WESTCHESTER COUNTY STREAMS, BYRAM RIVER BASIN FLOOD RISK MANAGEMENT FEASIBILITY STUDY

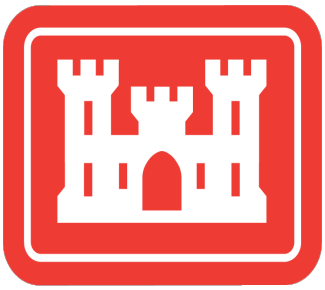
FAIRFIELD COUNTY, CONNECTICUT AND WESTCHESTER COUNTY, NEW YORK

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL IMPACT STATEMENT

MARCH 2020

Westchester County Streams,
Byram River Basin
Flood Risk Management
Fairfield County, Connecticut and
Westchester County, New York

Final Integrated Feasibility Report &
Environmental Impact Statement



New York District
U.S. Army Corps of Engineers
In Partnership with the
Town of Greenwich, CT

Cover Image: Eastbound U.S. Route 1 Bridge over the Byram River with high flow after spring 2007 storms. Photographed by the Town of Greenwich.

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), New York District (District) has partnered with the Town of Greenwich, Connecticut to undertake the Westchester County Streams, Byram River Basin, Connecticut and New York (Byram River Basin) flood risk management feasibility study (Figure ES 1). This Final Integrated Feasibility Report and Environmental Impact Statement (FR/EIS) presents the results of the study team's evaluation of various alternatives to manage the risk of damages caused by frequent fluvial, or riverine, flooding. This report fulfills the requirements of the National Environmental Policy Act of 1969 (NEPA) and was written in accordance with the President's Council on Environmental Quality Rules and Regulations for Implementing NEPA (40 CFR §§ 1500-1508), the USACE's Procedures for Implementing NEPA (Engineer Regulation 200-2-2), and other applicable federal and state environmental laws.

Low lying neighborhoods in the study area have been subjected to repeated, severe flooding from high precipitation events, with the largest events being the storms of October 1955, June 1972, September 1975, and April 2007. A large number of structures are affected by flooding; the majority of structures impacted by the floods are single-family residential structures located in the Pemberwick neighborhood of the Town of Greenwich, CT.

A factor contributing to the flooding issues in the basin are the West Putnam Avenue and Hillside Avenue bridges (U.S. Route 1 bridges) that carry U.S. Route 1 over the Byram River at the southern end of the study area. These bridges were built in the 19th and early 20th centuries and are currently owned and operated by the New York State Department of Transportation. Storm events deposit large amounts of precipitation in the Byram River Basin, all of which must pass beneath the U.S. Route 1 bridges. The U.S. Route 1 bridges have low roadway profiles and central piers. These features constrict the flow of the Byram River – acting as a bottleneck in the river – and cause the water surface elevation to increase upstream of the bridges and flood the Pemberwick neighborhood. Residents will continue to experience significant damages to their homes from fluvial flooding of the Byram River if no project is implemented.

The Byram River Basin study's purpose is to determine if there is a technically feasible, economically justified, and environmentally acceptable recommendation for federal participation in flood risk management for the Byram River Basin. The District considered a range of nonstructural and structural measures that have the potential to manage flood damages in the Town of Greenwich, CT, the basin's most frequently flooded and densely populated locality. Through an iterative planning process, five flood risk management alternative plans were identified, evaluated, and compared. These plans were made up of measures that include levees, floodwalls, bridge removals and replacements, wet and dry floodproofing, structure elevations, acquisition of properties, and localized ringwalls.

The Recommended Plan for flood risk management is the removal and replacement of the U.S. Route 1 bridges. The new bridges would not have central piers and would have roadway profiles with a higher elevation to allow more water to pass underneath them and decrease the risk of flooding. The Recommended Plan is estimated to provide $1,503,000 in annualized benefits under the USACE "intermediate" sea level change scenario (Price Level Fiscal Year 2020; Discount Rate 2.75%). The estimated benefit cost ratio of the plan is 1.3.

The Recommended Plan would not have significant adverse cumulative impacts to the natural environment. The U.S. Route 1 bridges are historic structures built in the 19th and early 20th

centuries and are excellent examples of design of double-arched stone bridges; the plan is to demolish these bridges, which constitutes an adverse impact to historic properties. This adverse effect will be mitigated by extensively documenting the architecture of the old bridges via architecture survey and photographs, reusing stone in the construction of the new bridges, and other activities based upon coordination and consultation with the New York and Connecticut State Historic Preservation Offices and other consulting parties. The Recommended Plan has been identified as the Environmentally Preferable Alternative through the NEPA evaluation documented in this Final Integrated FR/EIS.

There will be temporary adverse effects to the flow of commuter traffic during the construction phase of the project. To keep traffic flowing, only one bridge will be shut down at a time, reducing the two lane traffic each way to only one lane going each direction. The construction plan is for one bridge to be removed and replaced in each of two successive summertime construction seasons. There will be no adverse cumulative impacts to traffic flow once the construction is completed.

The Town of Greenwich, CT is the non-federal sponsor for the study and the bridges to be replaced are owned and operated by the New York State Department of Transportation. The Town of Greenwich, CT and New York State Department of Transportation have indicated their support for the Recommended Plan. The Town of Greenwich has indicated its willingness to be the non-federal sponsor for the project, and New York State Department of Transportation has indicated their willingness to act as a non-federal party for the project. The Town of Greenwich, in conjunction with New York State Department of Transportation, agrees to be responsible for all local cooperation requirements for the project. The estimated Project First Cost is $29,405,000. The non-federal sponsor is responsible for providing lands, easements, rights-of-way and relocations, and disposal/borrow areas. The total project cost share is 50 percent federal and 50 percent non-federal, however, the sponsor would be responsible for the real estate costs, have an initial cost of approximately $25 million, and would be due a reimbursement of approximately $10 million[1]. The non-federal sponsor's cost share is estimated to be $14,703,000.

This Final Integrated FR/EIS presents the Recommended Plan that was refined and optimized based off of comments received during the concurrent public and agency review of the draft report released in June 2018. The ultimate design of the project will be determined during Preconstruction Engineering and Design, when further coordination with local and state agencies will occur.

[1] USACE will be pursuing a budgetary policy exception such that the entire federal share of the project, to include the reimbursement, could be provided prior to project implementation.

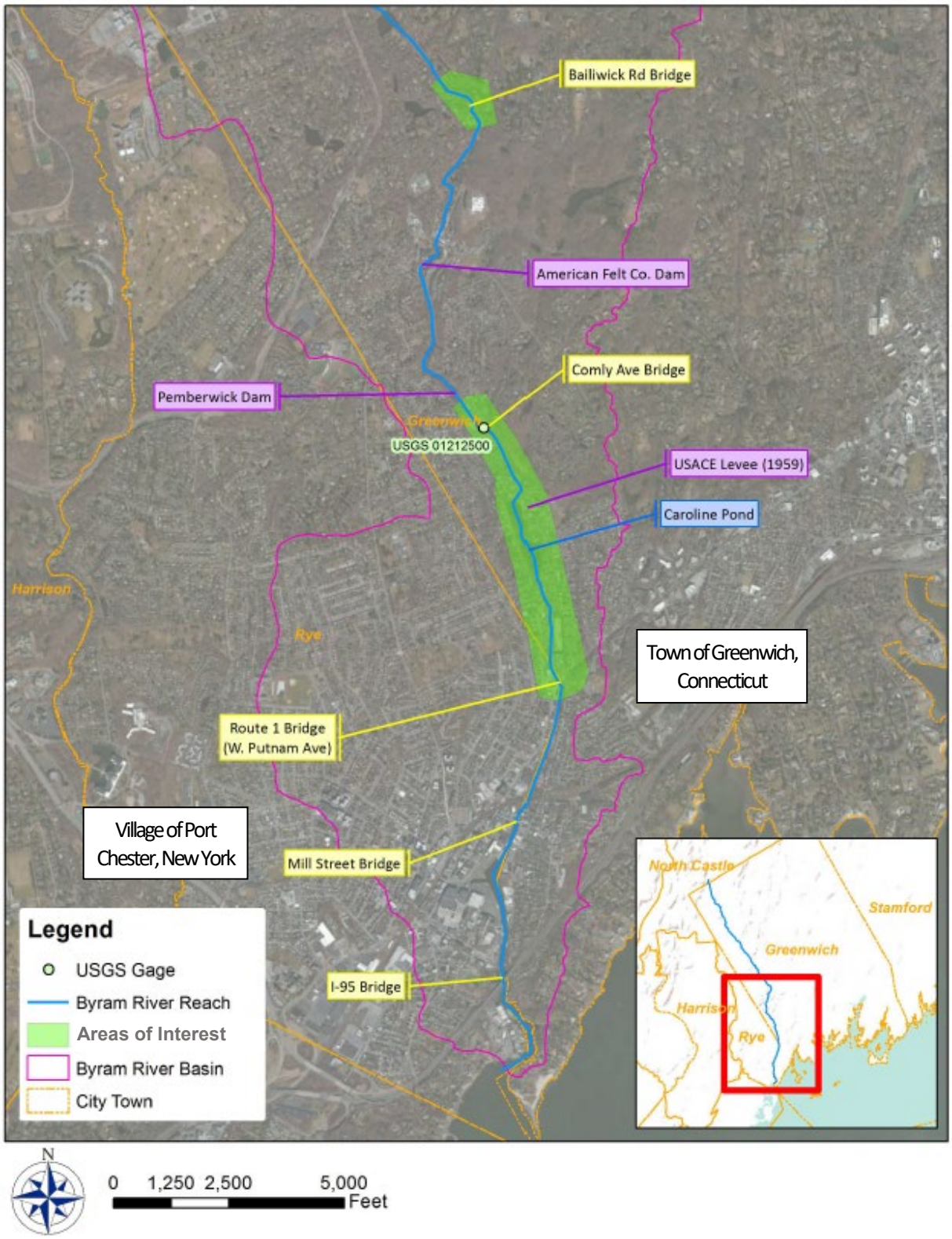


Figure ES 1: Study Area and Focus/Interest Areas

Westchester County Streams, Byram River Basin
Flood Risk Management Study
Connecticut and New York

**Sections of text marked with an asterisk are applicable to the satisfaction of National Environmental Policy Act (NEPA) requirements.*

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GLOSSARY OF TERMS, ACRONYMS, AND ABBREVIATIONS

ACE	Annual Chance Exceedance
ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effect
AQCRs	Air Quality Control Regions
CAA	Clean Air Act
CEQ	Council On Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	Comprehensive Environmental Response, Compensation, Liability Information System
CFR	Code Of Federal Regulations
CGS	Connecticut General Statutes
CTDEEP	Connecticut Department of Energy and Environmental Protection
CTSHPO	Connecticut State Historic Preservation Office
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
dBA	A-weighted decibels
District	U.S. Army Corps of Engineers, New York District
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ER	Engineer Regulation
ESA	Endangered Species Act
FCSA	Feasibility Cost Sharing Agreement
FEMA	Federal Emergency Management Agency
FHA	Federal Highways Administration
FR/EIS	Feasibility Report and Environmental Impact Statement (integrated)
FWCA	Fish and Wildlife Coordination Act
FY	Fiscal Year
GIS	Geographic Information System
HEC-FDA	Hydrologic Engineering Center – Flood Damage Analysis
HEC-HMS	Hydrologic Engineering Center – Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HTRW	Hazardous, Toxic, And Radioactive Waste
Ldn	Day-night noise level
LERRD	Lands, Easements, Rights-of-Way, Relocations, and Disposals/borrow Areas
LF	Linear Feet
LWRP	Local Waterfront Revitalization Plan
MOA	Memorandum of Agreement
MSFCMA	Magnuson-Stevenson Fisheries Conservation and Management Act
NAAQS	National Ambient Air Quality Standards
NAVD88	North American Vertical Datum of 1988
NED	National Economic Development
NEPA	National Environmental Policy Act

NHMP	Natural Hazard Mitigation Plan
NHP	Natural Heritage Program
NRHP	National Register of Historic Places
NOAA - NMFS	National Ocean and Atmospheric Administration - National Marine Fishery Service
NPL	National Priorities List
NRCS	Natural Resources Conservation Service
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
NYSHPO	New York State Historic Preservation Office
OSE	Other Social Effects
P.L.	Public Law
PM	Particulate Matter
RCRIS	Resource Conservation and Recovery Information System
RED	Regional Economic Development
S&A	Supervision And Administration
SHPO	State Historic Preservation Office
SIPs	State Implementation Plans
SLR	Sea Level Rise
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USACE–NNC	U.S. Army Corps of Engineers – National Nonstructural Committee
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish And Wildlife Service
WCCoG	Western Connecticut Council of Governments
WRDA	Water Resources Development Act

PERTINENT DATA

DESCRIPTION

The U.S. Army Corps of Engineers' (USACE) Recommended Plan for flood risk management for the Westchester County Streams, Byram River Basin feasibility study is presented in this report. The Recommended Plan proposes the removal of the two U.S. Route 1 bridges that straddle the Byram River in the Village of Port Chester, NY and replacing them at a higher elevation to allow more water to pass underneath. These historic bridges restrict the flow of the Byram River and induce flooding upstream in the Town of Greenwich, CT. Removing the bridges will allow the Byram River to flow freely without backing up into the residential neighborhood upstream. The bridges to be removed carry the local traffic of U.S. Route 1 as well as Interstate 95 traffic during emergencies, so they must be replaced after demolition. The new bridges will be built within the same footprint at a higher elevation and without any piers that enter the floodway in order to reduce restrictions to river flow. More details of the project will be determined as part of the Preconstruction Engineering and Design phase.

LOCATION

The Town of Greenwich is located in Fairfield County, CT, and the Village of Port Chester is located in Westchester County, NY, along the Byram River.

FEATURES

This study proposes the removal of the two U.S. Route 1 bridges and the construction of two new bridges. The new bridges will not have a central supporting pier and will have a roadway elevation three feet higher than the current U.S. Route 1 bridges. The Byram River will be able to flow unobstructed beneath the new bridges constructed by this project.

REAL ESTATE REQUIREMENTS

The project will require temporary and permanent easements, as well as fee simple purchase for environmental mitigation. The estimated cost for real estate, or Lands and Damages, is $1,433,000. Easement requirements are provided in Table ES 1.

Table ES 1: Real Estate Requirements for Byram River Project

	NEW YORK	CONNECTICUT	TOTAL
Permanent Easements (Acres)	±1.684	±0.013	±1.697
Temporary Easements (Acres)	±1.084	±0.393	±1.477
Total Acres	**±2.768**	**±0.406**	**±3.174**

ECONOMICS

The period of analysis for the project is 50 years. The Project First Cost is $29,405,000 (Price Level Fiscal Year (FY) 2020; Discount Rate 2.75%) with average annual net benefits of $358,000 and a benefit cost ratio of 1.3 (Table ES 2).

Table ES 2: Costs of the Byram River Project
(Price Level FY 2020; Discount Rate 2.75%)

CATEGORY	COSTS
Project First Costs	$29,405,000
Total Investment Costs	$30,218,000
Annualized Investment Costs	$1,119,000
Annual Operations and Maintenance Costs	$25,000
Total Average Annual Costs	$1,144,000
Annualized Without-Project Damages	$3,181,000
Annualized Benefits*	$1,503,000
Total Average Annual Net Benefits	$358,000
Benefit Cost Ratio	1.3

**Benefits include flood risk management benefits of $905,000, advanced bridge replacement benefits of $748,000, and emergency cost reduction benefits of $26,000. These benefits are reduced by $176,000 due to the cost of traffic delays during construction.*

1. INTRODUCTION

1.1 Study Purpose and Scope*

The U.S. Army Corps of Engineers (USACE), New York District (District) prepared this Final Integrated Feasibility Report and Environmental Impact Statement (FR/EIS) for the Westchester County Streams, Byram River Basin, Connecticut and New York, Flood Risk Management Feasibility Study (Byram River Basin study). The purpose of this study is to determine if there is a technically feasible, economically justified, and environmentally acceptable recommendation for federal participation in flood risk management for the Byram River Basin (Figure 1), with a focus on the Town of Greenwich, Connecticut and the Village of Port Chester, New York.

The federal objective of water and related land resources project planning is to "contribute to national economic development [NED] consistent with protecting the Nations' environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements" (U.S. Water Resources Council, 1983). Water and related land resources projects are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

The Byram River Basin Study is a fluvial flood risk management study. It is understood that the coastal region of Town of Greenwich and Village of Port Chester faces a combined hazard from both coastal flooding and riverine flooding. While previous studies have indicated that the coastal flooding mechanisms are largely separate from the riverine flooding mechanisms, the riverine events are influenced by coastal storm surge. This study considers the coastal-fluvial relationship while formulating to reduce the risk of fluvial flooding events.

This report presents a Recommended Plan for managing flood risk in the Byram River Basin. It takes into account input from the non-federal study sponsor, local governments, natural resource agencies, and the public. Sections of the report that are required to fulfill the requirements of National Environmental Policy Act (NEPA) of 1970 are marked with an asterisk (*) in the headings.

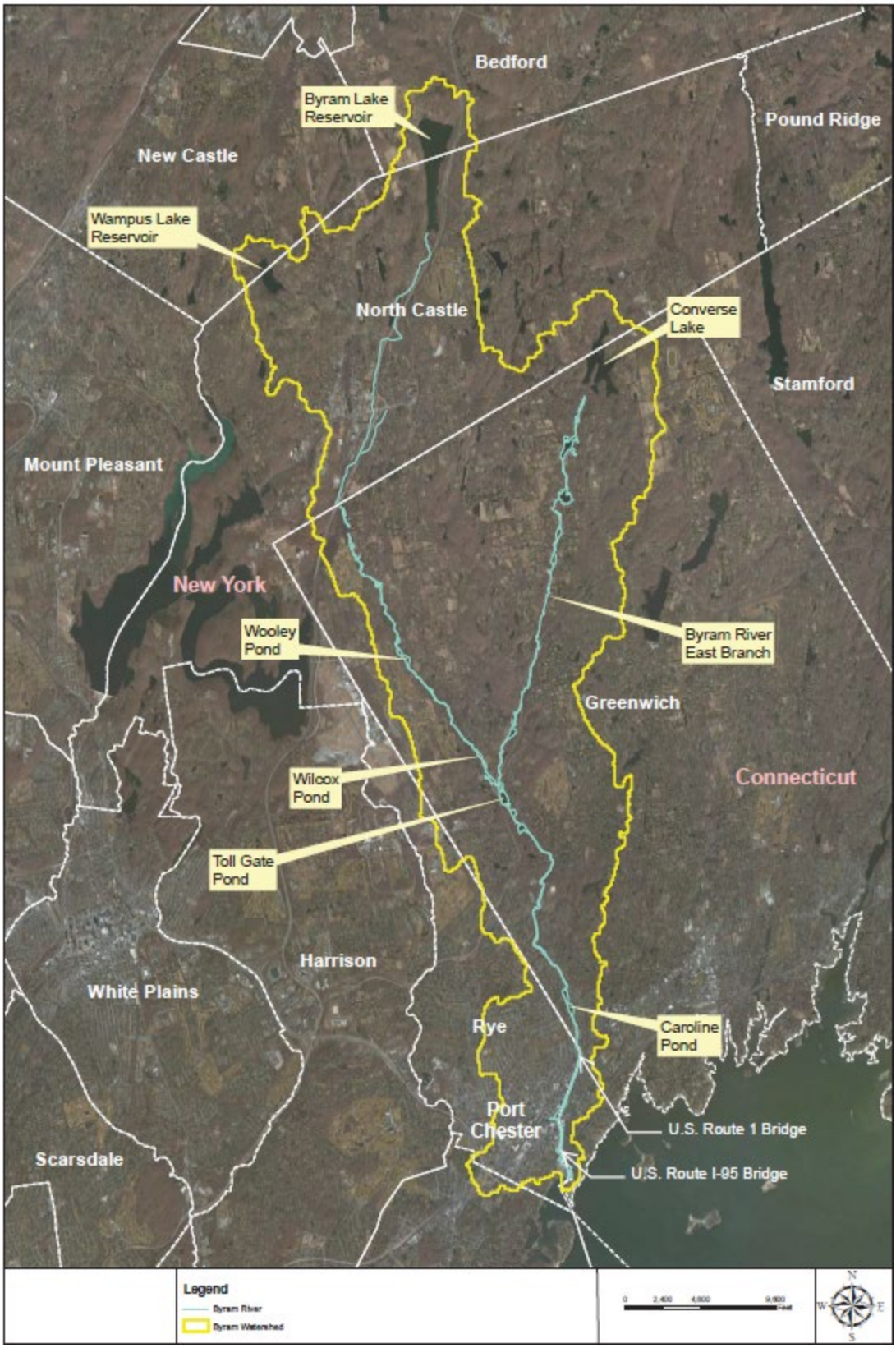

Figure 1: Byram River Flood Risk Management Study Area, the Byram River Basin

1.2 Need for Action*

The Town of Greenwich and the Village of Port Chester have been subjected to repeated, severe flooding caused by overflow of the Byram River due to precipitation of high intensity, large amounts, or prolonged duration. Due to flooding in the area, the USACE has been involved in studying the area intermittently since the 1940s. The USACE constructed levees under the Continuing Authorities Program in the Pemberwick area of the Byram River in the 1960s and recommended additional flood risk management plans in other areas. More information on the USACE's involvement in the study area is detailed in Section 1.5. The Final Integrated FR/EIS is intended to constitute a final response to the study authority.

1.3 Study Authorization

The Byram River Basin study was authorized by a resolution of the House Committee on Transportation and Infrastructure, Docket 2779, dated May 2, 2007 which reads as follows:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army review the report of the Chief of Engineers on the Streams in Westchester County, New York, and the Mamaroneck and Sheldrake Rivers Basin and Byram River Basin, New York and Connecticut published as House Document 98-112, and other pertinent reports on the Hutchinson, Mamaroneck and Sheldrake Rivers to determine whether modifications to the recommendations contained therein are advisable at the present time in the interest of water resources development, including flood damage reduction, storm damage reduction, environmental restoration, navigation, watershed management, water supply, and other allied purposes.*

The referenced resolution covers the Westchester County Streams study area, which includes the basins of the Byram River, Mamaroneck and Sheldrake Rivers, Hutchinson River, Blind Brook, Bronx River, and the Saw Mill River. The resulting *Section 905(B) Reconnaissance Study for Westchester County Streams, Westchester County, NY and Fairfield County, CT,* (USACE, 2009) recommended feasibility studies for all six river basins and for coastal flooding from Long Island Sound. A Feasibility Cost Sharing Agreement (FCSA) for the Byram River Basin, NY & CT, was signed with the Town of Greenwich in 2012 for just under $3,000,000 to conduct a flood risk management study.

1.4 Study Area

The study area is the Byram River Basin (Figure 1). The headwaters of the Byram River are in North Castle, NY and the river flows southward into the Town of Greenwich in Fairfield County, CT, over a length of 13.5 miles, and empties into Long Island Sound. The lower portion of the river is tidal for a length of 1.3 miles. The last 1.6 miles of the Byram River acts as the state boundary between Connecticut and New York. The drainage area at the river mouth is 30 square miles. The riparian zone of the lower three miles of the Byram River is populated with suburban housing and commercial buildings. In the upper reach, generally upstream of the bridge at Bailiwick Road the area is less densely developed. The Byram River study area for this study includes areas west and east of the river, extending between just north of Bailiwick Road to South of West Putnam Avenue. The Town of Greenwich, Connecticut (including the neighborhoods of Pemberwick, Glenville, and Round Hill) and the communities of Armonk and Port Chester in New

York are either wholly or partly in the basin. The study area lies within the following Congressional Districts: Connecticut – District 4 (Representative Jim Himes) and New York – District 17 (Representative Nita Lowey).

The project area is the area that may be directly or indirectly impacted by construction or operations of a proposed project. The Byram River study's project area includes the Village of Port Chester, Town of Greenwich, and areas further north alongside the Byram River. The tidal reach of the Long Island Sound extends to just downstream of the U.S. Route 1 bridges in the Village of Port Chester, the southernmost portion of the project area; the vast majority of the project area is considered fluvial and not tidal. The study team focused its plan formulation and technical analyses on the two areas that experience the majority of the damages within the study area. These areas are directly alongside the Byram River (Figure 2):

1. The neighborhood near the Bailiwick Bridge in the Town of Greenwich, CT. Small bridges on the Byram River narrow the channel and trap debris, which cause flood damages to residential structures and render Riversville Road, a major thoroughfare, impassable to vehicular traffic, including emergency services.
2. The southern section of the Pemberwick neighborhood in the Town of Greenwich, downstream of the existing Federal levee in the northern section of the neighborhood. Flood damages extend along the floodplain from the southern end of the existing project down to the U.S. Route 1 bridges, a distance of approximately 3,000 feet. The majority of the flood damages are in this portion. Additionally, there are approximately 30 structures within the Village of Port Chester, NY, that are within the hydraulic reach of the Pemberwick neighborhood.

