odor, vibration) environmental factor that if diminished, is generally accepted to result in a reduced standard of living, recreational value, or social benefit.
Age Class	An age grouping of plants or animals according to an interval of years.
Anchorage	An area designated by the USCG for the anchoring of ships in the Harbor.
Ambient Air	The surrounding local air.
Aquatic	Referring to freshwater.
Anadromous	An organism that spends most of its life in the ocean, then returns to spawn in freshwater.
Anthropogenic	Resulting from man-made processes.
Autotrophic	Needing only carbon dioxide or carbonates as a source of carbon and a simple inorganic nitrogen compound for metabolic synthesis.
Ballast Water	Water within a ship to help maintain balance.
Benthic	Referring to bottom dwelling species.
Benthos	The organisms living in or on the bottom surface.
Berth	The water area at the waterfront edge of a wharf, reserved for a vessel;. Sometimes used to refer to the dock or wharf structure.
Best Management Practices	Practices designed to prevent or reduce pollution.
Bioaccumulation	The process whereby chemicals are accumulated in living biological tissues.
Bioavailability	The degree to which a contaminant is available for uptake or absorption by an organism.
Biodiversity	The variety of living creatures in a given area.
Biogenic	Resulting from biological processes.
Biomagnification	The process by which a contaminant becomes more concentrated in biological tissue as it is transferred through higher levels in the food chain.
Biomass	The number of individual organisms (in some area, volume or region) multiplied by the average weight of the individuals.
Biota	The plant and animal life of a particular region.
Biotic	Living.
Bulkhead	A rigid vertical retaining wall built along a waterfront used to retain fill material or for erosion control.

Channel	The buoyed, dredged, and policed fairway through which ships proceed from the sea to their berth or from one berth to another within the Harbor.
Coastal Zone	Area of the ocean near the seashore.
Community	A distinctive collection of species occurring together in a particular habitat.
Cumulative Impacts	Impacts on the environment that result from separate, individual actions that collectively are significant.
Decibel	A unit of sound measurement.
Demersal	Living close to the bottom surface; demersal organisms often swim or rest near the bottom surface.
Dioxin	2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD). Dioxin is a by-product in the manufacture of chlorinated phenols and phenoxyherbicides, chlorine bleaching of paper pulp, and combustion of chlorine-containing waste. It is extremely toxic, producing a variety of symptoms including reproductive effects, chloracne, immunotoxicity, liver toxicity, and cancer. The term "dioxin" may also refer to a class of compounds with structures similar to 2,3,7,8-TCDD, but with varying degrees of chlorination.
Dissolution	The act of dissolving.
Dissolved Oxygen	A measure of the amount of oxygen available for biochemical activity in a given amount of water. Adequate levels of dissolved oxygen (DO) are needed to support aquatic life.
Dredging	The removal of bottom sediments in order to deepen or widen a waterway.
Embayment	Formation of a bay.
Endangered Species	A plant or animal that is in danger of extinction throughout all or a significant portion of its range.
Enhancement	Activities conducted in existing marine, aquatic, estuarine, or riparian areas, which improve one or more of the ecological functions and/or the biodiversity of existing, but degraded or impoverished, habitats.
Environmental Impact Statement	A statement of the environmental effects of a proposed action and its alternatives.
Environmental Justice	The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportional share of the negative environmental impacts.
Epibenthic	Referring to species that live upon the bottom surface.
Essential Fish Habitat	Defined by Congress as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity."
Estuary	A semienclosed coastal embayment where fresh and saltwater mix.