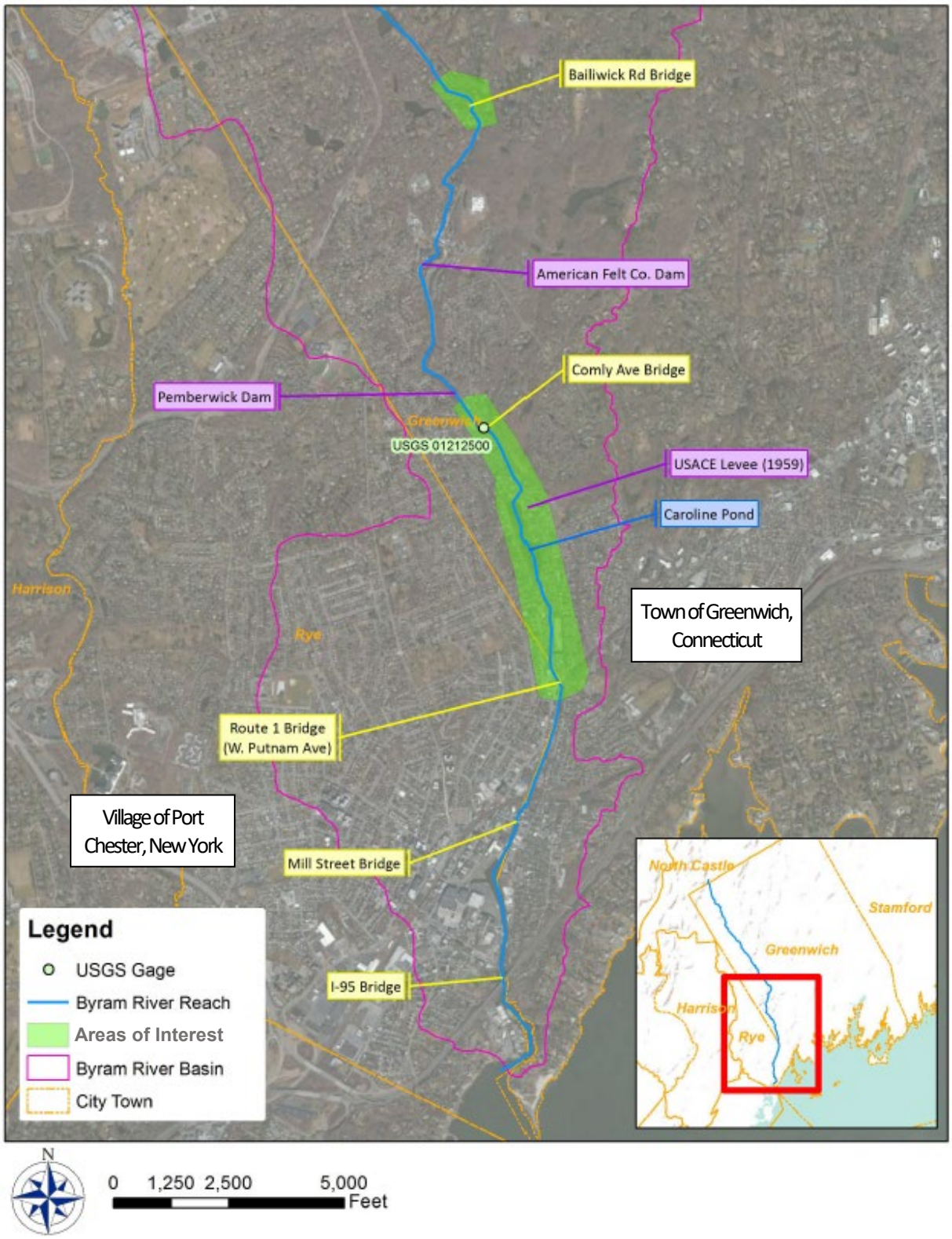

Figure 2: Byram River Focused Damage Areas Under Study

The critical infrastructure within the Byram River project area includes five bridges, two dams, one levee, one school, two fiberoptic cables, and one oil/gas pipeline (Figure 3).

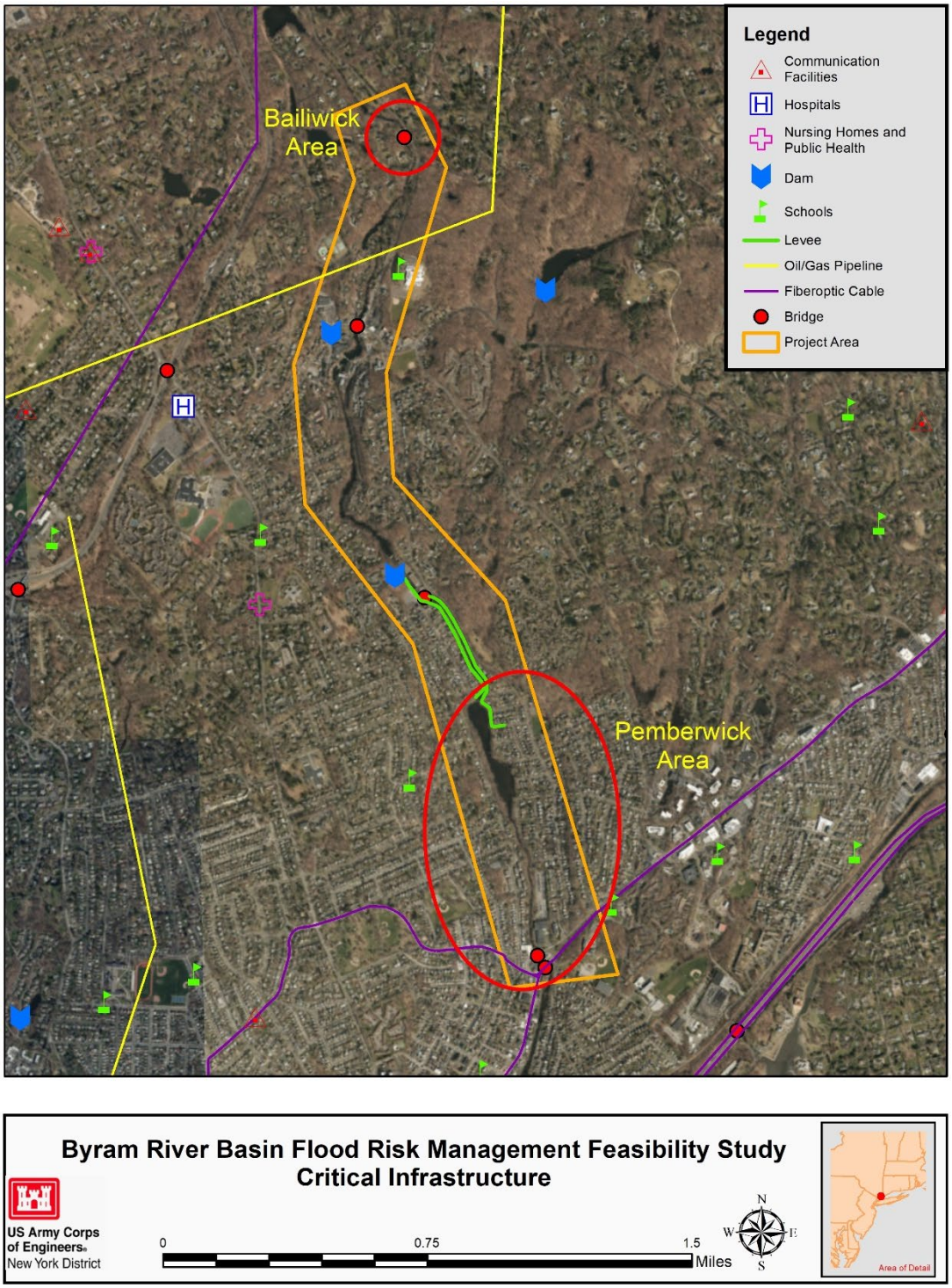

Figure 3: Critical Infrastructure within the Project Area

The project footprint, or project alignment, is the area in which measures will likely be built and consists of the alignment of the structural features associated with the proposed plan as well as any temporary construction easements or working areas.

1.5 Prior Studies, Reports, Storm Events, and Existing Water Projects

The majority of flood damages within the Byram River Basin are within the Town of Greenwich, CT[1]. Prior to the current study, the USACE has studied the Byram River Basin multiple times throughout the twentieth century, reflecting a pattern of recurring flood damages. Prior USACE reports are described below, along with major storm events to provide situational context:

- Storms of July 21-24 and September 19-22, 1938
- *Preliminary Examination Report for Flood Control, Byram River and Tributaries, Connecticut* (1942). The report considered channel improvement and rectification of Byram River above U.S. Route 1 to address flood damages in the Pemberwick area and a small portion of the Village Port Chester, NY (approximately 6,000 ft of channel improvements). The alternatives were determined not economically justified.
- Extra-Tropical Storm of October 14-18, 1955:
- *Reconnaissance Report: Byram River, Connecticut*, 1957. This report made a favorable recommendation for a Section 205 – Continuing Authorities Project within the most distressed portion of the Byram River Study area, solely within the Pemberwick neighborhood.
- *Byram River and Tributaries, Design Memorandum,* 1958. A Design Memorandum was developed for the Section 205 project within Pemberwick, which included channel work, levees, and rip-rap along 2,400 ft of the river. The project was constructed in 1959.
- *Survey of Streams in Westchester County, NY, and Fairfield County, CT,* 1968. This survey considered flood damages and potential solutions within all six river basins of the Westchester County Streams area. It did not find justification for a new project along the Byram River.
- Tropical Storm Doria, August 26-29, 1971
- Tropical Storm Agnes, June 16-22, 1972
- *Reconnaissance Report for Byram River, Port Chester, NY & Greenwich, CT,* 1973. The Reconnaissance Report recommended a new Section 205 study along the Byram River, downstream of the constructed project.
- Hurricane Eloise, September 19-27, 1975
- *Detailed Project Report for Byram River, Port Chester, NY & Greenwich, CT,* 1976. The report found that a project would be economically justified, but the Federal cost was in

[1]The Town of Greenwich is within the jurisdiction of the USACE-New England District for regulatory purposes, but New York District has jurisdiction over flood risk management for Byram River Basin, because district civil works boundaries are defined on a watershed basis and the Byram River Basin is within the civil works jurisdiction of the New York District.

excess of $1,000,000, the then-upper limit for Section 205 projects. A recommendation was made to study the Byram River under the General Investigations program.

- *Streams in Westchester County, NY and Fairfield County, CT: Feasibility Report for Flood Control, Mamaroneck and Sheldrake Rivers Basin (Village and Town of Mamaroneck, NY) and Byram River Basin (Greenwich, CT and Port Chester, NY)*, 1977. This Feasibility Report identified an economically justified project along 3,000 ft of the Byram River consisting of channel work, levees, and floodwalls, adjacent to and downstream of the existing levee in the Pemberwick neighborhood of Town of Greenwich, CT. The project was not authorized due to lack of non-federal support.
- March 30, 2007 Storm
- April 15-16, 2007 Storm
- *Section 905(B) Reconnaissance Study for Westchester County Streams, Westchester County, NY and Fairfield County, CT,* 2009. In response to extensive flood damages from the April 15-16, 2007 storms, a new reconnaissance study was conducted for the Westchester County Streams area. Byram River Basin was recommended for further feasibility level study.
- March 2010 Storm
- Hurricane Irene, August 27-29, 2011
- Hurricane Sandy, October 28-30, 2012
- Although damages from Hurricane Sandy were noted in the Port Chester section of the Byram River study area, the current feasibility study is scoped to address impacts from fluvial flooding only.

In addition to the existing flood risk management project constructed at Pemberwick in 1959, there is also an existing navigation project (Port Chester Harbor, NY) that was adopted in 1910 and modified in 1930 in the tidal portion of Byram River, in the Village of Port Chester, NY. It extends 1.7 miles from the Long Island Sound to the Mill Street Bridge in the Village of Port Chester, and the depth ranges from three to 12 feet deep, mean lower low water. The channel was last dredged in 1990 and no work is currently scheduled (USACE 2018a). A flood risk management project in the project area would not interfere with the operations of the navigation channel in the Village of Port Chester, as there is approximately half a mile between the southern limit of the flood damages area and the northern end of the navigation channel.

1.6 National Environmental Policy Act Requirements

This Final Integrated FR/EIS was prepared pursuant to the NEPA, the Council on Environmental Quality's (CEQ) Guidance Regarding NEPA Regulations, and's Procedures for Implementing NEPA (Engineer Regulation [ER]-200-2-2).

NEPA requires the USACE to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. Federal regulations to implement NEPA are found in Title 40 Code of Federal Regulations (CFR) Parts 1500-1508. The intent of NEPA is to ensure that information is made available to public officials and citizens about major actions taken by Federal agencies, and to

identify and consider public concerns and issues. "Any environmental document in compliance with NEPA may be combined with any other agency document to reduce duplication and paperwork" (40 CFR §1506.4). This report integrates discussions that normally would appear in a Final Environmental Impact Statement into the feasibility report. The purpose of an EIS is to aid a federal agency's compliance with NEPA.

The EIS must discuss:

- the purpose and need for the proposed action;
- the proposed action and alternatives;
- the probable environmental impacts of the proposed action and alternatives; and
- the agencies and persons consulted during preparation of the EIS.

This integrated report is consistent with NEPA regulatory requirements. The report reflects an integrated planning process which avoids, minimizes, and mitigates adverse project effects associated with flood risk management actions.

1.7 Non-Federal Partner

The non-federal cost sharing partner for the Byram River Basin Study is the Town of Greenwich, CT. The USACE and the Town of Greenwich executed a FCSA for the current study on August 29, 2012. Although the study area spans Connecticut and New York, most of the fluvial damages are within the Town of Greenwich. New York State (through the New York State Department of Environmental Conservation) participates as an active study team member to facilitate coordination for interstate activities.

1.8 Areas of Controversy*

Members of the public have had opportunities to comment to the development of study alternates via public information meetings and a formal NEPA scoping period. In addition, the District has coordinated with the Town of Greenwich, as the potential non-federal sponsor for implementation, as well as the Village of Port Chester, the New York Department of Transportation (NYSDOT), and the New York Department of Environmental Conservation as study stakeholders. Based on public and agency coordination conducted to date, no specific areas of controversy related to the study have been identified.

2. EXISTING CONDITIONS/AFFECTED ENVIRONMENT*

The following description of the environment to be affected within existing conditions is in accordance with the requirements of National Environmental Policy Act (NEPA) and serves as the baseline for Section 5: Environmental Effects and Section 6: Cumulative Effects of this draft integrated report. This section briefly describes the environmental setting.

An Environmental Resource Inventory report was prepared for this study and is excerpted within this report and in Appendix A.1. The full Environmental Resource Inventory report can be provided upon request. For the purposes of consistent orientation during discussions related to riverbanks, the banks will be referred to as left or right based on a downstream viewpoint.

2.1 Topography, Geology and Soils

2.1.1 Geology and Topography

The topography of the project area has a general slope downward from north to south. In the northernmost section of the project area, the elevation changes gradually from +130 North American Vertical Datum 1988 (NAVD88) just north of Bailiwick Road, southward to an elevation of +80 feet NAVD88 at the top of the Pemberwick Dam. The elevation drops to +40 feet NAVD88 at the base of the dam. From here, the elevation change from the dam base to the head of Caroline Pond is approximately 25 feet, while the last 2.5 miles has an elevation change of approximately five feet, a very shallow grade line. The banks of the Byram River vary throughout the project corridor from vertical walls to soil/sloped as gentle as 3:1, horizontal to vertical.

According to the Connecticut Department of Energy and Environmental Protection (CTDEEP) Bedrock Geology Geographic Information System (GIS) layer, and the NY State Museum Bedrock Geology GIS layer, the geology of the project area is generally consistent, with only three different types of bedrock consisting of Harrison gneiss, schist and granulite member, and Hartland Formation (CDM Smith, 2018).

2.1.2 Soils

Soils found within the project area are described in Table 1.

Table 1: Soils Found within Project Area

SOIL NAME	SLOPE	DESCRIPTION	PRIME FARMLAND SOIL	HYDRIC SOIL (NRCS-DESIGNATED)
Agawam Fine Sandy Loam	0-3%	Very deep, well drained; granite and/or schist and/or gneiss parent material.	Yes	Yes
Agawan-Urban land complex	0-8%	Very deep, well drained; granite and/or schist and/or gneiss parent material.	No	No
Canton and Charlton soils	3-25%	Very deep, well drained; granite and/or schist and/or gneiss parent material.	Yes	Yes
Charlton-Chatfield	3-45%	Very deep, well drained; granite and/or schist and/or gneiss parent material.	No	Yes
Charlton-Urban Complex	3-8%	Very deep, well drained; granite and/or schist and/or gneiss parent material.	No	No
Hollis-Chatfield	15-45%	Well drained to somewhat excessively well drained; granite, gneiss and schist parent material.	No	Yes
Ninigret and Tisbury	0-5%	Very deep, moderately well drained; granite and/or schist and/or gneiss parent material.	Yes	Yes
Paxton	3-8%	Very deep, well drained; granite and/or schist and/or gneiss parent material.	No	Yes
Pootatuck fine sandy loam	Nearly level	Very deep, moderately well drained; coarse-loamy alluvium parent material.	Yes	Yes
Rock outcrop-Hollis complex	3-45%	Shallow to moderately deep, somewhat excessively drained; granite and/or schist and/or gneiss parent material.	No	No
Udorthents	Nearly level	Very deep, well-drained soil. Drift as parent material.	No	Yes
Urban land-Charlton-Chatfield Complex	3%-45%	Very deep, well-drained; granite and/or schist and/or gneiss parent material.	No	No
Woodbridge	8-15%	Very deep, moderately well drained; granite and/or schist and/or gneiss parent material.	No	Yes

Hydric Soils

Hydric Soils are those that are saturated through natural or artificial means sufficiently enough to support the growth and regeneration of hydrophytic vegetation (NRCS, 2007). The Agawam, Canton and Charlton, Charlton-Chatfield, Hollis-Chatfield, Ninigret, Paxton, Pootattuck, Tisbury, Udorthents and Woodbridge soils are included on the list of hydric soils developed by the Natural Resources Conservation Service (NRCS)(NRCS, 2018a). The Pootatuck soils are listed as a soil that meets Connecticut inland wetland soil criteria (NRCS, 2018b).

Prime Farmland Soils

Prime Farmland Soils is defined by the US Department of Agriculture (USDA) as land that has the best combination of characteristics for producing food. It can have any land use including

cultivated land, pastureland, or forest, among others. However Prime Farmland Soils usually do not occur in urban or water areas. The USDA states that, "The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management and acceptable farming methods are applied"(NRCS, 2018c).

Four soil series within the project area are defined as Prime Farmland soil. These include the Agawam Fine Sandy Loam, Canton and Charlton soils, the Pootatuck Fine Sandy Loam and the Ninigret and Tisbury series.

2.2 Water Resources

2.2.1 Surface Water

The Byram River originates in New York and flows for approximately 13.5 miles before discharging into the Long Island Sound. The last approximately 1.6 miles of the river serves as the boundary between New York and Connecticut. The total watershed area is 30 square miles.

Within the project area, the Byram River has experienced modifications in the form of dams for historical milling operations and recreation, channel alteration for flood risk management purposes, and replacement of natural riverbanks with stone and concrete retaining walls.

Throughout the project area, the river width varies greatly, ranging from 35 feet to 80 feet and changes from natural river bank to retaining walls in several sections. A one-half mile segment of the Byram River immediately downstream of the Pemberwick Dam was modified into a trapezoidal channel stabilized with riprap along the banks and channel bottom by the USACE in 1956 for flood risk management. The substrate of the river is predominantly comprised of mud and muck, although large gravel bars have formed around the U.S. Route 1 bridges. The average depth of the river within the project area is 1.5 feet. The average width of the riparian zone along the river within the project area is 10 feet.

2.2.2 Water Quality and Habitat

From its headwaters until around the U.S. Route 1 bridges, the Byram River is freshwater. The water quality classification by the CTDEEP in this segment is Class B. This classification means its designated uses are: habitat for fish and other aquatic life and wildlife, recreation, and industrial and agricultural water supply. The impaired segment precludes swimming and other water contact related activities (C.G.S. 22a-426-4, 2018) (see Appendix A.1).

From the U.S. Route 1 bridges to its confluence with the Long Island Sound, the Byram River is designated as Class SB. The designated uses for Class SB waters are habitat for marine fish and aquatic and wildlife, commercial shellfish harvesting, recreation, industrial water supply and navigation.

New York State DEC classifies the Byram River as Class C and SC. The best usage of Class C waters is fishing. Waters with this classification are suitable for fish, shellfish and wildlife propagation and survival. The water quality is suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes. The best usage of Class SC waters is fishing. Such waters are suitable for fish, shellfish and wildlife propagation and survival. The water quality is suitable for primary and secondary contact recreation, although

other factors may limit the use for these purposes (New York State Department of Environmental Conservation (NYSDEC), 2018) (see Appendix A.1).

According to the 2016 State of Connecticut Integrated Water Quality Report, the Byram River watershed has one segment with a Total Maximum Daily Load on the impaired water list due to elevated levels of bacteria (fecal coliform). The segment is located between Pemberwick Dam and Caroline Pond. This impaired segment precludes swimming and other water contact related activities (CDM Smith, 2018).

2.2.3 Wetlands

The federal definition of wetlands (33 C.F.R. §328.3(b); Executive Order 11990) identifies wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." As defined above, wetlands generally include swamps, marshes, bogs, and similar areas. Federal wetland delineation methods require the identification of three parameters to confirm the presence of wetlands; hydric soils, hydrophytic vegetation, and wetland hydrology. All three parameters must be present for an area to qualify as a wetland under this method.

Based on a review the U.S. Fish and Wildlife National Wetland Inventory mapping system, there is a small freshwater forested/scrub shrub wetland approximately three acres in size within the project area just downstream of Caroline Pond (see Appendix A.1).

Connecticut Regulated Wetlands

The State of Connecticut criteria for identifying freshwater wetlands is primarily based on soil type with wetlands being defined as "land, including submerged land which consists of any of the soil types designated as poorly drained, very poorly drained, alluvial, and floodplain by the National Cooperative Soils Survey, as amended from time to time, of the NRCS of USDA" (CTDEEP, 2018a). The state of Connecticut has delegated permitting authority of inland wetlands to municipalities, which are also responsible for preparing "Inland Wetlands and Watercourse" maps that identify and indicate the general location and boundaries of inland wetlands and the general location of watercourses.

A review of the "Inland Wetland and Watercourse Map, Greenwich, Connecticut" (Wetland and Watercourses Map), indicated sixteen wetlands within the project area. Field investigations conducted in 2014 confirmed the presence of two of the sixteen wetlands and identified two additional wetland resource areas that were not identified on the Wetland and Watercourses Map. The wetlands were primarily located within the central portion of the project area and were all under 0.10 acres in size. A full description of these wetlands and their locations within the project area are included in Appendix A.1.

Tidal wetlands are regulated by the CTDEEP and are defined as "those areas which border or lie beneath tidal waters" which can include banks and lands subject to tidal action and support specific plant species listed in the implementing law, the Tidal Wetlands Act (CTDEEP, 2018b). Based on environmental mapping databases, there are no tidal wetlands within or near the project area.

New York Regulated Wetlands

The New York state criteria for identifying freshwater wetlands is predominantly based on vegetation. The State regulates wetlands that are 12.5 acres or greater in size. Smaller wetlands

may be eligible for protection if they are considered of unusual local importance. The law also requires a 100 foot buffer around any regulated wetlands. Based on a review of New York's environmental mapping system, there are no New York State regulated wetlands or buffer areas within or near the project area (NYSDEC, 2018b).

Generally, New York defines tidal wetlands as those areas which border on or lie beneath tidal waters and all banks subject to tides. Based on a review of New York's environmental mapping database, there are no regulated tidal wetlands within or near the project area (NYSDEC, 2018c) (see Appendix A.1).

2.3 Vegetation

2.3.1 Upland

The majority of the project area is densely developed with residential and commercial properties, therefore the vegetation in the project area is predominantly maintained lawn and landscaping. There are areas with hardwood forest in certain sections throughout the project area. However, the majority of these forested areas are thin fragments on the river banks directly adjacent to the river and Caroline Pond. The forest communities are comprised of red oak (*Quercus rubra*), tree of heaven (*Ailanthus altissima*), several maple species (*Acer* sp.), ash species (*Fraxinus* sp.), black locust (*Robinia pseudoacacia*), American elm (*Ulmus Americana*), American beech (*Fagus grandifolia*), sycamore (*Platanus* sp.), and catalpa (*Catalpa* sp.). The ground cover and shrub layer throughout the project area consists predominantly of Japanese knotweed (*Polygonum cuspidatum*), poison ivy (*Toxicodendron radicans*), skunk cabbage (*Symplocarpus foetidus*), silky dogwood (*Cornus amomum*), purple loosestrife (*Lythrum salicaria*), and Virginia creeper (*Parthenocissus quinquefolia*) (CDM Smith, 2018).

2.3.2 Wetlands

Vegetation observed in wetland areas include red maple (*Acer rubrum*), American beech, skunk cabbage, purple loosestrife, reed canary grass (*Phalaris arundinace*), soft rush (*Juncus effuses*), umbrella sedge (*Cyperus strigosus*), and willow (*Salix sp*.) (CDM Smith, 2018).

2.4 Fishery Resources

Information obtained from the CTDEEP indicates that there is a healthy population of American eel (*Anguilla rostrata*), in the section of the river near Pemberwick Dam, as well as bluegill (*Lepomis macrochirus*), brook trout (*Salvelinus fontinalis*), blacknose dace (*Rhinichthys atratulus*), pumpkinseed (*Lepomis gibbosus*), redbreast sunfish (*Lepomis auritus*), and white sucker (*Catostomus commersoni*) located throughout the project area. There is also an established eel run through the Byram River and the Town of Greenwich operates an eel pass and trap at Pemberwick Dam (CDM Smith, 2018).

The majority of these species are warm water fishes commonly found in small and medium sized rivers and pools with constant flow, adjacent to the coast. Additionally, species like the American eel prefer to spend daylight hours hiding in undercut banks and deep pools, while white sucker spend time in large pools and pool and riffle habitats. These types of habitats are found within the project area in both the Pemberwick dam pool and also the naturalized river channel in close proximity to Den Lane.

2.4.1 Essential Fish Habitat

Essential Fish Habitat (EFH) is defined under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." The MSFCMA requires federal agencies to conduct an assessment to determine whether the proposed action “may adversely affect” designated EFH and to consult with the National Marine Fishery Service on activities that may adversely affect Essential Fish Habitat. As part of the consultation, the Federal Agency must perform an EFH assessment and coordinate the assessment with the National Oceanic and Atmospheric Administration – National Marine Fishery Service (NOAA-NMFS). The objective of an EFH assessment is to determine relevant commercial, federally managed fisheries species within the proposed action area.

The NOAA-NMFS EFH Mapping System and NOAA-NMFS 10x10 square coordinates were consulted to determine the potential presence of EFH habitat within the Byram River. Unfortunately, neither resource is at a level of detail that shows the extent of possible EFH within the river. However, the Long Island Sound is designated as EFH habitat for 17 species (Table 2) near the confluence of the Byram River with the Long Island Sound. Given that the tidal range extends into the lower portion of the project area, there is a potential for EFH habitat for some species to occur in the Byram River. Refer to Appendix A.5 for further discussion of EFH designated species that may occur within the project area.

Table 2: Essential Fish Habitat Species Listed for the Long Island Sound near the Byram River

COMMON	LATIN	LIFE STAGE			
		EGGS	LARVAE	JUVENILE	ADULT
American butterfish	*Peprilus triacanthus*		X	X	X
Atlantic cod	*Gadus morhua*			X	X
Atlantic mackerel	*Scomber scombrus*			X	X
American plaice	*Hippoglossoides platessoides*			X	X
Atlantic salmon	*Salmo salar*			X	X
Atlantic sea herring	*Clupea harengus*		X	X	X
Black sea bass	*Centropristis striata*			X	
Bluefish	*Pomoatomus saltatrix*			X	X
Cobia	*Rachycentron canadum*	X	X	X	X
King mackerel	*Scomberomorus cavalla*	X	X	X	X
Pollock	*Pollachius virens*			X	X
Red hake	*Urophycis chuss*	X	X	X	X
Sand tiger shark	*Carcharias taurus*		X		
Scup	*Stenotoumus chrysops*	X	X	X	X
Summer flounder	*Paralichthys dentatus*		X	X	X
Winter flounder	*Pseudoplenuronectes americanus*	X	X	X	X
Windowpane flounder	*Scophthalmus aquosus*	X	X	X	X

2.5 Aquatic Macroinvertebrates

The CTDEEP conducts benthic macroinvertebrate sampling within the project area as part of their statewide water quality monitoring effort. The CTDEEP conducted sampling approximately 0.32 miles north of Caroline Pond near Comly Avenue in 2009. Macroinvertebrates collected at this location during included freshwater crustacean (*Amphipoda*), (*Gammaridae*), crane fly (*Tipulidae*), mayfly (*Baetidae*) (*Heptageniidae*), caddisfly (*Brachycentridae*), (*Hydroptilidae*) (*Hydropsychidae*) (*Philopotamidae*) (Lepidostomatidea) ((long horned caddisfly- (*Leptoceridae*), non-biting midge (*Chironomidae*), dance fly (*Empididae*), snail (*Hydrobiidae*), riffle beetles (*Elmidae*), freshwater roundworm (*Nematoda*), black fly (*Simuliidae*); bivalve mollusk (*Pisidiidae*), and flatworm (*Turbellaria*).

Species observed during field studies include freshwater mussel (*Unionoida* sp.), crayfish (*Cambarus* spp.), and water striders (*Gerridae* sp.) (CDM Smith, 2018).

2.6 Reptiles and Amphibians

During field visits, snapping turtles (*Chelydra s. serpentia*) were observed swimming and basking in Caroline Pond. Snapping turtles in this type of pond habitat are expected to be seen in areas in close proximity to humans. No amphibians were observed (CDM Smith, 2018). In addition to those observed, other species that would be anticipated to occur within the project area include American toad (*Bufo americanus*), bullfrog (*Rana catesbeiana*), garter snake (*Thamnophis sirtalis*), and eastern box turtle (*Terrapene Carolina*) (GCC, 2005).

2.7 Birds

Species found within the project area are those that are typically found in residential neighborhoods and are adapted to living in close proximity to humans such as house sparrow (*Passer domesticus*), gray catbird (*Dumetella carolinensis*), grackle (*Quiscalus quiscula*), rock pigeon (*Columba livia*), gull (*Larus* spp.), and blue jay (*Cyanocitta cristata*). The riparian habitat along the Byram River provides habitat supportive of species such as mallard (*Anas platyrhynchos*), great blue heron (*Ardea Herodias*), killdeer (*Charadrius vociferous*), and osprey (*Pandion haliaetus*) which use the riparian habitat for roosting, nesting and feeding during the summer months, before migrating south for the winter. The river and Caroline Pond also provide habitat for migrating waterfowl, such as mallard and geese, to feed and rest during their migrations (CDM Smith, 2018).

A full list of species observed during field studies is located in Appendix A.1.

2.8 Mammals

Given the urbanization found in the project area, mammalian species that would most likely be found would be those adapted to humans. Grey squirrel (*Sciurus carolinensis*) were observed during field visits, as were deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), and opossum (*Didelhis virginiana*) (CDM Smith, 2018). In addition to those observed, other species anticipated to occur within the project area include red fox (*Vulpes vulpes*), eastern mole (*Scalopus aquaticus*), white footed mouse (*Peromyscus leucopus*) and shrew (*Sorex* sp.) (GCC, 2005).

2.9 Threatened and Endangered Species

2.9.1 Federal Threatened and Endangered Species

United States Fish and Wildlife (USFWS) Trust Species

The District consulted the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Conservation database in November 2017, the northern long-eared bat (*Myotis septentrionalis*) and the rufa red knot (*Calidris canutus rufa*), both listed as threatened, were identified as potentially occurring within the project area (USFWS, 2017).

During the preparation of the Draft Integrated FR/EIS, the District obtained an official list of endangered and threatened species list in April 2018. The official list only identified the northern long-eared bat as potentially occurring within the project area. The list is included in Appendix A.9.

The northern long-eared bat hibernates in caves and abandoned mines with hibernation generally beginning in October/November and emergence typically occurring in April. Northern long-eared bats roost singly or in colonies underneath bark, in cavities or in crevices of both live and dead trees. Tree species commonly used as roost sites include American elm (*Ulmus americana*), slippery elm (*Ulmus rubra*), shagbark hickory (*Carya ovata*), silver maple (*Acer saccharinum*), and green ash (*Fraxinus pennsylvanica*). This species has also been observed in manmade structures such as bridges, buildings, barns, sheds, cabins, under eaves of buildings, and bat houses. Preferred foraging areas are in forested habitats (USFWS, 2015).

In addition, the USFWS is currently evaluating the little brown bat (*Myotis lucifugus*), and the tricolored bat (*Perimyotis subflavus*) to determine if listing under the Endangered Species Act (ESA) is warranted. Both species are known to occur in Connecticut.

Given that the official lists are only valid for 90 days, the District obtained an updated list in May 2019 as part of finalizing the Final Integrated FR/EIS. The updated list included bog turtle (*Glyptemys muhlengergii*) as potentially occurring within the project area in addition to northern long-eared bat.

The bog turtle is a semi-aquatic freshwater turtle that prefers shallow, emergent wetlands with highly penetrable substrates saturated by perennial groundwater discharge. Bog turtle habitats fall under several wetland community classifications including freshwater marsh, medium and rich fen, wet meadow and shrub swamp. Most bog turtle sites support a mosaic of herbaceous and woody-dominated communities. Key habitat features include soft, mucky soils (composed of organic material), springs and seeps, rivulets, shallow pools, hummocks, often in the form of tussock forming vegetation. Breeding occurs in the spring and in June with females laying eggs atop moss-covered sedge tussocks or other raised surfaces in the wetlands. Hatchlings emerge in September (USACE, 2018b).

NOAA-NMFS Trust Species

A list of endangered species under the jurisdiction of the NOAA-NMFS Greater Atlantic Regional Fisheries Office is included in Appendix A.1. The District consulted the NOAA-NMFS (ESA) Section 7 Mapper and Estimated Range Maps of each listed species located at the Greater Atlantic Regional Fisheries Office website to determine the potential occurrence of listed species within the project area. Although the ESA Section 7 Mapper did not indicate the potential presence of

any trust species within the project area, it did indicate the potential occurrence of Atlantic sturgeon (*Acipenser oxyrinchus*), shortnose sturgeon (*Acipenser brevirostrum*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), Kemp's ridley sea turtle (*Lepidcochelys kempii*), and Green sea turtle (*Chelonia mydas*) in the lower portion of the Byram River (see Appendix A.9) (NOAA-NMFS, 2018a).

Based on a review of the Estimated Range Maps, the project area is within "Accessible Waterways" for both Atlantic sturgeon and shortnose sturgeon (NOAA-NMFS, May 2018b; NOAA-NMFS, May 2018c). A review of the Atlantic Sturgeon Critical Habitat maps did not indicate that the project area is considered critical habitat (NOAA-NMFS, 2018d). The Estimated Range Maps for the shortnose and Atlantic sturgeon are located in Appendix A.9.

Brief descriptions of the species' habitat preferences are provided below:

Atlantic Sturgeon

Atlantic sturgeon are an anadromous species that spawn in freshwater in the spring and early summer and migrate into estuarine and marine waters where they spend most of their lives. They spawn in moderately flowing water (46-76 cm/s) in deep parts of large rivers. Sturgeon eggs are highly adhesive and are deposited on bottom substrate, usually on hard surfaces (e.g., cobble). Once larvae begin migrating downstream they use benthic structure (especially gravel matrices) as refuges. Juveniles usually reside in estuarine waters for months to years.

Subadults and adults live in coastal waters and estuaries when not spawning, generally in shallow (10-50 m depth) nearshore areas dominated by gravel and sand substrates. Long distance migrations away from spawning rivers are common. Preferred food sources are worms, mollusks and crustaceans (NOAA-NMFS, 2018e).

Shortnose Sturgeon

Shortnose sturgeon is an anadromous species that inhabit rivers and estuaries. They spawn in the coastal rivers along the east coast of North America from the St. John River in Canada to the St. Johns River in Florida. They prefer the nearshore marine, estuarine, and riverine habitat of large river systems and do not appear to make long distance offshore migrations. Shortnose sturgeon's preferred food sources include crustaceans, mollusks, and insects (NOAA-NMFS, 2018f).

Sea Turtles

The four sea turtle species would likely to be present as juveniles, subadults and adults within Long Island Sound and its associated bays and nearshore areas from May to November; using this area for foraging. Nesting for these species ranges from Mexico, Gulf of Mexico and the southeastern U.S. (NOAA-NMFS, 2018g).

2.9.2 State Threatened and Endangered Species

Based on coordination with the CTDEEP and the NYSDEC, no state threatened or endangered species are known to occur within the project area. Refer to Appendix A.11 for pertinent correspondence.

2.10 Socioeconomics

The populations of Town of Greenwich and Village of Port Chester have been increasing over the last two decades. The population of Greenwich increased 2.6% from 2010 to 2017, to 62,782. Its median household income increased 2.9% from the year 2010 to 2017, to $138,180. Although employment in Town of Greenwich declined from 2000 to 2010, it increased by 4.8% from 2010 to 2017.

The population of Village of Port Chester increased 2.3% from 2010 to 2017, to 29,623, which is slightly above the percentage increase of New York state overall. The Village of Port Chester's median household income increased by 24.6% from 2000 to 2010 and then by 6.2% from 2010 to 2017, to $60,041 per household. Employment in the Village of Port Chester increased by 16.3% from 2000 to 2010 and then was flat from 2010 to 2017. The resulting percentage increase from 2000 to 2017 is 16.3%. This was a greater percent increase for employment than the 10.9% increase for Westchester County or the 12.9% increase for the State of New York for the same time period.

Although the entire population that lives and works in the floodplain is vulnerable and at risk of flooding and harm, case studies have shown that certain sub-populations are more susceptible to harm from flooding. These "socially vulnerable groups" are typically children, the elderly, those disabled, low income, minorities and female head of households. Some of these have impediments to evacuating and therefore have a higher potential for loss of life, while others have a lack of resources or have special needs that may also inhibit preparing for an impending flood or evacuating. Table 3 provides demographic information indicating statistics of social vulnerability for the Town of Greenwich. Table 4 provides demographic information indicating statistics of social vulnerability for the Village of Port Chester.

Of the 263 structures with first floor elevations within the 0.2-percent floodplain, about 96% of the structures are residential, 3% are commercial, and one is public. Transportation in and around the project area is primarily via roadways and the roadway system is adequate. U.S. Route 1 crosses Byram River at the southern end of the project area in the Village of Port Chester. U.S. Route 1 is a major U.S. highway north-south vehicular travel along the entire east coast. Pemberwick Road, Comly Avenue, Glenville Road, and Riversville Road are arterial roads and the remaining roadways are secondary. More information on the socioeconomics of the project area can be found in Appendix D – Economics.

Table 3: Town of Greenwich, CT Social Vulnerability Data

				Percent of Total		
	2000	2010	2017[1]	2000	2010	2017
Total Population	61,101	61,171	62,782	NA	NA	NA
Under 5 Years	4,294	3,721	4,121	7.0%	6.1%	6.6%
5 Years thru 17 Years	11,250	12,617	12,062	18.4%	20.6%	19.2%
65 Years and Over	9,716	10,068	10,596	15.9%	16.5%	16.9%
Black or African American	1,017	1,314	2,045	1.7%	2.1%	3.3%
American Indian and Alaska Native	52	84	76	0.1%	0.1%	0.1%
Asian	3,165	4,039	4,886	5.2%	6.6%	7.8%
Native Hawaiian and Other Pacific Islander	16	14	18	0.03%	0.02%	0.03%
Hispanic or Latino (of any race)	3,846	5,964	7,994	6.3%	9.7%	12.7%
Individuals Below Poverty Level	2,436	NA	4,144	4.0%	NA	6.6%
Disabled	NA	NA	5,093	NA	NA	8.1%
Total Households	23,230	23,076	NA	NA	NA	NA
Female householder, no husband present	1,869	2,123	NA	8.0%	9.2%	NA

Source: U.S. Census Bureau's American FactFinder at factfinder.census.gov
American Community Survey 5-Year estimate.

Table 4: Village of Port Chester, NY Social Vulnerability Data

				Percent of Total		
	2000	2010	2017[1]	2000	2010	2017
Total Population	27,867	28,967	29,623	NA	NA	NA
Under 5 Years	1,947	1,998	1,947	7.0%	6.9%	6.6%
5 Years thru 17 Years	4,320	4,547	5,126	15.5%	15.7%	17.3%
65 Years and Over	3,603	3,082	3,298	12.9%	10.6%	11.1%
Black or African American	1,949	1,876	1,384	7.0%	6.5%	4.7%
American Indian and Alaska Native	112	271	420	0.4%	0.9%	1.4%
Asian	573	596	451	2.1%	2.1%	1.5%
Native Hawaiian and Other Pacific Islander	11	11	8	0.04%	0.04%	0.03%
Hispanic or Latino (of any race)	12,884	17,193	19,183	46.2%	59.4%	64.8%
Individuals Below Poverty Level	3,591	NA	3,673	12.9%	NA	12.4%
Disabled	NA	NA	2,790	NA	NA	9.4%
Total Households	9,531	9,240	NA	NA	NA	NA
Female householder, no husband present	1,299	1,320	NA	13.6%	14.3%	NA

Source: U.S. Census Bureau's American FactFinder at factfinder.census.gov
American Community Survey 5-Year estimate.

2.10.1 Environmental Justice

The Environmental Protection Agency defines Environmental Justice as 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 no group of peoples should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies". "Environmental justice is achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work" (USEPA, 2019).

Executive Order 12898, "Federal Actions to address Environmental Justice in Minority and Low Income Populations" mandates that each federal agency identify and address potential disproportionately high and adverse effects of its activities, programs, and policies on minority populations and low income populations. Specifically, the adverse effects pertain to human health, and the environment must be identified and addressed. According to Executive Order 12898, minority populations exist where the percentage of minorities exceeds 50% or where the minority population percentage in the affected area is meaningfully greater than in the general population. Executive Order 12898 does not provide criteria to determine if an affected area consists of a low-income population.

A cursory analysis was conducted to determine the potential applicability of Environmental Justice issues. The analysis took into account a comparison of the percentage of low income and minority populations occurring in each municipality within the counties in which they are located. Those municipalities where the combined minority populations and/or the low income populations are higher than the county would be subject to Environmental Justice considerations.

Fairfield County, CT has a combined minority population of 35.5% (U.S. Census, 2019e). The percentage of individuals living below the poverty level is 8.8% and the percentage of families living below the poverty level is 6.3% (U.S. Census, 2019f). The Town of Greenwich has a combined minority population of 23.3% which is lower than Fairfield County (U.S. Census, 2019g). In addition, the percentage of individuals living below the poverty level is 6.6% and families is 5.1% (U.S. Census, 2019h).

The combined minority population of Westchester County, NY is about 46.9% (U.S Census, 2019a). The percentage of individuals living below the poverty line is 9.4% and the percentage of families living below the poverty line is 6.5% (U.S. Census, 2019b). The Village of Port Chester has a combined minority population of about 72.4% which is higher than Westchester County overall (U.S. Census, 2019c). In addition, the percentage of individuals and families living below the poverty level is greater than Westchester County overall at 12.4% and 11.0%, respectively (U.S. Census 2019d).

Based on the cursory analysis, Environmental Justice considerations apply to the Village of Port Chester.

2.11 Cultural Resources

As an agency of the federal government, the USACE has certain responsibilities concerning the protection and preservation of historic properties. Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, the Advisory Council on

Historic Preservation's "Procedures for the Protection of Historic and Cultural Properties" (36 CFR 800), direct federal agencies to take into account the effect of an undertaking on historic properties included or eligible for listing on the National Register of Historic Places. In accordance with these guiding regulations, the District carried out a cultural resources investigation of the project area to identify historic properties, including archaeological sites, and initiated coordination with the New York and Connecticut State Historic Preservation Offices, federally-recognized tribes, and local interested parties.

Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments", requires all federal agencies to consult with Indian Tribes and respect tribal sovereignty as they develop policy on issues that impact Indian communities. This includes conducting government-to-government consultation on agency undertakings.

The NEPA mandate to assess proposed federal actions' environmental impacts includes the evaluation of impacts to historic and cultural resources. Under NEPA, a significant impact is based on context and intensity or severity of the impact. Context refers to the geographic, biophysical and social context of society as a whole, a region and/or local affected interests. Severity refers to the magnitude, duration and timing of the effect and can be beneficial or adverse, and direct, indirect or cumulative (40 C.F.R. §1508.8).

Several surveys were completed within the New York and Connecticut portions of the project area that identified a number of historic properties or sites, buildings and structures that are listed on, eligible for listing on, or have the potential to be eligible for the National Register of Historic Places.

New York

Archaeological Sites

Based on a review of the New York State Historic Preservation Office (NYSHPO) files, no sites have been documented within the New York State portion of the project area. The area was investigated in 1977 as part of the USACE original study and in 2000 and 2010 as part of a Phase IB and II archaeological survey for the Village of Port Chester Redevelopment Project (Zukerman and Rothschild 1977, John Milner and Associates 2000, Roberg-Lopez 2010).

Historic Buildings and Structures

The two Route 1 bridges are eligible for the National Register (Panamerican Consultants 2014a; New York State Office of Parks and Recreation 2015). A number of other buildings and structures were also identified within the New York portion of the project area. These include:

- The 1940s-era industrial building at 13 Riverdale Avenue;
- Two 1950s-era buildings at 604 North Main Street;
- The gas station on the east side of the Byram River at 780 Putnam Avenue;
- The William James Memorial Gateway park and 1920s pump house; and
- Retaining walls and related structures that line the river (Panamerican Consultants 2013a).

Connecticut

Archaeological Sites

Only one archaeological site is identified within the study area. It is identified as a potential Archaic campsite along the Byram River. The site was investigated in the 1920s and the current record in the Connecticut Office of State Archaeology/Connecticut Archaeology Center indicates it has since been destroyed. The Connecticut State Historic Preservation Office has records of eight archaeological sites within 0.75 miles of the study area boundaries. Historic period archaeological sites have been identified in the northern portion of the project area and include ruins and archaeological deposits associated with the Byram River Beagle Club (Panamerican Consultants 2014b).

Historic Buildings and Structures

There are five properties listed on the National Register within the Connecticut portion of the project area. These include the Glenville Historic District, the New Mill and Depot (formerly portions of the American Felt Company), the Glenville School, the Thomas Lyon House, and the Byram School. The New Mill and Depot and the Glenville School are listed as individual properties as well as contributing elements of the Glenville Historic District. The Glenville Historic District includes several structures associated with the mill that are not included in the individual nomination for the mill. These structures include the dam and adjacent system of retaining walls (Panamerican Consultants 2014b).

Two bridges, the Bailiwick Road Bridge and the Glenville Street Bridge, are eligible for the National Register (Panamerican Consultants 2014b).

Within the Connecticut portion of the study area there are a number of structures and buildings that may be eligible for the National Register. These include:

- Stone fences at the northern edge of the project area associated with 212 Riversville Road;
- The dam associated with the mill complex on the east side of Riversville Road;
- The cut-stone dam and factory building associated with the former Russell, Burdsall and Ward Bolt and Nut Company;
- The gas station on the east side of the Byram River in the center of the traffic circle near the south edge of the project area at 780 Putnam Avenue (due to the state boundary, the building is located in New York and the gas pumps are on a separate parcel within the Town of Greenwich in Connecticut);
- Cut- and rough-stone culverts and drain outlets that intersect the Byram River within the project area, as well as a rough-stone-lined drainage ditch extending from a concrete drain pipe beneath Riversville Road near Bailiwick Road, a cut-stone line drain at the Byram River near the south end of the Glenville Historic District, and a cut-stone culvert for the Pemberwick Brook beneath Pemberwick Road just southeast of its intersection with Comly Avenue; and
- Retaining walls and related structures stabilizing the banks of the Byram River and include large mortared cut-stone and poured-concrete structures adjacent to bridges and within the Mill and Depot complex as well as small un-mortared rough stone wall associated with individual residences (Panamerican Consultants 2014b).

2.12 Coastal Zone Management

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 Department of State. In addition, local governments can participate in Coastal Zone Management compliance through the development of Local Waterfront Revitalization Plans (LWRPs). Municipalities within the project area that have prepared LWRPs include the Village of Port Chester. In Connecticut, the Coastal Zone Management Act (CZMA) is regulated by the CTDEEP, and the municipality adopts the State policies.