Facies	A rock or stratified body distinguished from others by its appearance or composition.
Fetch	The distance over the water's surface that the wind blows to generate waves.
Fines	The category of sediment particles that includes silts and clays.
Flushing Time	The time required for a mass of water to be discharged from an estuary into the ocean.
Forage Fish	Fish that are consumed by larger, higher trophic level fish.
Furans	A class of chemicals structurally similar to dioxin, except that they lack one oxygen.
GIS (geographic information system)	A database designed to handle geographic data as well as a set of computer operations that can be used to analyze the data.
Groin	Series of small structures built perpendicular to the shore which extend from the beach into the surf zone to limit or prevent erosion.
Guild	A group of species that exploit a class of environmental resources the same way.
Habitat	The area where a plant or animal lives and grows under natural conditions.
Hydrodynamics	The motion and action of water and other liquids.
Hydrology	The science dealing with the study of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.
Ichthyoplankton	Finfish life history stage, either egg or larvae, that occurs in the water column with limited independent movement (planktonic).
Impoundment	A body of water unnaturally closed.
Inshore	Coastal marine and estuarine environments.
Isobath	A line on a map connecting places of equal depth.
Jetties	Structures built perpendicular to the shore at mouth of a channel or inlet, often used to protect a harbor or channel.
Lead Agency	The public agency that has the principal responsibility for carrying out or approving a project.
Life History	Development of an organism.
Littoral Zone	The region between the high and low tides along the shore, alternately covered by water and exposed to the air.
Macroinvertebrate	For the purpose of this report, invertebrte species grater than ½ inch.
Marine	Referring to saltwater environments.
Mean High Water	The average height of the water at high tide.
Mean Low Water	The average height of the water at low tide.
Mitigation	A means of sequentially avoiding impacts, minimizing impacts, and compensating for remaining unavoidable impacts.
Mud	Wet soft earth composed predominantly of clay and silt-fine material sediments less than 0.074 mm in diameter (Black 1968; Liu 1970).
Natural Resource	A feature of the natural environment that is of value in serving human needs.

National Environmental Policy Act (NEPA)	A law passed by Congress in 1969 to encourage productive and enjoyable harmony between people and their environment.
Neotropical	Of, relating to, or constituting the biogeographic region that extends south, east, and west from the central plateau of Mexico.
New York Bight	An area of the Atlantic Ocean near New York Harbor.
No-Action Alternative	The most likely condition expected to persist or develop in the future if management practices continue unchanged.
Notice of Intent (NOI)	A notice in the federal register of intent to prepare an environmental impact statement on the proposed action.
Nutrient	A substance that promotes growth or provides energy for biological processes; common nutrients are phosphate, nitrate, calcium, and potassium.
Ocean Disposal	Disposal of dredged materials into territorial seas and/or ocean waters, as regulated by the Ocean Dumping Act.
Ocean Waters	Those waters of the open seas lying seaward of the baseline from which the territorial sea is measured, as provided for in the Convention on the Territorial Sea and the Contiguous Zone.
One Hundred Year Flood Plain	The area that has a 1 percent chance of inundation in a given year or has a probability of inundation once every 100 years.
Open-Water Disposal	Disposal of dredged materials into waters of the United States, as defined in the Clean Water Act.
Pelagic	Referring to the ocean water column and the organisms living therein.
Peninsula	A portion of land nearly surrounded by water and connected with a larger body by an isthmus; also, a piece of land jutting out into the water whether with or without a well-defined isthmus.
Phytoplankton	Autotrophic plankton.
Prop Wash	The result of a ship propeller or impeller disturbing bottom sediments.
Raptor	A bird of prey, such as an eagle, owl, or hawk.
Record of Decision (ROD)	An official document in which a deciding official states the alternative that will be implemented from a prepared EIS.
Restoration	Re-establishment of marine, aquatic, estuarine, or riparian resource characteristics and function(s) at a site where they have ceased to exist, or exist in a substantially degraded state.
Salinity	The total amount of solid material in grams contained in 1 kg of water when all the carbonate has been converted to oxide, the bromine and iodine replaced by chlorine, and all the organic matter completely oxidized.
Salt Marsh	Coastal communities periodically drained and flooded by tidal waters and characterized by a muddy substrate.
Scoping	The ongoing process to determine public opinion, receive comments and suggestions, and determine issues during the environmental analysis process