The southernmost portion of the project area – just downstream of the U.S. Route 1 bridges – lies within the Coastal Zone Management jurisdictional boundaries of both states and within the Village of Port Chester Local Waterfront Redevelopment Plan boundaries (see Appendix A.1).

2.13 Floodplains

2.13.1 Describing Storms and Flood Levels

Floods are often defined according to their likelihood of occurring in any given year at a specific location. The most commonly used definition is the "100-year flood." This refers to a flood level or peak that has a 1 in 100, or 1-percent chance of being equaled or exceeded in any given year (i.e., 1-percent "annual exceedance probability"). Therefore, the 100-year flood is also referred to as the "1-percent flood," or as having a "recurrence interval," or "return period" of 100 years.

A common misinterpretation is that a 100-year flood is likely to occur only once in a 100-year period. In fact, a second 100-year flood could occur a year or even a week after the first one. The term only means that the average interval between floods greater than the 100-year flood over a very long period (say 1,000 years) will be 100 years. However, the actual interval between floods greater than this magnitude will vary considerably.

In addition, the probability of a certain flood occurring will increase for a longer period of time. For example, over the life of an average 30-year mortgage, a home located within the 100-year flood zone has a 26-percent chance of being flooded at least once. Even more significantly, a house in a 10-year flood zone is almost certain to be flooded at least once (96-percent chance) in the same 30-year mortgage cycle. The probability (P) that one or more of a certain-size flood occurring during any period will exceed a given flood threshold can be estimated as

$$P = 1 - \left[1 - \frac{1}{T}\right]^n$$

where T is the return period of a given flood (e.g., 100 years, 50 years, 25 years) and n is the number of years in the period. The probability of flooding by various return period floods in any given year and over the life of a 30-year mortgage is summarized in Table 5.

Table 5: Examples of Flooding by Various Return Periods

RETURN PERIOD (YEARS)	CHANCE OF FLOODING IN ANY GIVEN YEAR	PERCENT CHANCE OF FLOODING DURING 30-YEAR MORTGAGE
10	10 in 100 (10%)	96%
50	2 in 100 (2%)	46%
100	1 in 100 (1%)	26%
500	0.2 in 100 (0.2%)	6%

Because of the potential confusion, recent USACE guidance documents and policy letters recommend use of the annual exceedance probability terminology instead of the recurrence interval or return period terminology. For example, one would discuss the "1-percent-annual-exceedance-probability flood" or "1-percent-chance-exceedance flood," which may be shortened to "1-percent flood" as opposed to the "100-year flood." This report uses the short form "1-percent flood."

2.13.2 Water Surface Elevation

The 1-percent and 0.2-percent floodplains extend out from the current floodway into the Pemberwick area (Figure 4). Due to topography, the 0.2-percent floodplain is not much more expansive than the 1-percent floodplain. The area around Caroline Pond has the widest floodplain within the project area. The floodplain widens upstream from the U.S. Route 1 bridges.

The water surface elevations for the existing condition of the Byram River in the project area from the Long Island Sound to upstream of the Merritt Parkway are shown below in Table 6. The surface water elevation of the Long Island Sound is influenced by coastal-surge events, not rainfall events. This study analyzes the effects of rainfall, or fluvial, events. Extreme flood conditions due to fluvial events on the Byram River are generally not concurrent with extreme coastal events. The 0.2-percent coastal storm surge elevation in the Long Island Sound is the most likely coastal event that will occur with strong rainfall, or fluvial, events. Therefore, a constant water surface elevation associated with the 0.2-percent coastal event was used for the Long Island Sound for all analyzed rainfall events. For more detail, please see Appendix B.2 – Hydraulics.

Table 6: Existing Conditions Flood Elevations – Selected Area of Interest Cross Sections

LOCATION	PEAK WATER SURFACE ELEVATIONS (FT NAVD88)					
	50% FLOOD	10% FLOOD	4% FLOOD	2% FLOOD	1% FLOOD	0.2% FLOOD
Long Island Sound (50-percent coastal flood boundary condition)	6.9	6.9	6.9	6.9	6.9	6.9
Upstream of Amtrak RR Bridge	7.1	7.7	8.3	9.0	9.9	12.8
Downstream of Northbound U.S. Route 1 Bridge	7.6	9.2	10.4	11.4	12.4	15.4
Upstream of Southbound U.S. Route 1 Bridge	8.1	10.6	14.4	16.1	17.8	20.6
Caroline Pond	11.9	14.5	16.5	18.0	19.5	22.6
Upstream of Comly Ave Bridge	31.3	33.6	34.9	35.9	37.0	42.0
Byram River Reservoir	74.9	76.8	77.8	78.6	79.4	81.4
Downstream of Glenville Road Bridge	113.6	115.6	116.2	116.7	117.2	118.1
Upstream of Glenville Rd Bridge	113.7	115.8	116.6	117.4	120.3	122.4
Downstream of Bailiwick Rd Bridge	127.4	130.9	133.4	135.5	136.1	139.5
Upstream of Bailiwick Rd Bridge	128	133.1	134.7	135.7	136.1	139.6
Toll Gate Pond	143.6	146.0	146.8	147.4	148.0	149.5
Downstream of Merritt Pkwy (SR 15)	144.0	146.4	147.4	148.1	148.8	150.1
Upstream of Merritt Pkwy (SR 15)	145.0	147.2	148.4	149.3	150.2	152.2

2.14 Land Uses and Zoning

The project area includes primarily two land uses; commercial and residential. The northern section of the project area, from Bailiwick Road to Pemberwick Dam is predominantly residential with undeveloped areas of woods and open space. The middle section from Pemberwick Dam to Caroline Pond, is primarily developed residential with some commercial uses and undeveloped areas comprised of wetlands, woods and open space. Directly adjacent to Caroline Pond, on both the eastern and western sides, the existing land use is predominantly developed residential.

The 2013 National Land Cover Dataset was used to calculate the land cover within the project area (Figure 55). About 85.5% of the project area is developed, 12.9% is forested, and 1.7% is open water.

2.15 Hazardous, Toxic, and Radioactive Waste

A Phase 1 Environmental Site Assessment was prepared under USACE ER 1165-2-132 Hazardous, Toxic and Radioactive Wastes (HTRW) Guidance for Civil Works Projects to facilitate early identification and appropriate consideration of potential HTRW problems (Appendix A.7). The purpose of the Phase 1 Environmental Site Assessment is to ensure that HTRW and contamination issues are properly considered in project planning and implementation. The Phase 1 Assessment generally consists of a review of all properties in the project area to determine the potential for HTRW concerns on each property. In addition, a complete review of appropriate state and Federal environmental enforcement agency records is conducted to identify any potential hazardous situations. The results of the Phase 1 Site Assessment provide early detection of HTRW, determine viable options to avoid HTRW problems, and establish procedures for resolution of HTRW concerns, issues, or problems.

The scope of this effort is limited to the areas of proposed construction as defined by the Recommended Plan. Sites identified from environmental data bases will be classified based on the potential to impact project construction.

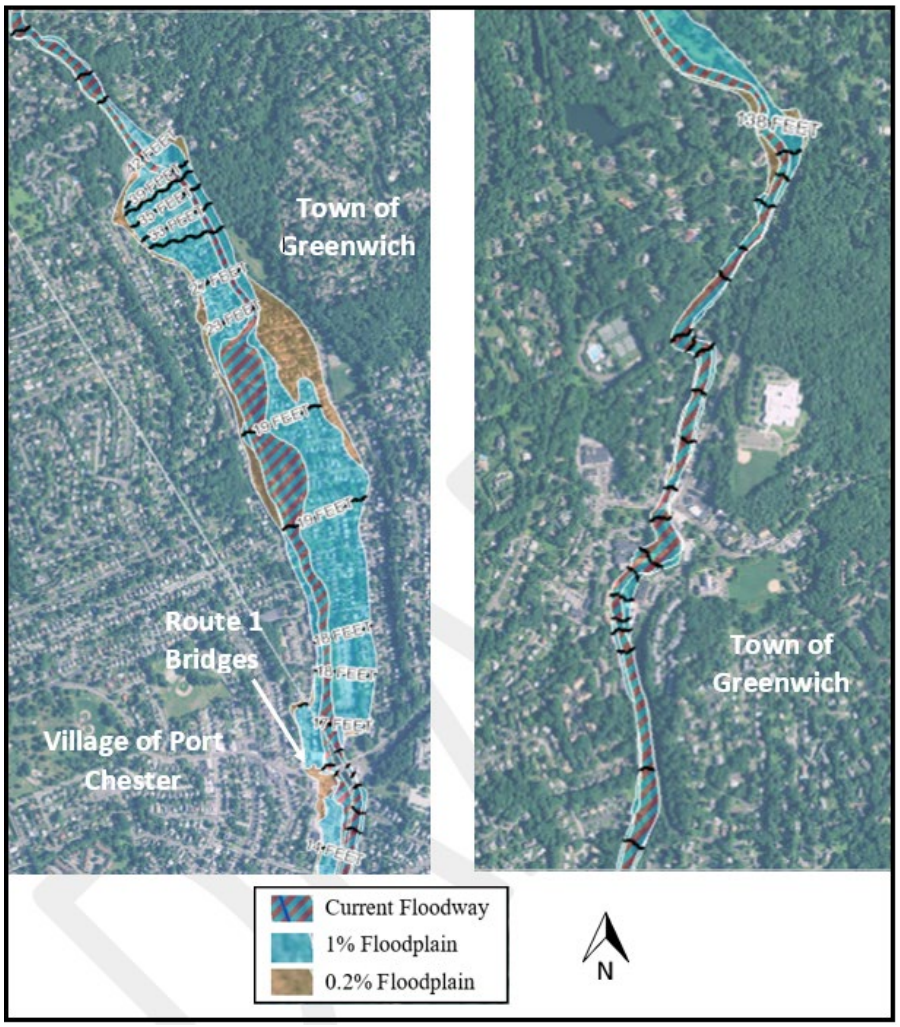

Figure 4: Federal Emergency Management Agency (FEMA)'s Current Floodplains within the Project Area (FEMA's National Flood Hazard Layer, accessed 2019)

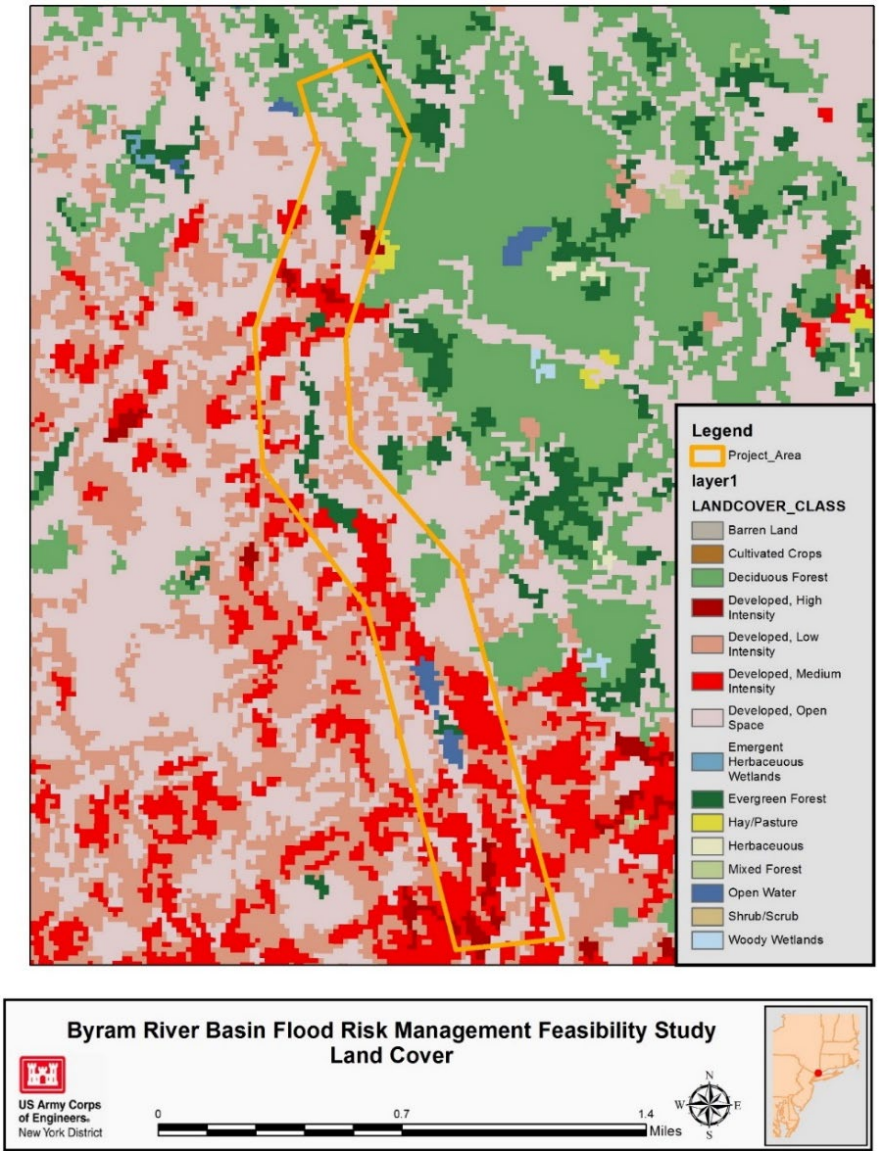

Figure 5: Land cover within the Byram River Basin project area
(2013 National Land Cover Dataset, produced by the Multi-Resolution Land Characteristics Consortium)

As part of the Phase I Environmental Site Assessment, the following databases were reviewed:

- National Priorities List;
- CERCLIS – Comprehensive Environmental Response Compensation and Liability Information System;
- Superfund Enterprise Management System;
- RCRIS – Resource Conservation and Recovery Information System;
- Toxic Release Inventory System;
- CTDEEP State Superfund List;
- NYSDEC Spills Incident Data Base; and
- NYSDEC Environmental Site Remediation Data Base (Appendix A.7).

As a result of this review, a total of 55 sites were located within the study area, primarily consisting of homeowners heating oil tanks that are still in remediation or have been listed as closed or remediated. All but three sites are well outside the project area. Two of the three sites are located on West Putnam Avenue at the Byram River and are former gas stations that have gone through remedial actions and are closed. The third location, the Pemberwick, which is a multiunit apartment building on West Putnam Avenue and Homestead Lane just east of the U.S. Route 1 bridges, is in remediation for a leaking underground storage tank for home heating oil (CDM Smith 2018).

2.16 Aesthetic and Scenic Resources

The aesthetic quality within the project area is influenced by heavy residential and business development. Much of the land along the river is developed with single family residences in the northern portion of the project area and business in the southern portion of the project area.

There are two town-designated scenic resources located within the project area (Town of Greenwich, 2009). The northernmost scenic area is located just north of Caroline Pond. This is an identified resource due to scenic views of Caroline Pond, facing south. The second resource is the section of the project area that borders the State of New York. That section of the Connecticut and New York border is considered a Coastal Scenic Area by the Town of Greenwich due to the views of the tidal channel of the Byram River, and the views continuing south to the Village of Port Chester Harbor and the Long Island Sound. A figure showing the locations of the Town designated scenic resources is located in Appendix A.1.

There are no scenic byways, National Wildlife Refuges, National Parks, National Forests, National Natural Landmarks or National Heritage sites within the project area.

2.17 Recreation

Specific areas supportive of active and/or passive recreational activities within the project area include the William James Memorial Gateway Park and Caroline Pond. The William James Memorial Gateway Park is located in Village of Port Chester along the right bank of the Byram River downstream of the bridges. Park features include a restored pump house that serves as a pavilion overlooking the Byram River. Caroline Pond is a 20-acre manmade pond used for boating/kayaking, fishing, and ice skating.

2.18 Air Quality

The Clean Air Act, as amended, assigns the USEPA the responsibility to establish primary and secondary National Ambient Air Quality Standards (NAAQS) that specify acceptable concentration levels of six criteria pollutants: particulate matter (measured as both particulate matter less than 10 microns in diameter (PM_{10}) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), sulfur dioxide (SO_2), carbon monoxide (CO), oxides of nitrogen (NO_x), ozone (O_3), and lead. Short term NAAQS (1-, 8- and 24-hour periods) have been established for regulated emissions contributing to acute health effects while long term NAAQS (annual averages) have been established for those emissions contributing to chronic health effects.

Federal regulations designated Air Quality Control Regions (AQCRs) in violation of the NAAQS as nonattainment areas. Federal regulations designated AQCRs with levels below the NAAQS as nonattainment and have been redesignated to attainment for a probation period through implementation of maintained plans. According to the severity of the pollution problem ozone and PM_{10} nonattainment areas can be categorized as marginal, moderate, serious severe or extreme.

Westchester and Fairfield Counties are located in the New York-New Jersey-Long Island Air Quality Control Region. Similar to most urban industrial areas, emissions from automobiles, manufacturing processes, utility plants, and refineries have impacted air quality in the project area. Based on the NAAQS for this region, Westchester and Fairfield Counties are designated as moderate non-attainment areas for ozone and as a maintenance area for carbon monoxide (USEPA, 2019).

2.19 Noise

Noise is defined as unwanted sound. The day-night noise level (Ldn) is widely used to describe noise levels in any given community (USEPA 1978). The unit of measurement for Ldn is the "A"-weighted decibel (dBA), which closely approximates the frequency responses of human hearing. The primary source of noise in the study area is vehicular traffic on local roadways and local construction projects that may be underway. The typical Ldn in residential areas ranges from 39 to 59 dBA (USEPA 1978). It is assumed that the existing sound levels in the study area are roughly within this range.

2.20 Transportation

The main north/southbound access roads located to the west of and parallel to the Byram River include Riverdale Avenue, Caroline Place, Fletcher Avenue and North Main Street. Pemberwick and Byram Roads are the primary north/southbound access roads east of the Byram River. Bridge crossings within the project area include U.S. Route 1 (two bridges), Comly Avenue, and Bailiwick Road.

U.S. Route 1 (also known as Putnam Avenue within the project area) is an interstate that runs east/west through several states across the northeast, including New York and Connecticut. It begins and ends at Fort Kent, Maine at the U.S.-Canada border and at Key West, Florida and provides travel among most major east coast cities including Boston, New York, Philadelphia, Baltimore, and Washington D.C. Other roads in and around the project area provide adequate capacity for normal traffic flow. Within the project area, U.S. Route 1 has two lanes in each direction with a 35 mph speed limit and is considered a main artery. At the U.S. Route 1 bridges, traffic is circulated through a roundabout (Byram Traffic Circle) connecting Putnam Avenue, North Main Street, and West Putnam Avenue. Several businesses reside inside the roundabout. Connecticut Transit's Bus 11 is routed through the roundabout and has a stop located on West Putnam Avenue at the eastside of the roundabout. Currently, U.S. Route 1 is the largest road within the project area, connecting New York City to Bridgeport, CT.

U.S. Route 1 is approximately a half mile north of and parallel to Interstate 95 (I-95). Due to its proximity to I-95, U.S. Route 1 often serves as an alternate route when travel conditions on I-95 become impacted from accidents or general congestion. The Byram Traffic Circle East connector

serves as the main access from I-95 Exit 2 to westbound Hillside Avenue and U.S. Route 1 southbound. Byram road serves as a main access from I-95 Exit 2 to U.S. Route 1 northbound and southbound as well as Hillside Avenue. Putnam Avenue provides eastbound access to U.S. Route 1 southbound, U.S. Route 1 northbound as well as I-95 Exit via Byram Road.

3. PLAN FORMULATION

3.1 Problem Identification and Opportunities

The problem definition is the detailed description of a problem. It begins with a problem statement, a simple assertion of the basic problem.

Problem statement: *The Town of Greenwich and the Village of Port Chester have been subjected to repeated, severe flooding caused by overflow of the Byram River due to precipitation of high intensity, large amounts, or prolonged duration.*

The flooding caused by overflow of the Byram River causes damages to structures. Flood damages are particularly severe in the southern section of the Pemberwick neighborhood in Town of Greenwich, CT; this area is just downstream of an existing federal levee, built in the 1950s, and continues approximately 3,000 feet south to the U.S. Route 1 bridges. A group of about 30 structures within the Village of Port Chester, New York are also affected by flooding from the Byram River.

Flooding from the Byram River also causes disruptions to Riverdale Avenue, Riversville Road, and Bailiwick Road. The neighborhood near the Bailiwick Bridge is a major thoroughfare and is rendered impassable to vehicular traffic, including emergency services, due to flooding. This creates a life safety concern because it can inhibit the ability of residents to evacuate flooded areas and the ability of emergency services to reach people in need of assistance.

A brief summary of rain events that have impacted the area is provided below.

- Flood of 1955: The October 1955 flood is considered a 4-percent flood event and was caused by a combination of a cold front with moderate to heavy rains and an extra-tropical storm with heavy rainfall. The flooding caused county officials to declare a state of emergency (Connecticut History, 2018). The Byram River was two feet over the flood state in the Pemberwick section of the Town of Greenwich. Roads were flooded, more than 30 families were evacuated from their homes, and about 95% of the Town of Greenwich was without electrical power. Three homes were carried away by the flood waters (Figure 4 and Figure 5). It is estimated that this flood caused a flow discharge of 4,520 cubic feet per second on the Byram River at U.S. Route 1 (USACE, 1977). Damages from this event amounted to $1,066,000 (1976 price level). In response, the Town of Greenwich hired an engineer to conduct a flood control survey to ascertain how to prevent a flood like this from reoccurring.
- Storm of 1971: The storm of August 26-29, 1971 caused 5.7 inches of rain to fall at the Westchester County Airport, which is adjacent to the Byram River Basin.
- Flood of 1972: The flood of 1972 was caused by Tropical Storm Agnes. This flood caused substantial damages in the Byram River Basin totaling $483,000 (1976 price level). The basin-wide total rainfall for Byram River was 5.5 inches.
- Storm of 1975: The storm of September 19-27, 1975 was caused by Hurricane Eloise and is the largest recorded flood event to affect the Byram River Basin; based off the USACE hydraulic modeling, this event was a 2-percent event. The Byram River basin-wide rainfall

was 9.1 inches. The flood discharge was estimated to be 4,400 cubic feet per second (USACE, 1977).

- 2007 Nor'easter: The 2007 Nor'easter flooding also heavily impacted the Town of Greenwich area. FEMA had a disaster recovery center open in Greenwich for three months after the event (FEMA, 2007). The 2007 Nor'easter is considered a 4-percent flood event.

Figure 4: Byram River, Pemberwick, during the October 16, 1955 flood (Greenwich Historical Society)

Figure 5: A house destroyed by the Byram River Flood of 1955 (Greenwich Historical Society)

There are opportunities in the study area to reduce the risk of fluvial flooding to residents, property, and infrastructure. Another opportunity is to reduce damages related to isolation caused by flooded roads. The 1977 Feasibility Report identified plans to achieve these opportunities and evaluated seven alternative plans in the Town of Greenwich and Village of Port Chester to reduce the risk of flooding. Included among these alternatives is a nonstructural plan, three plans consisting of combinations of levees, floodwalls and channel modification, one plan involving a combination of levees and floodwalls, a bridge replacement plan and an alternative combining bridge replacement with other structural measures. Each of these alternatives is described below in Table 7.

Table 7: Summary of 1977 Feasibility Report Plans and Conclusions
Note: This table continues on the next page

1977 FEASIBILITY STUDY ALTERNATIVE PLANS	1977 FEASIBILITY STUDY CONCLUSIONS*
Nonstructural Plan: One industrial and 61 residential structures floodproofed, and 80 residences acquired.	Economically unjustified with a benefit cost ratio of 0.6.
Plan 1: Modified 60 foot channel (2,000 linear feet or LF), and levees (3,400 LF), floodwalls (1,100 LF) and the floodproofing of one industrial structure.	Economically justified with a benefit cost ratio of 1.57 but does not maximize net benefits.
Plan 2: Modified 60 foot channel (2,400 LF), and levees (3,400 LF), floodwalls (1,100 LF) and the floodproofing of one indusial structure.	Economically justified with a benefit cost ratio of 1.58 but does not maximize net benefits.
Plan 3 (recommended in 1977): Modified 40 foot channel (2,400 LF), and levees (3,400 LF), floodwalls	Economically justified with a benefit cost ratio of 1.64 and recommended for implementation

1977 FEASIBILITY STUDY ALTERNATIVE PLANS	1977 FEASIBILITY STUDY CONCLUSIONS*
(1,100 LF) and the floodproofing of one industrial structure.	because it maximizes net economic benefits in meeting the range of planning objectives.
Plan 4: Levees (3,400 LF) and floodwalls (1,100 LF) at study area; and additional floodwall (500 LF) along right bank and knee wall atop existing levee.	Economically justified with a benefit cost ratio of 1.3 but does not maximize net benefits.
Plan 5: Replacement of U.S. Route 1 bridges with a bridge that is hydraulically more efficient.	Economically unjustified with a benefit cost ratio of 0.3.
Plan 6: Modified 60 foot channel (1,950 LF), and levees (3,400 LF), floodwalls (1,100 LF), replacement of bridges, and the floodproofing of one industrial structure.	Economically unjustified with a benefit cost ratio of 0.9.

Note: A ponding area, pumping station, and associated interior drainage facilities would be required for all plans except Plan 5.

**Since the 1977 Feasibility Report, there have been changes is study area conditions that include increased development and water surface elevations, as described in Section 2 – Existing Conditions / Affected Environment.*

3.1.1 Future Without-Project Conditions/ No Action *

The future without-project condition, or No Action alternative, is the condition that would occur if no federal action is taken to reduce the risk of fluvial flooding in the study area. This condition is used for comparison during all of the alternative analyses. The period of analysis used in the comparison of potential costs and benefits of alternative plans is 2023 through 2072. Relevant resources of the area and the No Action alternative are succinctly described as required by NEPA. The No Action alternative and the plan formulation "future without-project" condition are equivalent.

In the absence of federal action, flooding problems in the Byram River Basin associated with rainfall events, as well as the associated maintenance and reconstruction of flood risk management facilities, are expected to continue. It is expected, based on future land use projections in the study area, there will be limited new development within the Basin in the 50-year period of analysis.

In the long term, properties in flood prone areas are likely to sustain continued damage during future storm events. Without addressing flood risks, damages will continue to accrue. The estimate of future without-project damages is based on structure and content damages to commercial and residential buildings and is estimated through the USACE Hydrologic Engineering Center – Flood Damage Analysis (HEC-FDA) software. Content damages include damages to material items housed within the buildings. The estimated total future without-project equivalent annual damages is $3,181,000 for the USACE "intermediate" sea level change scenario and includes damages to automobiles and utilities, as well as emergency costs (Price Level Fiscal Year [FY] 2020; Discount Rate 2.75%). More than half of the without-project damages occur to commercial facilities and approximately 36% occur to residential structures. Approximately 85% of these damages occur in the Pemberwick neighborhood in the Town of Greenwich.

These problems may be exacerbated by increased damage potential with anticipated climate change, which is expected to lead to an increase in intensity and frequency of precipitation and storm events (U.S. Global Change Research Program, 2014). It is understood that the coastal region of Town of Greenwich and Village of Port Chester faces a combined hazard from both

coastal flooding and riverine flooding. While previous studies have indicated that the coastal flooding mechanisms are largely separate from the riverine flooding mechanisms, the riverine events are influenced by coastal storm surge. This study considers the coastal-fluvial relationship while formulating to reduce the risk of fluvial flooding events and therefore must consider sea level change.

Sea level in the Long Island Sound is predicted to continue to rise and influence the fluvial mechanisms of our study area. Table 8 and Figure 6 show predicted sea level change scenarios based on long term trends measured in the area over the 50 year planning horizon (2023 – 2073) and the 100 year adaptation horizon (2023 – 2123) at the Kings Point gage, as calculated using procedures in ER 1100-2-8162 (USACE Climate Preparedness and Resilience, 2017). The USACE "low" Curve is based on the historic rate of sea level change. The rate for the USACE "Intermediate" and "High" Curves are computed from the modified National Research Council Curve I and Curve III, respectively, considering both the most recent Intergovernmental Panel on Climate Change projections and modified National Research Council projections with the local rate of vertical land movement added.

Within the 50 years between 2023 and 2072, the USACE historic "low" sea level change scenario predicts a 0.4 foot increase, while the USACE "intermediate" and "high" sea level change scenarios predict a 0.9 foot and 2.5 foot increase, respectively. Within the 100 years between 2023 and 2123, the USACE historic "low" sea level change scenario predicts a 0.8 foot increase, while the USACE "intermediate" and "high" sea level change scenarios predict a 2.2 foot and 6.8 foot increase, respectively. These increases may increase the risk of coastal flood damage and may influence the fluvial mechanisms to increase the risk of fluvial flood damages, as well.

Table 8: Estimated Relative Sea Level Change Projections at Kings Point Gauge
Gauge: 8516945, Kings Point, NY

Year	Relative Sea Level Change [feet]		
	USACE "Low"	USACE "Intermediate"	USACE "High"
2023	0.00	0.00	0.00
2033	0.08	0.14	0.35
2043	0.16	0.30	0.76
2053	0.23	0.48	1.26
2063	0.31	0.67	1.82
2073	0.39	0.89	2.47
2083	0.47	1.12	3.18
2093	0.54	1.37	3.97
2103	0.62	1.63	4.83
2113	0.70	1.92	5.77
2123	0.78	2.22	6.78

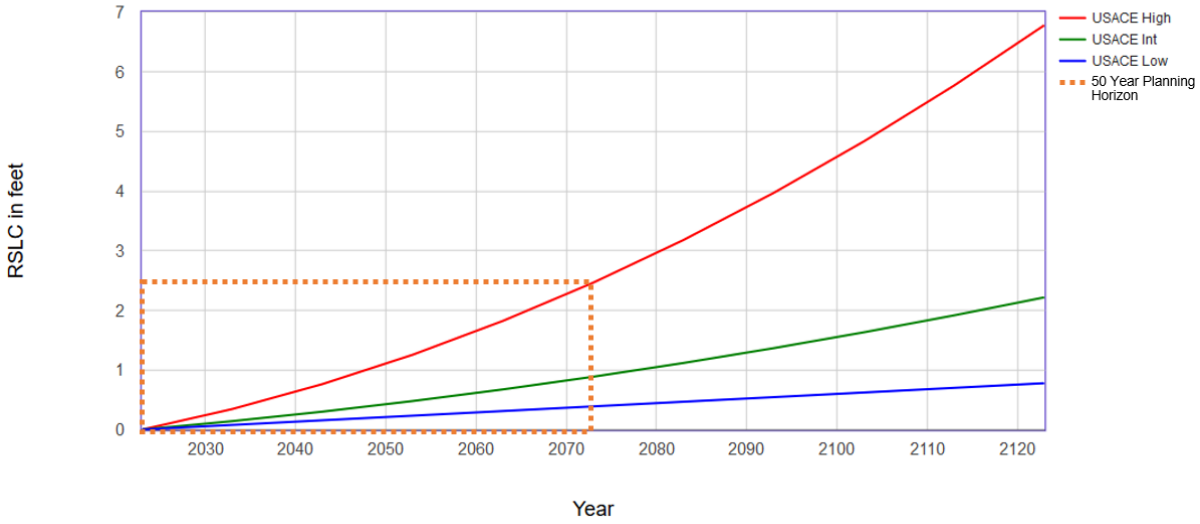

Figure 6: Estimated Relative Sea Level Change Projections at Kings Point Gauge
Gauge: 8516945, Kings Point, NY. The orange dotted line represents the 50-year period of analysis.

3.2 Planning Goal and Objectives

A study goal based on problems and opportunities was developed to help create and evaluate alternative plans. It is the overarching intent of the project.

Project Goal: *Reduce the risk of damages from fluvial flooding of the Byram River.*

Study Goal: *Determine if there is a technically feasible, economically justifiable, and environmentally acceptable flood risk management recommendation for federal participation in the Byram River Basin.*

Plans are formulated to achieve planning objectives. Planning objectives and constraints are directly linked to problems and opportunities. A planning objective states the intended purposes of the planning process. It is a statement of what solutions should try to achieve. Objectives provide a clear statement of the study purpose.

The planning objectives are to:

1. *Manage the risk of damages from flooding caused by fluvial events from the Byram River through 2072.*
   Measurement: estimated annual damages, as calculated by the HEC-FDA model
2. *Support community resiliency through 2072.*
   Measurement: qualitative analysis of how a project would aid the community in recovery from floods by reducing flood damages

3.2.1 Federal Action

Per the 1983 Principles and Guidelines by the U.S. Water Resources Council, the federal objective of water and related land resources project planning is to "contribute to national economic

development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements." Water and related land resources project plans are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective. Contributions to NED are increases in the net value of the national output of goods and services. In addition to the NED and environmental quality accounts, evaluation of the beneficial and adverse effects of the alternatives will provide a basis to determine which plans should be considered further, dropped, or reformulated; these accounts include regional economic development and other social effects.

3.3 Planning Constraints and Key Uncertainties

Constraints are restrictions that limit the extent of the planning process. They can be divided into universal constraints and study-specific constraints. Universal planning constraints are the legal and policy constraints to be included in every planning study. Study-specific planning constraints are statements of things unique to a specific planning study that alternative plans should avoid. Constraints are designed to avoid undesirable changes between without- and with-project conditions.

The study specific constraints are physical. The topography of the study area is characterized by a quick rise in elevation out of the 0.2-percent floodplain. Based on the quick rise in elevation and the high level of development within the floodplain, there are physical space constraints that will affect the screening of measures.

Limitations to the quantity and quality of information result in uncertainties. The four key uncertainties are:

- Hydrology and Hydraulics: The Byram River is tidal from the mouth to about the location of the U.S. Route 1 bridges, which is at the southern end of the Pemberwick neighborhood. The Byram River Basin study is a fluvial flood risk management study. It is understood that the coastal region of the Town of Greenwich and Village of Port Chester face a combined hazard from both coastal flooding and riverine flooding. While previous studies have indicated that the coastal flooding mechanisms are largely separate from the riverine flooding mechanisms, the riverine events are influenced by coastal storm surge. This study considers the coastal-fluvial relationship while formulating to reduce the risk of fluvial flooding events. There are uncertainties in hydrologic parameters (such as discharge-frequency relationship and runoff model) and hydraulic parameters (such as Manning's roughness coefficients, contraction and expansion coefficients, and the downstream boundary condition). Over the next 50 years sea levels may increase over two feet due to sea level change; this would increase the tidal influence on the river and may extend into study area. A rise in water surface elevation through sea level change may exacerbate flood damages from rainfall events over the 50 year period of analysis. The range of possible water surface elevations due to these hydrologic and hydraulic uncertainties with the proposed project in place are detailed in Section 4.3.1 of the main report, Appendix B.1 – Hydrology, and Appendix B.2 – Hydraulics.
- Economics: It is assumed that the people will continue to live along the Byram River based on real estate market appeal of the Town of Greenwich. There are uncertainties in the economic parameters that are used to calculate the economic benefits of alternative plans, including structure first floor elevations, structure values, structure-to-content value ratios,

and depth-damage functions. The uncertainties of these inputs may contribute to the over- or under-estimation of the benefits provided by alternative plans. The study team conducted a structure inventory to inform the parameters and conducted a Monte Carlo simulation to capture the uncertainty surrounding these parameters. These uncertainties and methods are further described in the Appendix D – Economics and Section 4.3.1 of the main report.

- Public Acceptability: It is uncertain whether that public will support the alternatives being considered. The study team has been engaging the public early and often in the planning process to minimize this uncertainty.
- Data: The study team is relying on existing data and literature surveys for HTRW, Cultural Resources, and geotechnical information based on the data collected for the 1977 Feasibility Report and the extensive record keeping by the Town of Greenwich. There is a possibility that the presence of unrecorded HTRW or Cultural Resources, or discrepancies in the geotechnical data, may require project design modifications.

3.4 Identification and Screening of Management Measures

Plans to manage the risk of flood damage are composed of measures. A measure can be structural (a physical modification designed to reduce the frequency of damaging levels of flood inundation) or nonstructural (actions to reduce flood damages without significantly altering the nature or extent of flooding). Measures can be used individually or combined with other management measures to form alternative plans. Measures were developed to address problems and to make the most of opportunities. They were derived from a variety of sources including prior studies, the public scoping process, and the study team's experience.

The following nonstructural and structural measures were considered to provide flood risk management and maximize project benefits. All measures were screened for their capability to meet objectives and avoid constraints, as well as for engineering and economic feasibility. Measures were screened in consideration of the 10-percent event under existing conditions to compare the results amongst the measures. Measures that warranted consideration were assembled into alternative plans. Management measures were retained for further consideration based on their ability to meet the following screening criteria:

1. Does the measure meet objectives?
2. Does the measure avoid constraints?
3. Is the measure feasible to design and construct?
4. Is the measure economically feasible?

This section describes the screening of the flood risk management measures used to develop the alternatives for the Byram River Study and explains why diversions, storage, and pumps were screened out. The measures have been grouped under structural and nonstructural flood risk management measures.

3.4.1 Structural Features

Structural flood risk management measures involve physical modifications to the river and/or its surrounding area to control the flow of the river and to reduce the frequency of flooding. Structural alternatives evaluated include levees and floodwalls, channel modifications, bridge modifications,

diversions, storage, pumps, and natural and nature-based features. The structural measures described here may require rain runoff storage and interior drainage facilities, such as pump stations, ponding areas, or pipe diversions.

1. Levees and floodwalls

Floodwalls and levees are intended to reduce the risk of flooding to homes, commercial buildings, municipal buildings, roadways, and bridges by preventing floodwaters from reaching these structures. While levees and floodwalls can provide a cost-effective means to reduce flooding of low-lying areas, interior drainage facilities are required to handle run-off trapped upstream of the levees and floodwalls to prevent interior residual flooding.

As part of the Pemberwick Flood Control Project (USACE, 1958), a levee was constructed from Halock Drive to Rex Street along the east bank of the Byram River (as show in Figure 3). The USACE made recommendations in the 1977 Feasibility Report to extend the existing levee on the east bank and floodwalls along both banks of the river, between U.S. Route 1 and Rex Street (USACE, 1977). At the time, these recommendations were found to meet objectives, avoid constraints, and be technically and economically feasible; however, the plan was not constructed due to lack of non-federal support. Further description of the 1977 Feasibility Report's recommended plan can be found in Section 3.5.3. The current study revisited the levees and floodwalls proposed in 1977 while updating the designs to accommodate existing conditions.

2. Channel modifications

Channel modifications may be used to help communities by reducing the risk of stream blockages and increasing river flow conveyance. Channel modifications are manmade alterations to the channel's characteristics and can include deepening, widening, and re-channelization. Channel modifications are typically only effective for the more frequent, low intensity floods and may have significant environmental impacts.

Channel modifications considered as part of the Byram River Basin study include:

- Dredging of the river that would include the removal of accumulated silt and debris from the channel bottom
- Channel widening between the U.S. Route 1 bridges and the Comly Avenue bridge

As part of the 1977 Feasibility Report, dredging was proposed from a point approximately 700 feet downstream of the U.S. Route 1 bridges to a point near the outlet of Caroline Pond. A "dredging only" scenario was considered and initially evaluated using the models Hydrologic Engineering Center – River Analysis System (HEC-RAS) and Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS). The modeled water surface for the "dredging only" scenario showed a slight reduction in the water surface elevation upstream of the U.S. Route 1 bridges for 1-percent flood event; the majority of the reduction in flooding is due to the increased conveyance under the U.S. Route 1 bridges. The preliminary evaluation of the channel modification measures indicated the slight decrease in water surface would not be sufficient enough to provide substantial benefits; other measures – such as levees or floodwalls – would need to be constructed in conjunction with channel modifications to be able to reduce the water surface elevation enough to benefit the community. The study team kept channel modifications, to be combined with other measures, for further analysis.

Similar to channel deepening, channel widening would not be an effective solution on its own to decrease the risk of flooding in the study area. Additionally, channel widening would require

major acquisitions of riparian properties; the study area is highly developed and this would be a significant cost that would interfere with project justification. Therefore, channel widening was not further considered for flood risk management for this study.

3. Bridge modification

Bridge modifications can include modifying or removing bridges to improve the conveyance of water flow and accommodate channel modifications. Bridge modifications considered as part of this project included:

- Removal and replacement of the U.S. Route 1 bridges (Northbound and Southbound)
- Adjustments to the private bridge near Pecksland Road (Pecksland Road bridge) and/or Bailiwick Road bridges

The U.S. Route 1 bridges are located in the downstream region of the river, while the private and Bailiwick Road bridges cross the river at the upstream end of the study area (Figure 7).

To evaluate the potential for flood risk management associated with modifications to the U.S. Route 1 bridges, adjustments were made to the existing HEC-RAS and HEC-HMS models to represent the removal of the U.S. Route 1 bridges, including the loss of storage upstream of the bridges. Removing the bridges from the models would maximize the possible conveyance for the region and would represent the maximum reduction in water surface elevation possible with bridge improvements. The analysis showed the removal of the U.S. Route 1 bridges would result in a water surface over 4.5 feet lower than existing conditions for the 1-percent flood at the upstream face of the southbound bridge. This substantial decrease in water surface elevations is because the U.S. Route 1 bridges have large central piers and low roadway profiles that constrict the flow of the Byram River and increase the water surface elevation of the River upstream of the bridges. Having identified the U.S. Route 1 bridges as a major constricting factor for the Byram River, modifications to the U.S. Route 1 bridges were kept for further analysis.

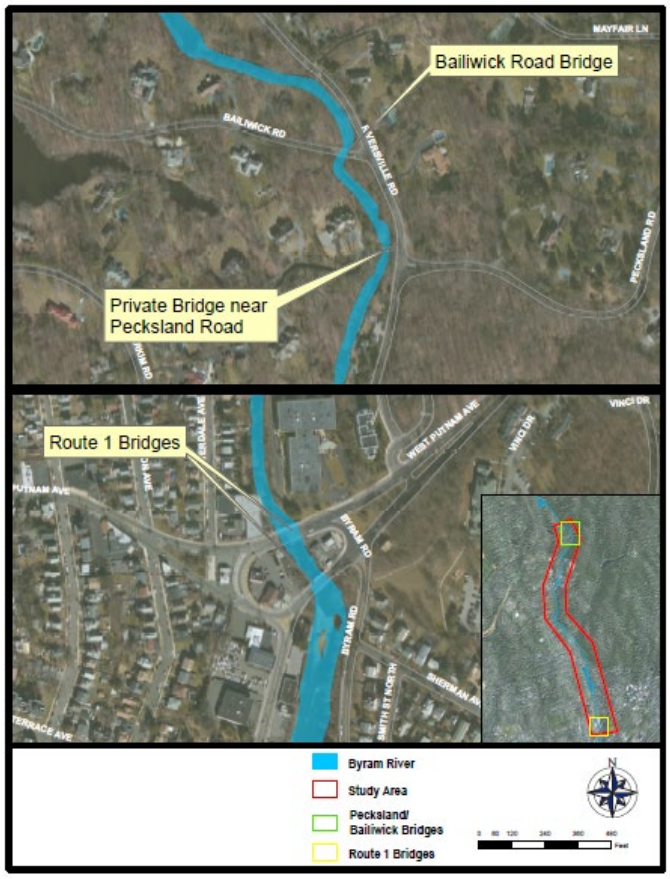

Figure 7: Locations of bridges considered for modifications

The Peckland Road bridge and Bailiwick Road bridge are smaller than the U.S. Route 1 bridges. Under current conditions, the Peckland Road private bridge controls upstream flooding for events larger than the 4-percent event; raising the Peckland Road private bridge by two feet increases the capacity of the structure to the 1-percent flood and decreases water surface elevations by up to two feet upstream. Modifications to the Bailiwick Road bridge would only have an impact on events smaller than the 2-percent event. The analyses of the Peckland Road and Bailiwick Road bridges do not contribute to the constriction of the river as significantly as the U.S. Route 1 bridges; therefore, the Peckland Road and Bailiwick Road bridges were not carried forward for further analysis.

4. Diversions

Diversions involve rerouting floodwater either to a location downstream or to another waterway with adequate capacity. An underground culvert may be used to divert river overflow upstream of a developed area; flood flows contained within the culvert would bypass the developed area and re-enter the river downstream. Under normal conditions, base flow would continue to flow within the river channel and would not enter the diversion. During rain events, an intake structure would allow flood flows to be diverted into the culvert. This type of alternative can minimize environmental impacts to the stream by avoiding alterations within the river channel.

Diversions considered as part of the Byram Study include:

- Diversion of flow from the wetlands just downstream of I-684 and north of the Bedford Road culvert (Basin 01) to Rye Lake in the neighboring Bronx River watershed
- Diversion of flow from Comly Avenue to south of U.S. Route 1

Diverting the Byram River at the wetlands just south of I-684 removes 8.5 square miles of drainage area from the watershed. While this represents a significant portion (28%) of the overall watershed area, the removal does not significantly reduce the downstream discharge. This is because the diverted portion is primarily a less developed area, producing relatively less runoff than the other large, more developed sub-basins. The area currently discharges to a flat wetland area which stores storm runoff and significantly attenuates any contribution to the peak discharge downstream.

Diverting flows from Comly Avenue to U.S. Route 1 was evaluated to reduce flood conditions during a 1-percent storm event to a 10-percent storm event equivalent to attain substantial benefits. A 12-foot high by 45-foot wide box culvert would be required to meet this reduction. The large culvert size that would be required to be effective was determined to be infeasible because of the density of the existing development and estimated high construction costs. Therefore, diversions were removed from further consideration. Diversions were also screened out at an early stage in the 1977 Feasibility Study for the same reasons, but were revisited for the current study due to requests received from the public.

5. Detention basins

Detention basins are be used to reduce the peak flood flows by temporarily storing (detaining) floodwater in an excavated area prior to entering the project area, then releasing it at a substantially reduced flow. This reduces peak water surface elevations and helps to minimize flood damages downstream.

Analyses determined that a storage volume in excess of 1,500 acre-feet would be required to reduce flood impacts from a 1-percent storm event to impacts experienced during a 10-percent storm event. Two locations, one near the Merritt Parkway and another along Pemberwick Road, were considered for construction of a 150 acre storage pond 10 feet deep (Figure 8). As neither location was sufficient to accommodate the volume needed to reduce flood impacts to that of a 10-percent storm, an additional, more realistic storage scenario was evaluated near the Merritt Parkway.

The Merritt Parkway Storage area would require raising the existing dam at the Toll Gate Pond outlet. As an additional measure, major excavation could be done on the west bank all the way to the Merritt Parkway where a retaining wall would be necessary to support the road embankment. This would add an additional 19 acres of storage area, increasing the available storage of the project by nearly 70%.

The reduction in downstream peak discharge is at the cost of increased inundation upstream of the dam during extreme events. Storage was found to be an unsuitable solution for the level of flood risk management provided by these measures due to limited areas applicable for storage and costs associated with acquiring and/or relocating properties, maintenance, and environmental impacts from tree clearing and land disturbances. Therefore, detention basins were removed from further consideration; storage was also screened out at an early stage in the 1977 Feasibility Study for the same reasons, but were revisited for the current study due to requests received from the public.

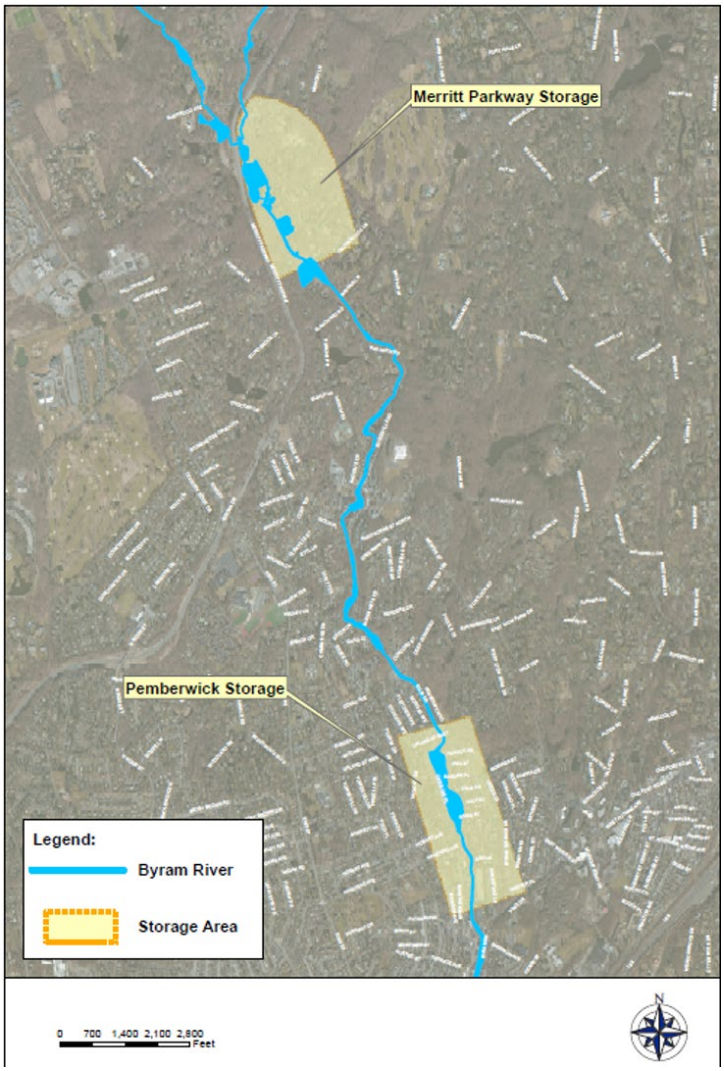

Figure 8: Locations considered for storage along the Byram River

6. Pumps

Pumps can be implemented as an independent flood risk management measure or may be required to reduce the risk of residual interior flooding. Flood risk management utilizing pumps involves removing and relocating flow from within a river channel and diverting it to a location downstream of the flood prone area. Analyses determined that reducing the Byram River's flow from a 1-percent storm event to a 10-percent storm event within the Pemberwick area, the pumping capacity requirement would be approximately 3,450 cubic feet per second. It was estimated that a facility with the desired capacity would cost over $350,000,000 and, due to the space constraints in the area, obtaining the land required for implementation would be difficult and add additional costs. Therefore pumps were determined to be infeasible and did not move forward for further consideration.