Sediment	Small particles of rock debris or organic materials deposited by wind, water, or ice.
Submerged Aquatic Vegetation	Rooted, vascular, flowering plants, that, except for some flowering structures, live and grow below the water surface.
Sublittoral	The seashore zone below the littoral zone, not exposed to the air at low tide.
Substrate	Material making up the base on which an organism lives or to which it is attached.
Suspended Particle	Sediment or organic matter within the water column.
Terrestrial	Pertaining to the upland or inland environment.
Territorial Seas*	The belt of seas measured from the baseline (mean sea level and the imaginary line between Rockaway Point and Sandy Hook) along that portion of the coast which is in direct contact with the open sea, in the line marking the seaward limit of inland waters, and extending seaward a distance of 3 miles.
Threatened Species	Those plants and animal species likely to become endangered throughout all or a specific portion of their range within the foreseeable future as designated by the US Fish and Wildlife Service under the Endangered Species Act of 1973.
Tide	A long wave caused mainly by the gravitational attraction between the Earth, moon, and sun, and by the Earth's rotation. Movements of these long waves cause the level of water to rise (high tide) and fall (low tide).
Trace Elements	Those elements generally present in natural water samples at concentrations of less than 1 milligram per liter.
Trophic Level	The feeding position occupied by a given organism in a food chain, measured by the number of steps it is removed from producers.
Turbidity	Reduced visibility in water due to the presence of suspended particles.
Watershed	The entire region drained by a waterway.
Wetlands	Any non-tidal or tidally influenced areas meeting the state and Federal criteria (typically the presence of hydric soils, hydrologic indicators, and hydrophytic vegetation) but including littoral zones, tidal flats and mudflats.
Unconsolidated Sediments	Those sediments that have not been compressed into a firm consistency.
Zooplankton	Planktonic animals.

* USEPA Region II-Draft definitions language, Patricia Barnwell Pechko (12 April 1995)

Metric Conversion Table			
QUANTITY	**U.S. UNIT**	**MULTIPLY BY**	**TO GET METRIC EQUIVALENT**
Length	Inches (in.)	25.4	Millimeters (mm)
		0.0254	Meters (m)
	Feet (ft)	0.3048	Meters (m)
	Miles (mi)	1.6093	Kilometers (km)
Area	Square inches (in^2)	6.4516×10^4	Square meters (m^2)
	Square feet (ft^2)	0.092903	Square meters (m^2)
	Acres	4046.9	Square meters (m^2)
		0.40469	Hectares (ha)
		0.0040469	Square kilometers(km^2)
	Square miles (mi^2)	2.590	Square kilometers(km^2)
Volume	Gallons (gal)	3.7854	Liters (L)
		0.0037854	Cubic meters (m^3)
	Million gallons (10^6 gal)	3785.4	Cubic meters (m^3)
	Cubic feet (ft^3)	0.028317	Cubic meters (m^3)
	Cubic yards (yd^3)	0.76455	Cubic meters (m^3)
Volume Time (Flow)	Cubic feet per sec (ft^3/s)	28.317	Liters per second (L/s)
		0.028317	Cubic meters per sec (m^3/sec)
	Gallons per minute (gal/min)	0.06309	Liters per second (L/s)
		6.309×10^{-5}	Cubic meters per sec (m^3/sec)
	Million gallons per day (mgd)	0.043813	Cubic meters per sec (m^3/sec)
Water Usage	Acre-feet per acre	0.3048	Cubic meters per square meter (m^3/m^2)
Mass	Pounds (lbs)	0.45359	Kilograms (kg)
		454000	Milligrams (mg)
	Tons (2000 lbs)	907.18	Kilograms (kg)
Temperature	Degrees Fahrenheit (°F)-32/1.8		Degrees Celsius (°C)
Specific Capacity	Gallons per minute per foot drawdown	12.419	Liters per minute per meter drawdown