7. Natural and Nature-Based Features

Natural and nature-based features are landscape features that are used to provide engineering functions relevant to flood risk management that work with natural processes or mimic the natural

environment. Examples of these features include beaches, dunes, and vegetated environments such as wetlands and fluvial floodplains. These features can be effective at reducing the flood risk of low-intensity flood events, however, they require a significant amount of space to implement. The study team determined natural and nature-based features were not appropriate to reduce fluvial flooding for the Byram River Basin study due to steep topography and high level of development in the study area. These characteristics limit the space available for implementation and the natural and nature-based features would not provide substantial benefits for flood risk management as compared to costs. Therefore natural and nature-based features were determined to be infeasible and did not move forward for further consideration.

3.4.2 Nonstructural Actions

Nonstructural measures are measures that do not involve physical modifications to the river nor its surrounding area. These measures include floodproofing, elevations, and acquisition. Unlike the structural measures, the nonstructural measure types were looked at collectively instead of individually. Participation in nonstructural solutions would be voluntary for the identified properties. The structures in the floodplain are primarily single-family residential structures along with some commercial and public facilities. The nonstructural measures considered are described below. More information on nonstructural measures can be found by contacting the USACE – National Nonstructural Committee (USACE–NNC).

1. Floodproofing of frequently flooded structures

Floodproofing is a body of techniques for preventing damages due to floods, and requires adjustments both to structures and to building contents. Dry floodproofing consists of waterproofing a structure by keeping water out of structures. Wet floodproofing entails using water resistant construction and finishing materials, and elevating all utilities above the design flood elevation.

2. Ringwalls/structural peripheral wall

Ringwalls, technically considered a structural measure, are small-scale berms or floodwalls that can be implemented around a single structure or a neighborhood. This measure is intended to reduce the frequency of flooding but not eliminate floodplain management and flood insurance requirements.

3. Elevation (raising) of frequently flooded structures

This involves raising the buildings in place so that the structure sees a reduction in frequency and/or depth of flooding during high-water events. Elevation can be performed using fill material, on extended foundation walls, on piers, post, piles, and columns.

4. Acquisition of frequently flooded structures

This technique includes permanent evacuation of existing areas subject to inundation and involves the acquisition of this land and its structures, either by purchase or by exercising the powers of eminent domain. Following this action, all development in these areas is either demolished or relocated.

3.4.3 Summary of Management Measure Evaluation

The screening of flood risk management measures included an assessment of the potential engineering, economic, environmental, public, financial, and institutional feasibility of

implementing each measure. Of the structural measures considered, diversions and storage were screened out because of physical space constraints. Pumps were also considered because they were requested by the public. All of the nonstructural measures were retained for formulation of alternatives. The structural measures that remained for consideration include levees, floodwalls, channel modifications, and bridge modifications.

Those measures that were not screened out are carried forward for more detailed analysis as alternative plan components. Based on the physical layout of the study area, the flood hydrology, and the profiles of structures at risk, the initial array of alternative plans was developed for consideration for flood risk management in the study area.

3.5 Evaluation of the Initial Array of Alternatives

Alternative plans consist of one or more management measures. The purpose of the evaluation step is to carefully examine each alternative plan and determine if it is worthy of additional consideration. Criteria used to evaluate a plan to determine if it qualifies for further consideration include all significant resources, outputs, and plan effects. Significant plan effects must include contributions to planning objectives and constraints. They also include the federal objective, environmental compliance requirements, the 1983 Principles and Guidelines Criteria four evaluation criteria (completeness, effectiveness, efficiency, and acceptability, which are discussed in Section 3.5.5), and other impacts important to the study team and stakeholders. Following guidance in the USACE ER 1100-2-8162, the evaluation of the initial array of alternatives was conducted assuming the USACE "intermediate" sea level change scenario.

Based on results from the preliminary analysis of potential flood risk management measures, five alternatives were initially formulated:

- Alternative 1: No Action, as required by the USACE's regulations
- Alternative 2: Nonstructural alternatives, as required by the USACE's regulations
  - Nonstructural treatments in the 10-percent floodplain
  - Nonstructural treatments in the 1-percent floodplain
- Alternative 3: An update of the structural plan identified in the 1977 Feasibility Report that includes levees and floodwalls
- Alternative 4: A structural alternative involving channel widening, bridge modifications, and levees and floodwalls that are smaller than those evaluated in Alternative 3

3.5.1 Alternative 1 – No Action Alternative

This plan fails to meet the objectives or needs for the majority of the project area. It will, however, provide the base against which project benefits are measured. This plan would be recommended if all alternatives have costs that exceed benefits, indicating that flood risk management measures are not in the federal interest. The economic analysis of this alternative is presented in Table 9.

Table 9: Alternative 1 Preliminary Costs and Benefits

ALTERNATIVE		ANNUAL BENEFITS	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
1	No Action	$0	$0	$0	$0	-

3.5.2 Alternative 2 – Nonstructural

Nonstructural measures are required to be evaluated during feasibility studies. The nonstructural flood damage reduction analysis involved looking at treatments of individual structures for two storm events (10-percent and 1-percent). Under this alternative, almost 500 structures were evaluated for nonstructural flood risk reduction measures within the project area (Table 10). Table 11 shows the results of the preliminary economic analysis of the two nonstructural alternatives. Figure 9 and Figure 10 show the structures recommended for nonstructural treatments in the 1-percent floodplain that encompasses the 10-percent floodplain.

Table 10: Summary of Nonstructural Alternatives

FLOOD TREATMENT	NUMBER OF STRUCTURES REQUIRING TREATMENT FOR EACH FLOODPLAIN	
	10-PERCENT	1-PERCENT
Dry Floodproofing	5	45
Wet Floodproofing	1	93
Ringwall	10	12
Elevation	30	51
Acquisition	1	1
Total	47	202

Table 11: Alternative 2 Preliminary Costs and Benefits
(Price level FY 2016; Federal Discount Rate 3.125%)

ALTERNATIVE	ANNUAL BENEFITS	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
Nonstructural treatments in the 10-percent floodplain	$851,000	$19,170,000	$799,000	$52,000	1.07
Nonstructural treatments in the 1-percent floodplain	$1,050,000	$33,169,000	$1,382,000	-$332,000	0.77

The preliminary economic analysis of nonstructural treatments in the 1-percent floodplain shows that the costs outweigh the benefits and that the benefit cost ratio is below one; therefore, the alternative is not economically justified. The preliminary economic analysis of nonstructural treatments in the 10-percent floodplain shows that the benefits outweigh the costs and that the benefit cost ratio is above one; therefore, the alternative will be retained for further detailed economic analysis in the final array of alternatives.

Implementing nonstructural measures in the 10-percent floodplain meets the overall project objective of reducing storm damage in the Town of Greenwich. However, as the measures only protect buildings and structures from flooding, considerable residual damage would remain after a storm (i.e. to the infrastructure and vehicles), and significant emergency personnel activity would

be required. The nonstructural features will not obstruct water views, nor will waterfront access need to be modified.

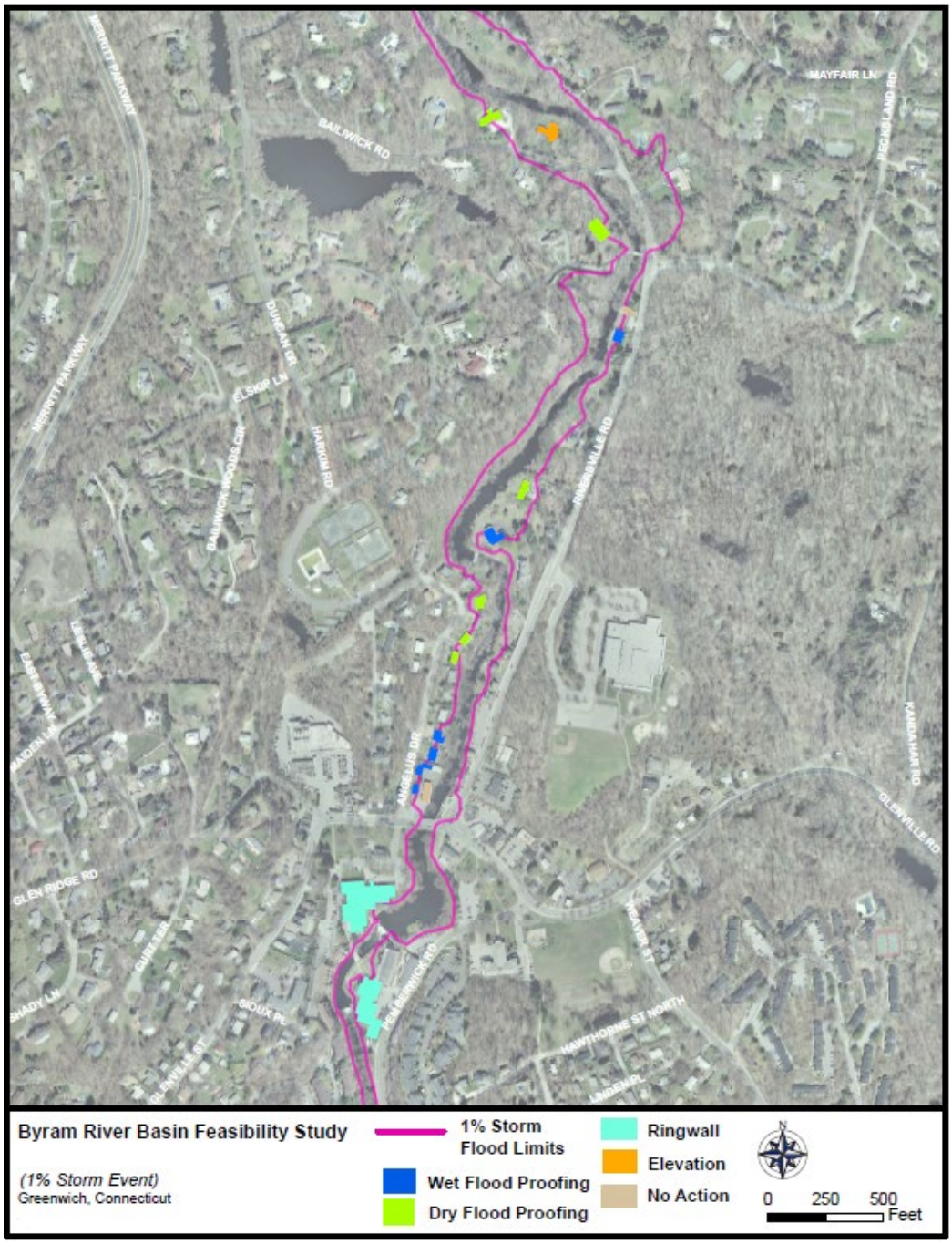

Figure 9: Nonstructural Treatments in the Existing 1-percent Floodplain in the Bailiwick Area

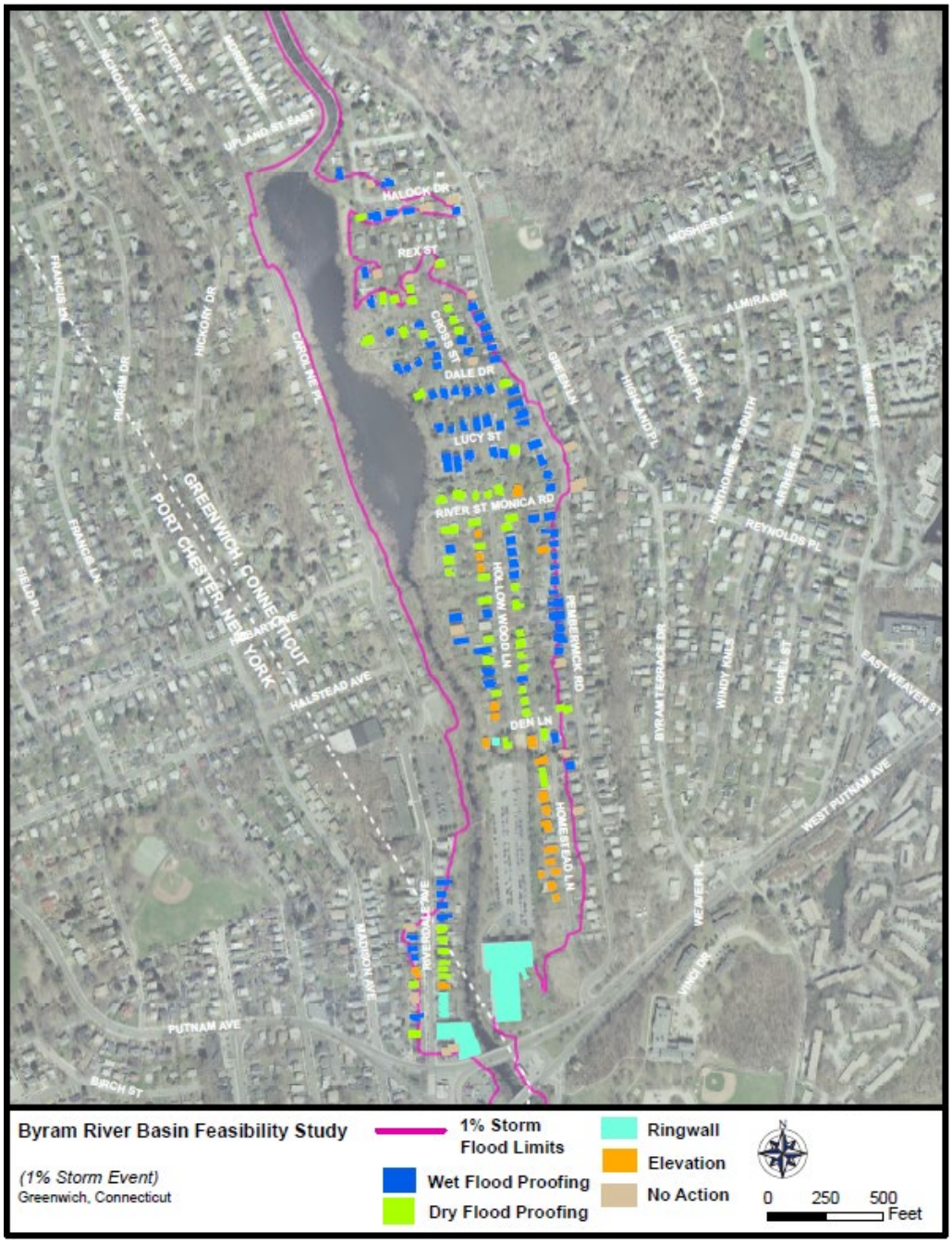

Figure 10: Initial Array Nonstructural Treatments in the 1-percent Floodplain in the Pemberwick Area

3.5.3 Alternative 3 – Structural (1977 updated) – Levees, floodwalls, and channel modifications

Alternative 3 includes the structural alternative formulated using federal recommendations from the 1977 Feasibility Report. The 1977 Feasibility Report recommended levees, floodwalls, and channel work for our current study area; the plan also included ponding areas, pumping stations,

storm drainage interceptors, and other associated interior drainage facilities (Figure 11). The 1977 Feasibility Report's recommended plan was not implemented due to lack of non-federal support.

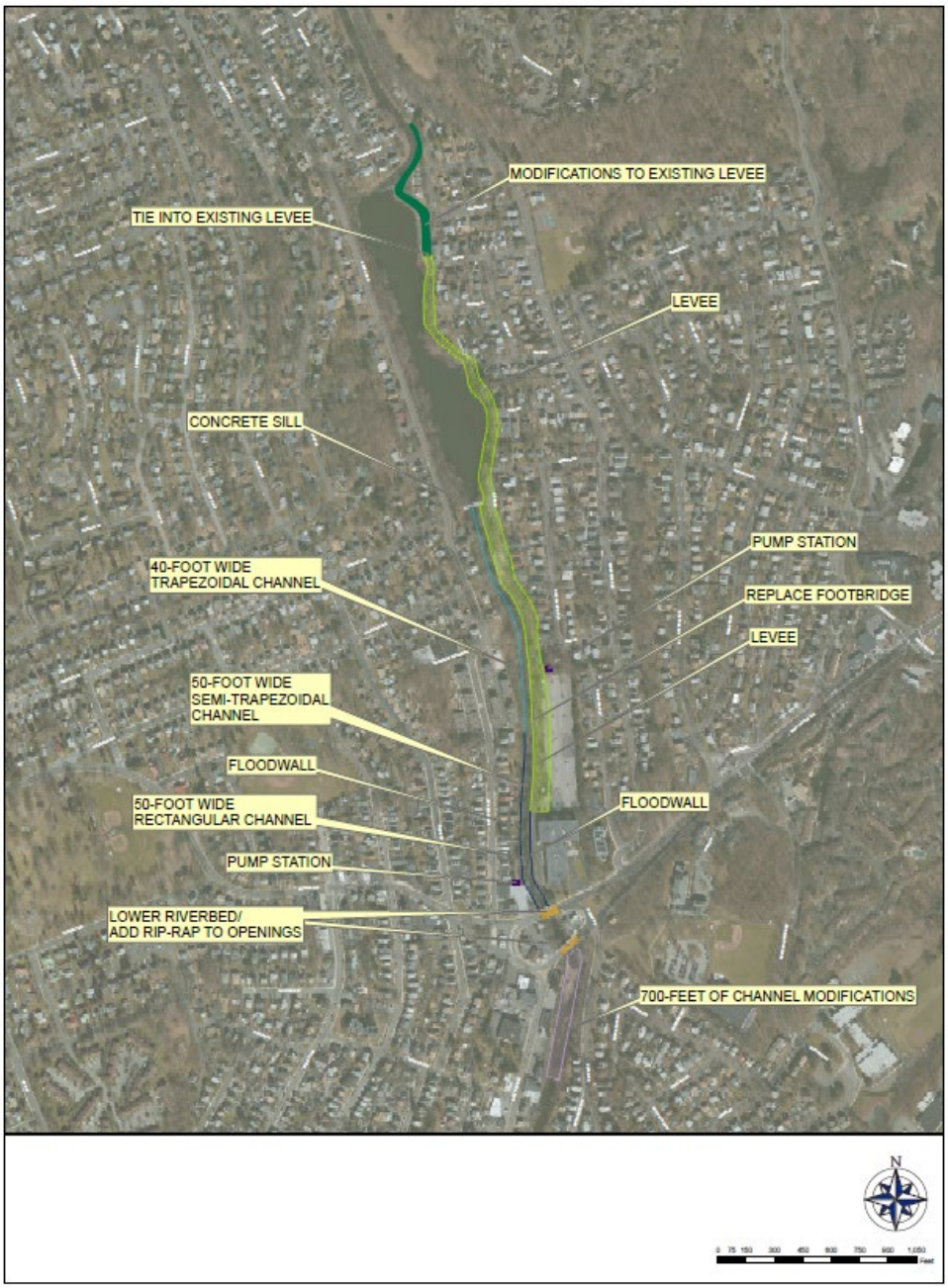

Figure 11: Plan Recommended in 1977 Feasibility Report

The 1977 Feasibility Report's recommended plan was modified to accommodate existing conditions and evaluated in the current Byram River Basin study as Alternative 3. Alternative 3 includes dredging, channel modifications, and construction of floodwalls and levees to reduce flooding risk (Figure 12). The proposed floodwalls have a top elevation of 19 to 20 feet NAVD88. The existing levee near Rex Street would need to be raised by an average of two feet. Some parts of the 1977

Feasibility Study alignment were changed from levee to floodwalls because of residential or commercial development since 1977. Dredging would begin approximately 700 feet downstream of the northbound U.S. Route 1 bridge and extends north for approximately 3,200 feet, matching the existing channel bottom around River Street. In addition to the channel modifications, a concrete sill was also added at the mouth of Caroline Pond.

The analysis indicated that there would be little to no benefit of channel dredging. The preliminary economic analysis of Alternative 3 in Table 12 shows that the costs outweigh the benefits and that the benefit cost ratio is below one; therefore, the alternative is not economically justified.

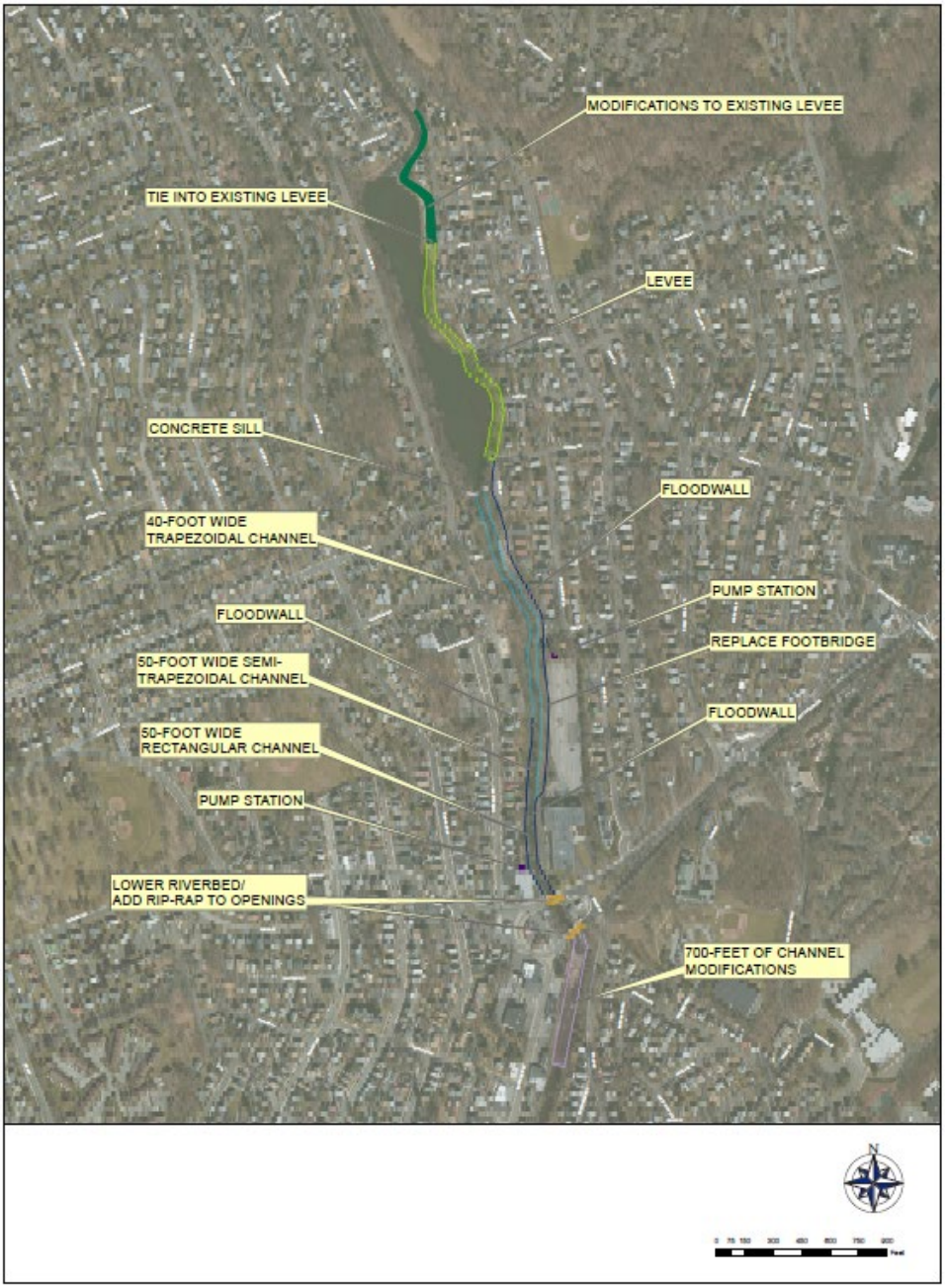

Figure 12: Alternative 3 Plan

Table 12: Alternative 3 Preliminary Costs and Benefits
(Price level FY 2016; Federal Discount Rate 3.125%)

ALTERNATIVE 3	ANNUAL BENEFITS	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
Update of 1977 Plan – Levees & Floodwall	$2,467,000	$98,896,000	$4,328,000	-$1,861,000	0.57

3.5.4 Alternative 4 – Smaller levees and floodwalls with bridge removals and replacements and channel modifications

Alternative 4 incorporates many of the features used in Alternative 3 including dredging, channel modifications, and construction of floodwalls and levees, and also includes the replacement of both U.S. Route 1 bridges that are owned and operated by the NYSDOT (Figure 13). This plan is designed to reduce flooding risk in the 1-percent floodplain. The crown elevations needed for the floodwalls and levees in Alternative 4 are lower than those needed in Alternative 3 because the removal and replacement of both U.S. Route 1 bridges – previously identified as a major constricting factor of the Byram River– increases the conveyance of water under the bridges and downstream; allowing more water to move under the bridges would prevent the water from backing up at the bridges and decrease the water surface elevation upstream of the bridges.

The levee and floodwalls' top elevation in Alternative 4 could be reduced by up to 3.5 feet from the levees and floodwalls proposed in Alternative 3. Under Alternative 4, the existing federal levee would be modified to ensure the proper level of flood risk management. The proposed sill at the mouth of Caroline Pond discussed in Alternative 3 will also be included in Alternative 4 along with the removal and replacement of a small footbridge upstream of the U.S. Route 1 bridges.

The NYSDOT own and operate the U.S. Route 1 bridges and, based on inspection reports from 2015 and 2016, the NYSDOT estimated that remaining life of the bridges is 25 years. Besides reducing the risk of flooding damages, there is an additional benefit for the alternatives that include replacing the U.S. Route 1 bridges as a measure. Replacing the bridges 25 years before their useful life is finished would extend the serviceable life of the bridges and postpone the bridge replacements by 25 years (50 year period of analysis minus 25 years remaining life = 25 additional years of serviceable life before replacement is required). Since the costs of the new bridges are included in the first costs of the project, a credit is needed on the benefit side, which is accomplished by the advanced bridge replacement benefit calculation. The advanced bridge replacement calculation uses multiple inputs including the cost of the new bridges, life of the new bridges, and the operation and maintenance costs of the old and new bridges. The credit is a constant annuity in years 26-50 of the period of analysis and adds an additional $303,000 in annualized benefits to the economic analysis of Alternative 4. Please see Appendix D – Economics for details on this calculation.

The preliminary economic analysis of Alternative 4 in Table 13 shows that the costs outweigh the benefits and that the benefit cost ratio is below one; therefore, the alternative is not economically justified. The 1977 Feasibility Study evaluated an alternative consisting of bridge replacements, floodwalls, and levees, and also included channel modifications (Plan 6 in the 1977 Feasibility Report); the alternative was also not economically justified.

Table 13: Alternative 4 Preliminary Costs and Benefits
(Price level FY 2016; Federal Discount Rate 3.125%)

ALTERNATIVE 4	ANNUAL BENEFITS	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
Levee & Floodwall, U.S. Route 1 Bridges	$2,601,000*	$101,646,000	$4,236,000	-$1,635,000	0.58

**Alternative 4 includes advanced bridge replacement benefits of $303,000.*

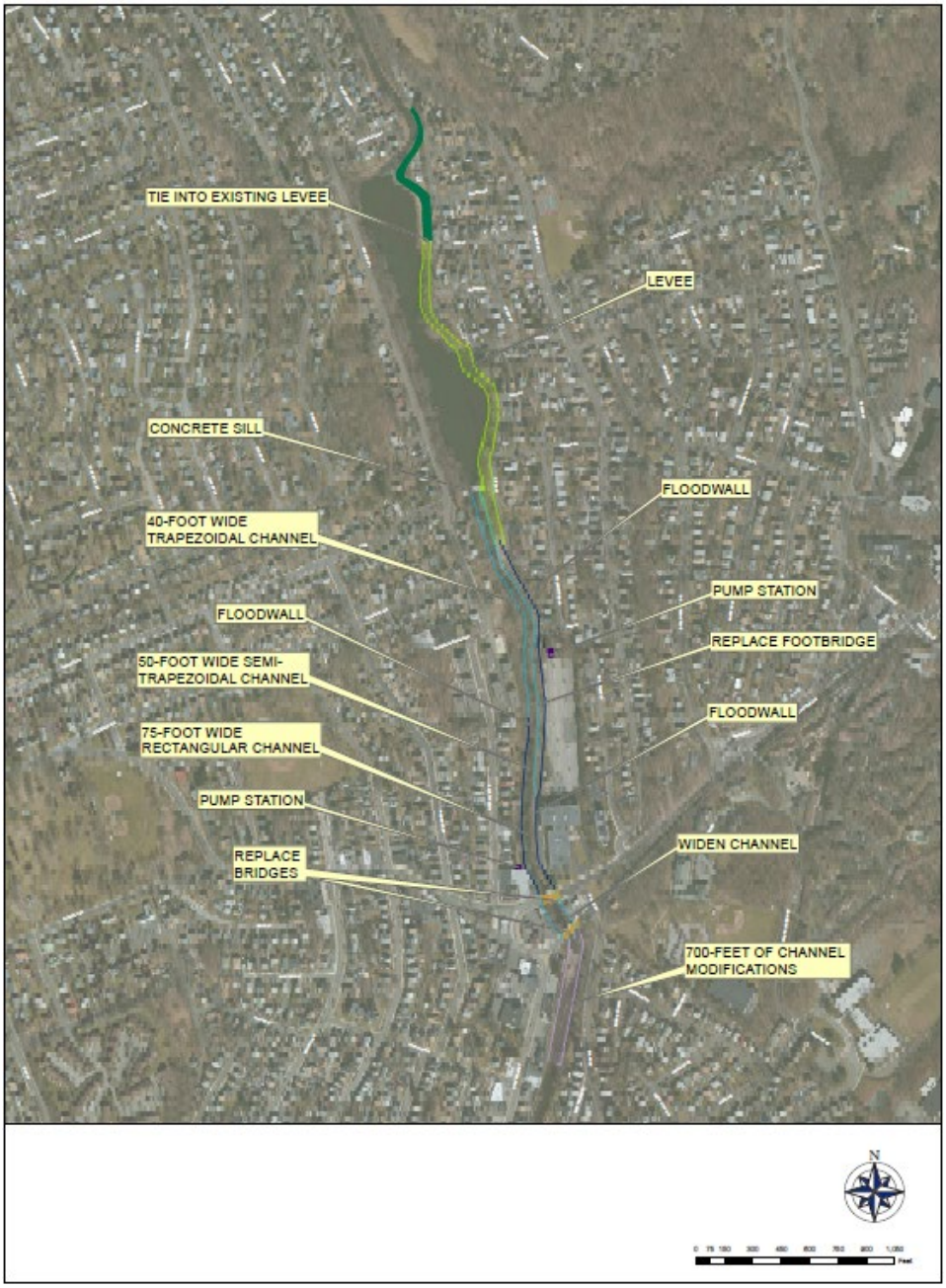

Figure 13: Alternative 4 Plan

3.5.5 Summary of the Initial Array Evaluation

The Federal Objective

Per the 1983 Principles and Guidelines by the U. S. Water Resources Council (1983), the federal objective of water and related land resources project planning is to "contribute to national economic development consistent with protecting the Nations' environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements."

The 1983 Principles and Guidelines require that plans are formulated in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability.

Completeness is 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.

The alternatives in the initial array were evaluated with consideration of necessary investments and other actions. The plans were looked at for environmental, traffic, and cultural resource impacts, as well as the costs associated with mitigating those impacts and acquiring the required real estate for implementation.

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

All of the actionable alternatives in the final array alleviate the problem of flooding from the Byram River and achieve the study opportunities to reduce flood damages to residents, property, and infrastructure, and reduce damages related to isolation from flooded roads. Therefore, all alternatives considered as part of the initial array are effective.

Efficiency is 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.

Efficiency was measured through a comparison of benefit cost ratios, reduced damages, and benefits from the project. This preliminary analysis indicated that nonstructural measures in the 10-percent floodplain may be the only efficient alternative from the initial array.

Acceptability is 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.

The study team formulated the alternatives in accordance with applicable laws and regulations. One important facet of acceptability is implementability, which is the feasibility of a plan in the technical, environmental, economic, social, and similar senses. All alternatives considered as part of the initial array are acceptable.

For ease of comparison, the annualized costs and benefits for the initial array of alternatives are presented in Table 14. Consideration of the benefit cost ratios shows that the only alternative that is cost effective is nonstructural measures to structures in the 10-percent floodplain.

Table 14: Summary Economics of Initial Array of Alternatives
(Price level FY 2018; Federal Discount Rate 2.75%)

ALTERNATIVE	ANNUAL BENEFITS	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
1 – No Action	$0	$0	$0	$0	-
2 – 10-percent	$851,000	$19,170,000	$799,000	$52,000	1.07
2 – 1-percent	$1,050,000	$33,169,000	$1,382,000	-$332,000	0.77
3 – 1977 Plan	$2,467,000	$98,896,000	$4,328,000	-$1,861,000	0.57
4* – Bridges	$2,601,000	$101,646,000	$4,236,000	-$1,635,000	0.58

**Alternative 4 includes advanced bridge replacement benefits of $303,000.*

Table 15: Summary Principles and Guidelines Criteria on the Initial Array of Alternatives

ALTERNATIVE	COMPLETENESS	EFFECTIVENESS	EFFICIENCY	ACCEPTABILITY
1 – No Action	N	N	N	N
2 – 10-percent	Y	Y	Y	Y
2 – 1-percent	Y	Y	N	Y
3 – 1977 Plan	Y	Y	N	Y
4 – Bridges	Y	Y	N	Y

The study team carefully analyzed and compared all of the alternatives for completeness, their effectiveness at alleviating flooding problems, their benefits and costs, and their legality (Table 15). The preliminary economic analysis of the initial array of alternatives indicated that nonstructural measures in the 10-percent floodplain is the only alternative that may produce more benefits than costs. Alternatives 3, 4, and nonstructural measures in the 1-percent floodplain have more costs than benefits with a benefit cost ratio of less than one. This preliminary analysis does not include additional costs such as real estate and cultural resources; these additional costs would only increase the cost and lower the benefit cost ratio. Therefore, the study team determined that Alternatives 3 and 4 were not economically viable options to address flooding risk in the Byram River Basin study area and removed the alternatives from further analysis. Nonstructural measures will be included in further analyses.

Initial Array Impacts to Environmental and Socioeconomic Resources

A brief summary of the magnitude of impacts the alternatives that are being carried forward for further analysis are likely to have on environmental and socioeconomic resources is presented below. Table 16 defines the criteria used to identify magnitude of the potential impacts. Table 17 and Table 18 summarize the impacts of the initial array of alternatives on the various environmental and socioeconomic resources.

Table 16: Defining Criteria for Scale of Impacts

IMPACT SCALE	CRITERIA
No Effect	The resource area would not be affected and there would be no impact.
Negligible	Changes would either be non-detectable or, if detected, would have effects that would be slight and local. Impacts would be well below regulatory standards, as applicable.
Minor	Changes to the resource would be measurable, but the changes would be small and localized. Impacts would be within or below regulatory standards, as applicable. Mitigation measures would reduce any potential adverse effects.
Moderate	Changes to the resource would be measurable and could have either localized or regional scale impacts. Impacts would be within or below regulatory standards, but historical conditions would be altered on a short term basis. Mitigation measures would be necessary, and the measures would reduce any potential adverse effects.
Major	Changes to the resource would be readily measurable and would have substantial consequences on regional levels. Impacts would exceed regulatory standards. Mitigation measures to offset the adverse effects would be required to reduce impacts, though long term changes to the resource would be expected.

Table 17: Scale of Initial Array's Impacts to Environmental Resources

	1 – NO ACTION	2 – NONSTRUCTURAL 1% AND 10%
WATER RESOURCES	No Effect	No Effect
VEGETATION	No Effect	Negligible
FISH AND WILDLIFE	No Effect	No Effect
CULTURAL RESOURCES	No Effect	Minor
AIR QUALITY	No Effect	Negligible
TOPOGRAPHY	No Effect	No Effect
HTRW	Minor	Minor

Table 18: Scale of Impacts to Socioeconomic Resources

	1 – NO ACTION	2 – NONSTRUCTURAL 1% AND 10%
RECREATION	No Effect	No Effect
AESTHETICS	No Effect	Negligible
SOCIOECONOMIC/ ENV. JUSTICE	Moderate	Negligible
TRANSPORTATION	Minor	Minor
NOISE	No Effect	Moderate

The No Action Alternative has no effect on the majority of environmental and socioeconomic resources. There are negative impacts to socioeconomics/environmental justice and transportation because the roads currently subject to flooding along the Byram River will continue to experience flooding. The No Action alternative is characterized as having minor impacts to HTRW because there is a likelihood that river flooding will introduce and/or transport pollutants such as oil and general debris throughout the study area.

The nonstructural alternatives, Alternatives 2a though 2d, do not interfere with the existing floodplains and therefore would not impact water resources or fish and wildlife. There would be only negligible and minor effects on vegetation and cultural resources as the project footprint would be localized to individual, already developed properties. The nonstructural alternatives are considered to have a minor impact to HTRW because it is likely that some of the buildings being treated may have asbestos-containing material, lead based paint, and/or underground oil storage tanks. The nonstructural impacts to transportation and noise would be minor and moderate, respectively; however, these impacts would be temporary as they would only be experienced during the construction duration.

3.6 Evaluation of the Final Array of Alternatives

The final array of alternatives consists of the alternative plans that made it through the evaluation of the initial array and are analyzed at a more refined level. Three main changes occurred between the initial and final array of alternatives:

1. Alternative 3 and Alternative 4 were removed from further consideration because the initial evaluation determined they are not cost effective options.
2. The analysis of Alternative 2 was expanded by analyzing the costs and benefits associated with the 2-percent and 4-percent floods in addition to the 10-percent and 1-percent events analyzed in the initial array.
3. The removal and replacement of the U.S. Route 1 bridges included in Alternative 4 was broken out to be analyzed on its own as a separate alternative; this became Alternative 5. Removal and replacement of the U.S. Route 1 bridges was also analyzed in conjunction with nonstructural measures in the resulting 10-percent, 4-percent, 2-percent, and 1-percent floodplains as Alternatives 5a, 5b, 5c, and 5d, respectively.

With the three changes mentioned above, the final array of alternatives consists of ten alternative plans. These ten alternatives were analyzed in more detail than the initial array of alternatives. Significant refinements were made to the structure inventory to more accurately represent the study area. These updates include applying land surveyed first floor and ground elevations to a majority of the structures, determining structure depreciated replacement values with Marshall & Swift valuation services, and eliminating errors that resulted in double counting structure damages obtained from flood events. The net effect of these updates decreased the without-project damages that can be prevented. The evaluation of the final array of alternatives was conducted assuming the USACE "intermediate" sea level change scenario.

- Alternative 1: No Action, as required by the USACE's regulations
- Alternative 2: Nonstructural alternatives, as required by the USACE's regulations
- Alternative 2a: Nonstructural treatments in the 10-percent floodplain
- Alternative 2b: Nonstructural treatments in the 4-percent floodplain
- Alternative 2c: Nonstructural treatments in the 2-percent floodplain
- Alternative 2d: Nonstructural treatments in the 1-percent floodplain
- Alternative 5: U.S. Route 1 bridge removals and replacements
- Alternative 5a: U.S. Route 1 bridge removals and replacements and nonstructural treatments in resulting 10-percent floodplain
- Alternative 5b: U.S. Route 1 bridge removals and replacements and nonstructural treatments in resulting 4-percent floodplain
- Alternative 5c: U.S. Route 1 bridge removals and replacements and nonstructural treatments in resulting 2-percent floodplain
- Alternative 5d: U.S. Route 1 bridge removals and replacements and nonstructural treatments in resulting 1-percent floodplain

3.6.1 Alternative 1 – No Action Alternative

The no action alternative was kept for comparison purposes. The plan still provides no economic benefits to the study area (Table 19).

Table 19: Alternative 1 Costs and Benefits

ALTERNATIVE	ANNUAL BENEFITS	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
1 No Action	$0	$0	$0	$0	-

3.6.2 Alternative 2 – Nonstructural

The economic analysis of Alternative 2 was refined from its original analysis in the initial array of alternatives. Additionally, in order to investigate the possibility of capturing more benefits, the 4-percent and 2-percent flood events were added to the analysis (Table 20).

Table 20: Alternative 2a, 2b, 2c, and 2d Refined Costs and Benefits
(Price level FY 2018; Federal Discount Rate 2.75%)

ALTERNATIVE		ANNUAL BENEFITS	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
2a	Nonstructural in 10-percent floodplain	$434,000	$18,444,000	$701,000	-$268,000	0.62
2b	Nonstructural in 4-percent floodplain	$559,000	$29,745,000	$1,131,000	-$572,000	0.49
2c	Nonstructural in 2-percent floodplain	$1,337,000	$36,962,000	$1,405,000	-$68,000	0.95
2d	Nonstructural in 1-percent floodplain	$1,358,000	$42,605,000	$1,620,000	-$262,000	0.84

The refined economic analysis indicates that Alternatives 2a, 2b, 2c, and 2d each have costs that outweigh their benefits and have a benefit cost ratio below one. Nonstructural measures in the 10-percent floodplain, which was previously found to be economically justified during the evaluation of the initial array of alternatives, was found to be economically unjustified during this analysis due to the structure inventory updates.

3.6.3 Alternative 5 – Bridge Removals and Replacements and Nonstructural Treatments

Alternative 5 consists of five different sub-alternatives by combining the removal of the U.S. Route 1 bridges with nonstructural measures. The removal of the U.S. Route 1 bridges modifies the floodplains upstream of the bridges; the structures were reevaluated within the new floodplain limits for nonstructural floodproofing. The resulting alternatives were the removal of the U.S. Route 1 bridges in conjunction with nonstructural treatments in the resulting 10-percent, 4-percent, 2-percent, and 1-percent floodplains. The bridges to be removed carry the local traffic of U.S. Route 1 as well as I-95 traffic during emergencies, so the bridges must be replaced after they are demolished. A single two-way bridge was considered to replace the two existing one-way bridges; however, due to the cost of obtaining real estate for the single two-way bridge, it was determined that replacing the bridges within their current footprint is the more cost effective option. The new bridges will be built within the same footprint at a higher elevation and without any piers that enter the floodway in order to reduce restrictions to river flow.

The number of structures that would receive the various types of nonstructural treatments for each floodplain in conjunction with removal of the U.S. Route 1 bridges is found in Table 21. The economic analysis of Alternatives 5, 5a, 5b, 5c, and 5d are shown in Table 22.

Table 21: Summary of Nonstructural Measures with U.S. Route 1 Bridge Removals and Replacements

ALTERNATIVE		NONSTRUCTURAL				
		DRY FLOOD-PROOFING	WET FLOOD-PROOFING	RINGWALL	ELEVATION	TOTAL
5a	Nonstructural in resulting 10-percent floodplain	6	20	9	6	41
5b	Nonstructural in resulting 4-percent floodplain	11	40	10	6	67
5c	Nonstructural in resulting 2-percent floodplain	20	56	11	8	95
5d	Nonstructural in resulting 1-percent floodplain	24	85	11	8	128

Table 22: Alternative 5, 5a, 5b, 5c, and 5d Costs and Benefits
(Price level FY 2018; Federal Discount Rate 2.75%)

ALTERNATIVE		ANNUAL BENEFITS*	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
5	Replacement of U.S. Route 1 Bridges	$1,071,000	$24,302,000	$949,000	$122,000	1.13
5a	U.S. Route 1 Bridges w/ nonstructural in resulting 10% floodplain	$1,305,000	$42,877,000	$1,715,000	-$410,000	0.76
5b	U.S. Route 1 Bridges w/ nonstructural in resulting 4% floodplain	$1,325,000	$46,749,000	$1,862,000	-$537,000	0.71
5c	U.S. Route 1 Bridges w/ nonstructural in resulting 2% floodplain	$1,339,000	$52,502,000	$2,081,000	-$741,000	0.64
5d	U.S. Route 1 Bridges w/ nonstructural in resulting 1% floodplain	$1,355,000	$58,319,000	$2,302,000	-$947,000	0.59

**All bridge replacement alternatives include annualized advanced bridge replacement benefits of $303,000.*

Similar to Alternative 4 in the initial array of alternatives, Alternative 5, 5a, 5b, 5c, and 5d include annual advanced bridge replacement benefits of $303,000. The economic analysis indicates that the removal and replacement of the U.S. Route 1 bridges in conjunction with nonstructural

measures does not have benefits that outweigh their costs in any of the resulting floodplains. Since the benefit cost ratio is below one, Alternatives 5a, 5b, 5c, and 5d are not economically justified as flood risk management plans. Alternative 5, removal and replacement of the U.S. Route 1 bridges without any nonstructural measures, is economically justified with benefits that outweigh its costs. Alternative 5 has average annual net benefits of about $122,000 and a benefit cost ratio of 1.13 (Price level FY 2018; Federal Discount Rate 2.75%).

Combining the removal and replacement of the U.S. Route 1 bridges with dredging the Byram River was considered for evaluation to further benefit the project area. Analyses showed that the removal and replacement of the U.S. Route 1 bridges significantly lowers the water surface elevation of the Byram River to be almost parallel with the channel slope. Dredging the channel in addition to replacing the U.S. Route 1 bridges would be costly and would provide only modest incremental reductions in water surface elevation and damages. Therefore, a plan including replacing the U.S. Route 1 bridges and channel modifications was not evaluated.

3.6.4 Summary of the Final Array Evaluation

After considering the federal objective and environmental effects of the final array of alternatives the study team identified Alternative 5 as the NED Plan and Recommended Plan. This section lays out the details of the comparison.

The Federal Objective

The 1983 Principles and Guidelines require that plans are formulated in consideration of four criteria as defined in Section 3.5.5: completeness, effectiveness, efficiency, and acceptability.

Completeness: The alternatives in the final array were evaluated with consideration of necessary investments and other actions. The plans were looked at for environmental, traffic, and cultural resource impacts, as well as the costs associated with mitigating those impacts and acquiring the required real estate for implementation.

Effectiveness: All of the actionable alternatives in the final array alleviate the problem of flooding from the Byram River and achieve the study opportunities to reduce flood damages to residents, property, and infrastructure, and reduce damages related to isolation from flooded roads. Therefore, Alternatives 2 and Alternatives 5 are effective.

Efficiency: Efficiency was measured through a comparison of benefit cost ratios, reduced damages, and benefits from the project, as described in Section 3.6. This comparison revealed that only Alternative 5 is efficient.

Acceptability: The study team formulated the alternatives in accordance with applicable laws and regulations. The No Action alternative is the only alternative that does not meet the acceptability criteria.

For ease of comparison, the annualized costs and benefits for the final array of alternatives are presented in Table 23. Consideration of the benefit cost ratios shows that the only alternative that is cost effective is Alternative 5, removal and replacement of the U.S. Route 1 bridges (Table 23). The study team carefully analyzed and compared all of the alternatives for completeness, their effectiveness at alleviating flooding problems, their benefits and costs, and their legality (Table 24). All alternatives besides the No Action Alternative were complete, effective, and acceptable. While the evaluated alternatives would provide flood risk management benefits to the community, the costs outweigh the benefits and do not contribute to NED. Alternative 5 is estimated to provide

less annualized benefits than Alternatives 2c, 2d, 5a, 5b, 5c, and 5d, and is therefore estimated to have more residual risk than these alternatives. However, Alternative 5 is estimated to cost significantly less and the other alternatives and results in positive net benefits, contributing to NED. Alternative 5 is efficient because it has the most net benefits as compared to the other alternatives.

Table 23: Summary Economics of the Final Array of Alternatives
(Price level FY 2018; Federal Discount Rate 2.75%)

ALTERNATIVE	ANNUAL BENEFITS	TOTAL FIRST COST	TOTAL ANNUAL COST	NET BENEFITS	BENEFIT COST RATIO
No Action	$0	$0	$0	$0	-
2a	$434,000	$18,444,000	$701,000	-$268,000	0.62
2b	$559,000	$29,745,000	$1,131,000	-$572,000	0.49
2c	$1,337,000	$36,962,000	$1,405,000	-$68,000	0.95
2d	$1,358,000	$42,605,000	$1,620,000	-$262,000	0.84
5*	$1,071,000	$24,302,000	$949,000	$122,000	1.13
5a*	$1,305,000	$42,877,000	$1,715,000	-$410,000	0.76
5b*	$1,325,000	$46,749,000	$1,862,000	-$537,000	0.71
5c*	$1,339,000	$52,502,000	$2,081,000	-$741,000	0.64
5d*	$1,355,000	$58,319,000	$2,302,000	-$947,000	0.59

**All bridge replacement alternatives include annualized advanced bridge replacement benefits of $303,000.*

Table 24: Summary of Consideration of Principles and Guidelines Criteria

	ALTERNATIVES			
	1 - No Action	2a, 2b, 2c, 2d	5	5a, 5b, 5c, 5d
COMPLETENESS	N	Y	Y	Y
EFFECTIVENESS	N	Y	Y	Y
EFFICIENCY	N	N	Y	N
ACCEPTABILITY	N	Y	Y	Y

Economic, Environmental, and Other Social Effects

The 1983 Principles and Guidelines also requires that study alternatives be evaluated under the following accounts:

National Economic Development (NED): NED effects are changes in the economic value of the National output of goods and services. Alternative 1 does not contribute to NED. Alternatives 2a, 2b, 2c, 2d, 5a, 5b, 5c, and 5d all have costs that outweigh the benefits they provide. Therefore, Alternative 5 is the only alternative that positively contributes to NED with benefits that outweigh its costs.

Regional Economic Development (RED): RED effects are the impact of project spending, either directly or indirectly, on the local economy. Besides Alternative 1, implementation of the any of these alternatives could induce RED benefits in the area as residents and business owners may be able to allocate resources and spending on goods and services rather than on repairing and replacing structures or goods damaged by flooding. However, similarly to NED, while Alternatives 2a, 2b, 2c, 2d, 5a, 5b, 5c, and 5d all provide economic benefits for the region, Alternative 5 is the only alternative that has benefits that outweigh the costs and results in net benefits.

Environmental Quality (EQ): EQ is the non-monetary beneficial effects on significant natural and cultural resources. The categories that make up EQ are considered for each alternative in the following subsection.

Other Social Effects (OSE): OSE include the effects that are not covered in the NED, RED, and EQ. This account includes things such as community impacts, health and safety, and displacement. Besides Alternative 1, all alternatives reduce the risk to life safety by reducing the risk of flooding. They also contribute to community cohesion by reducing the risk of flooding and reducing the risk of displacing people from their homes. Alternatives 5, 5a, 5b, 5c, and 5d reduce the risk of road flooding, which can reduce the risk to life safety by increasing the ability of residents to evacuate flooded areas and the ability of emergency services to reach people in need of assistance. There is residual risk for every alternative because the risk of flooding cannot be fully eliminated.

Final Array Impacts to Environmental and Socioeconomic Resources

This section also provides a brief summary of the magnitude of impacts the final array of alternatives are likely to have on environmental and socioeconomic resources. The criteria were previously defined in Table 16 located in Section 3.10.5. Table 25 and Table 26 summarize the impacts of the alternatives on the various environmental and socioeconomic resources. The Recommended Plan has been identified as the Environmentally Preferable Alternative as required by the NEPA (see Section 4.5 for more details).

Table 25: Scale of Final Array's Impacts to Environmental Resources

	ALTERNATIVES		
	1– No Action	**2a 2b 2c 2d**	**5, 5a, 5b, 5c, 5d**
WATER RESOURCES	No Effect	No Effect	Minor
VEGETATION	No Effect	Negligible	Minor
FISH AND WILDLIFE	No Effect	No Effect	Minor
CULTURAL RESOURCES	No Effect	Moderate	Major
AIR QUALITY	No Effect	Negligible	Negligible
TOPOGRAPHY	No Effect	No Effect	Negligible
HTRW	Minor	Minor	Minor

Table 26: Scale of Final Array's Impacts to Socioeconomic Resources

	ALTERNATIVES		
	1– No Action	**2a 2b 2c 2d**	**5, 5a, 5b, 5c, 5d**
RECREATION	No Effect	No Effect	Minor
AESTHETICS	No Effect	Negligible	Moderate
SOCIOECONOMIC/ ENV. JUSTICE	Moderate	Negligible	Negligible
TRANSPORTATION	Minor	Minor	Major
NOISE	No Effect	Moderate	Moderate

3.6.5 Trade-Off Analysis

The implementation of the Recommended Plan has short term and long term tradeoffs. In the short term, the removal of the current U.S. Route 1 bridges and construction of the new U.S. Route 1 bridges will create impacts associated with construction including noise, air pollution, as well as traffic and recreation impacts; the majority of these impacts will occur in the Village of Port Chester, NY where the bridges are located (for more information, see Section 6). However, in the long term, the Recommended Plan will decrease the risk of flooding in the Town of Greenwich and traffic will not be negatively impacted.

While the removal of the U.S. Route 1 bridges will result in a decreased risk of flooding, the bridges that will be subsequently constructed in their place will not be historic bridges. Efforts are being made to make the replacement bridges similar in appearance to the current structures, however, the replacement bridges will be different and will no longer have historic value.

4. THE RECOMMENDED PLAN

The Recommended Plan for flood risk management at Byram River is Alternative 5, removing the U.S. Route 1 bridges that straddle the Byram River in the Village of Port Chester, NY and replacing them at a higher elevation to allow more water to pass underneath. In the existing condition, the wide piers supporting the bridges and the low road profile constrict the flow of water; this causes water to build up upstream of the bridges, increases the water surface elevation, and causes properties to flood. Since the U.S. Route 1 bridges carry the local traffic of U.S. Route 1 as well as Interstate 95 traffic during emergencies, the bridges must be replaced after they are demolished. The U.S. Route 1 bridges would be replaced with two bridges in the same location that have roadway profiles about three feet higher than the existing profile and do not have center piers (Figure 15). The U.S. Route 1 bridges are owned and operated by the NYSDOT. The Recommended Plan would decrease the extent of the floodplain and reduce the water surface elevation upstream of the bridges during storm events, resulting in decreased risk of damages to structures.

This Final Integrated FR/EIS presents the Recommended Plan that was refined based off of comments received during the concurrent public and agency review of the draft report released in June 2018. Subsequent to the formulation of alternatives described in previous sections, more detailed hydrologic, hydraulic, cost, and economic analyses were conducted to refine the estimates of project costs and benefits. These refined values are presented throughout Section 4.

Figure 14: Existing U.S. Route 1 Bridges

Left: West Putnam Avenue/ U.S. Route 1 eastbound; Right: Hillside Avenue/ U.S. Route 1 westbound

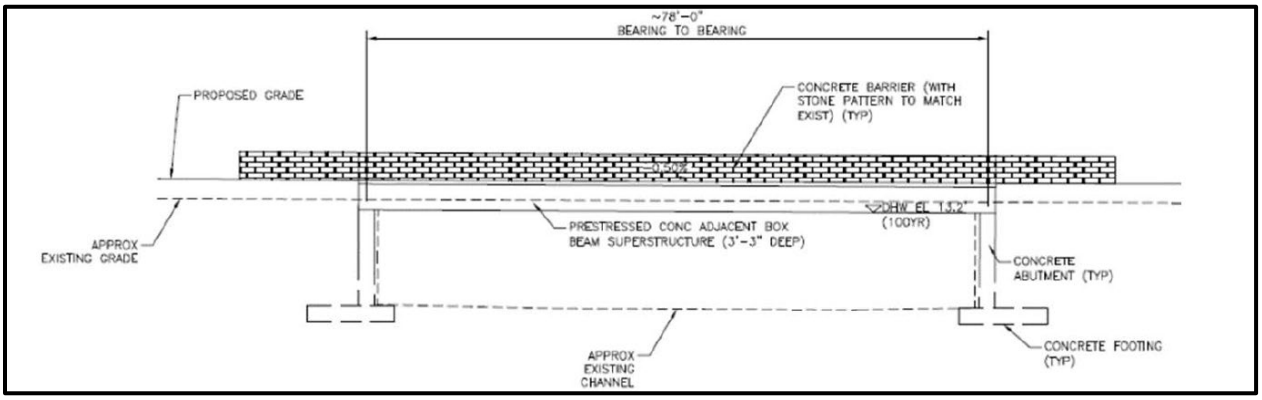

Figure 15: Concept Design of Replacement of the U.S. Route 1 Bridges

4.1 Refined Cost Estimate

The refined Project First Cost of the Recommended Plan is estimated to be $29,405,000. The total average annual costs is estimated to be $1,144,000 and includes interest during construction and the estimated annual cost of Operations, Maintenance, Repair, Replacement, & Rehabilitation. The existing U.S. Route 1 bridges are owned and operated by the NYSDOT. Although the newly constructed U.S. Route 1 bridges will be self-sustaining, some periodic maintenance will be required. The annual operation and maintenance costs include annual inspections and maintenance of the project. From coordination with NYSDOT, the total annual Operations, Maintenance, Repair, Replacement, & Rehabilitation costs are estimated to be lower than $25,000, which is the annual operation and maintenance cost for the existing bridges. A summary of the costs of the Recommended Plan is presented in Table 27 and Table 28.

Table 27: Recommended Plan Refined Cost Estimate
(Price Level FY 2020; Federal Discount Rate 2.75%)

CATEGORY	COSTS
Project First Cost	$29,405,000
Interest During Construction	$813,000
Total Investment Costs	$30,218,000
Annualized Investment Costs	$1,119,000
Operations, Maintenance, Repair, Replacement, & Rehabilitation	$25,000
Total Average Annual Costs	$1,144,000

Table 28: Recommended Plan Refined Project First Cost Components
(Price Level FY 2020; Discount Rate 2.75%)

ACCOUNT/DESCRIPTION	COST
01 – Lands and Damages	$1,433,000
02 – Relocations	$19,152,000
06 – Fish and Wildlife Facilities	$39,000
18 – Cultural Resource Preservation	$1,702,000
30 – Planning, Engineering, & Design	$5,054,000
31 – Construction Management	$2,025,000
Project First Cost	**$29,405,000**

4.2 Refined Benefits Estimate

Removing the U.S. Route 1 bridges and replacing them with bridges with higher bridge decks and no abutments will lower the water surface elevation upstream of the bridges during rain events. For example, the water surface elevation would decrease by up to four feet during for the 1-percent flood event. The Recommended Plan would decrease the extent of the 1-percent floodplain (Figure 16) and reduce the water surface elevation upstream of the bridges during storm events, resulting in decreased risk of damages to structures.

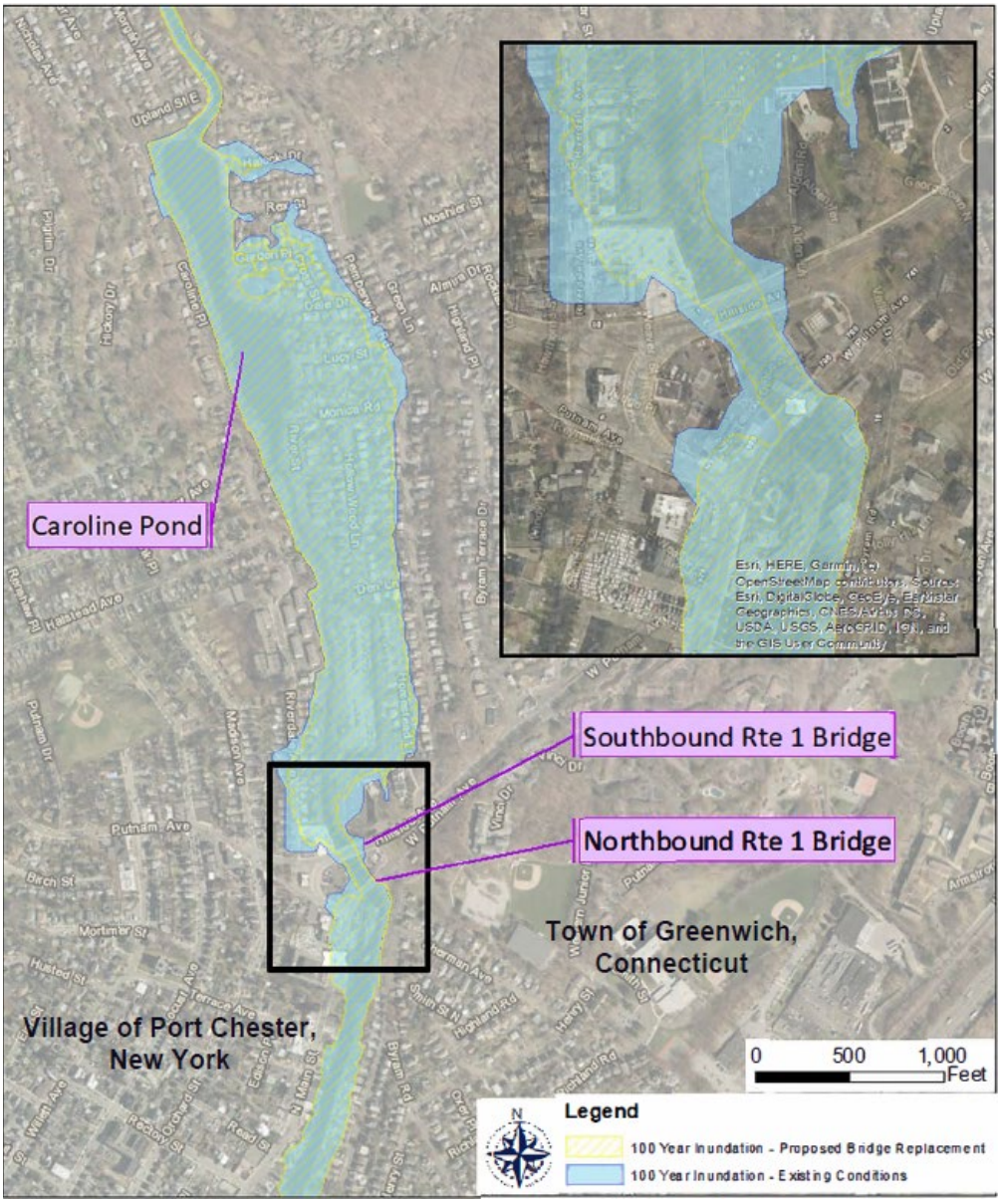

Figure 16: Without-Project 1-percent Floodplain and Resulting 1-percent Floodplain after the Recommended Plan is Implemented Assuming USACE "Intermediate" Sea Level Rise

The figure shows how the 1-percent floodplain would change between the with- and without-project conditions. The difference between the floodplains does not appear significant because of the steep topography of the area; however, the removal of the U.S. Route 1 bridges would lower the water surface elevation for all modeled flood events for almost 0.9 mile upstream of the north U.S. Route 1 bridge. The water surface elevation is reduced by up to 3.8 feet for the 1-percent event and up to 4.0 feet for the 2-percent event. The risk of flooding and consequent damage are reduced for the majority of structures in the Pemberwick area and flooding is eliminated by the Recommended Plan for 33 structures, or 19%, in the 1-percent floodplain based on flooding at beginning damage elevations. The decrease in water surface elevation would also result in the removal of 43 structures with first floor flooding from the 1-percent floodplain, or about 64% of

the structures that experience first floor flooding in the without-project condition. Riverdale Avenue along the west side of the Byram River upstream of the U.S. Route 1 bridges would experience a decrease in flooding. Water depths at the low spots on the road are expected to decrease by over 3.5 feet during a 1-percent flood event. This will help vehicular traffic, including emergency services, reach the area during flood events.

The economic analysis of the benefits incorporates four categories: physical damage reduction, non-physical emergency costs, advanced bridge replacement benefits, and traffic delays.

The Recommended Plan is expected to reduce the expected annual physical damages to residential, commercial, and public structures, structure contents, automobiles, and utilities by $884,000. The Recommended Plan will also reduce the non-physical damage of emergency costs. Emergency costs is a non-physical damage category that can typically include several types of costs, such as flood fighting, evacuations, shelters to provide mass care, assistance to families, and cleanup of debris removal and disposal costs. Estimates of debris costs reduction and clean-up costs of structure interiors were made and included as benefits for the Recommended Plan. The Recommended Plan provides approximately $26,000 in emergency cost reduction benefits annually.

While evaluating the initial array of alternatives, the NYSDOT estimated that remaining life of the U.S. Route 1 bridges was 25 years. Recent NYSDOT inspections have revealed that that condition of the U.S. Route 1 bridges is poorer than originally perceived and that 25 years is the upper limit of when the bridges would need to be replaced. With this new information, the NYSDOT staff estimate the bridges would need to be replaced in 11 to 25 years. The average of this range is 18 years. The credit is a constant annuity in years 19-50 of the period of analysis. The 11, 18, and 25 year remaining bridge lives correspond to $839,000, $748,000 and $667,000 in advanced bridge replacement benefits, respectively. For simplicity, the annualized project benefits are presented assuming the average remaining life of the bridges. The credit is a constant annuity in years 19-50 of the period of analysis and results in annual advanced bridge replacement benefits of $748,000.

The construction of the Recommended Plan will temporarily increase vehicular traffic near the U.S. Route 1 bridges. Construction is expected to occur during two consecutive construction seasons. Only one bridge will be replaced at a time and traffic will be diverted to the other bridge during that time, leaving one lane open in each direction; there are also other potential diversion routes around the U.S. Route 1 bridges altogether. However, there will still be construction-induced delays. The cost of these delays are accounted for as a decrease in benefits.

A feasibility level traffic analysis was conducted to assess construction impacts associated with roadway closures during the bridge replacement and is detailed in Appendix A.10 of this report. Results of the traffic analysis were used to estimate the monetary impact of the traffic delays during construction. The traffic impacts during construction were annualized over the 50-year economic period of analysis. The annual value of this impact is $176,000. Annual benefits of the bridge replacement plan are reduced by this amount.

If the Recommended Plan was not implemented, it is estimated that the study area would experience about $3,181,000 in annual economic damage in the intermediate sea level change scenario. The Recommended Plan would decrease the expected annual damages by about $931,000, which includes physical flood damage reduction and emergency cost reduction. The Recommended Plan decreases the average annual economic risk in the area by about 29%.

Table 29: Recommended Plan Benefits
(Price Level FY 2020; Discount Rate 2.75%; USACE "Intermediate" Sea Level Change Scenario)

	VALUE
Annualized Without-Project Damages	$3,181,000
Annualized With-Project Damages	$2,197,000
Annualized Benefits*	$1,503,000
Total Average Annual Net Benefits	$358,000
Benefit Cost Ratio	1.3

**Benefits include flood risk management benefits of $905,000, advanced bridge replacement benefits of $748,000, and emergency cost reduction benefits of $26,000. These benefits are reduced by $176,000 due to the cost of traffic delays during construction.*

4.3 Risk and Uncertainty Analysis

4.3.1 Performance Risk

The performance of the Recommended Plan depends on multiple factors.

Hydrologic and Hydraulic Parameters

The hydrologic and hydraulic analyses contain many uncertainties and assumptions. For the hydrologic analysis, there is uncertainty around the discharge-frequency relationship and runoff model due uncertainties in the rainfall infiltration losses, basin response, baseflow and recession parameters, and more. Annual peak flows were estimated based on record extension of the Byram River gage at Pemberwick. Using the 51 year equivalent, there is a 95% chance that the 1-percent storm event produces a discharge between 4,360 and 8,600 cubic feet per second, while the 10-percent storm event produces a discharge between 130 and 256 cubic feet per second.

The three parameters that have the most uncertainty and impact on the hydraulic profile are Manning's roughness coefficients, contraction and expansion coefficients, and the downstream boundary condition representing the tidal stillwater coinciding with peak. The two factors that contribute to the uncertainty of the downstream boundary condition are the correlation between peak tidal events and riverine events and the impact of sea level rise over the project life. These factors were integrated to generate a median, upper, and lower bound for a detailed uncertainty analysis.

The water surface elevations generated using the combined scenario of all high parameters and all low parameters is shown in Figure 17 for the 1-percent event. The difference between the upper and lower bound at the Byram River outlet to the U.S. Route 1 bridges is identical to the existing condition. Upstream of the U.S. Route 1 Bridges, the difference between the upper and lower band ranges from 3 to 5 feet for the 1-percent event. The flood profiles associated with the Recommended Plan are consistently lower than the without-project condition, even with a lot of uncertainty. Even the high parameter input model does not result in either of the proposed U.S. Route 1 bridges overtopping. Therefore, the design is considered conservative and will adequately convey the 1-percent flood waters without causing roadway inundation. Please see Appendix B.2 – Hydraulics for more details of this uncertainty analysis.

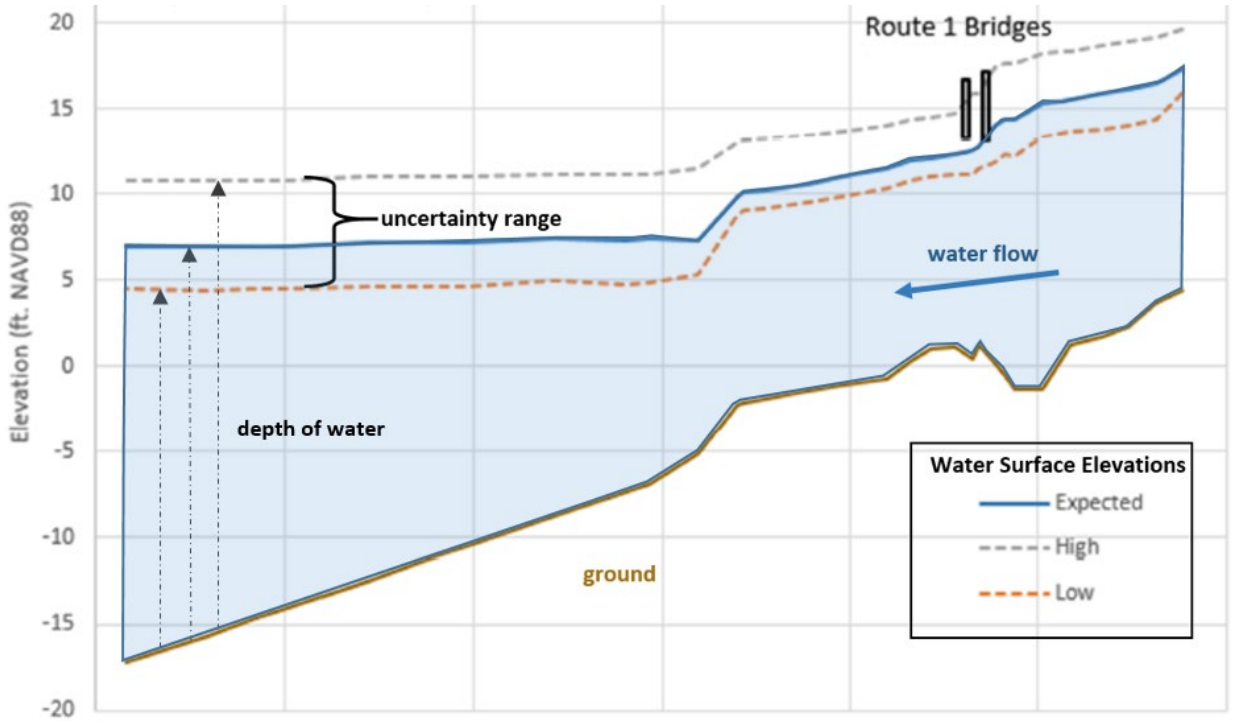

Figure 17: Uncertain Hydraulic Profile Range of Recommended Plan for the 1-Percent Flood Event Assuming USACE "Intermediate" Sea Level Change Scenario

Climate Change

A review of temperature, precipitation, and stream flow data indicate climate change will likely have minimal impacts on inland hydrology from precipitation for this project. The results suggest that the balance between increasing temperatures and increasing precipitation simultaneously may contribute to the lack of streamflow sensitivity to changes in climate. Additional streamflow analyses will be conducted in Preconstruction Engineering and Design. As described in Section 3.1.1, while sea level is expected to change, the rate at which they will rise is uncertain. Within the 50 years between 2023 and 2072, the USACE historic "low" sea level change scenario predicts a 0.4 foot increase, while the USACE "intermediate" and "high" sea level change scenarios predict a 0.9 foot and 2.5 foot increase, respectively. Within the 100 years between 2023 and 2123, the USACE historic "low" sea level change scenario predicts a 0.8 foot increase, while the USACE "intermediate" and "high" sea level change scenarios predict a 2.2 foot and 6.8 foot increase, respectively.

Sea level change affects the design height performance and reliability as sea level changes and high intensity storms become more frequent; the reliability of the Recommended Plan decreases as sea level rises. The proposed U.S. Route 1 bridges will substantially decrease water level stages within the vicinity of U.S. Route 1. Regardless of potential future climate changes, there will still be a net improvement with implementation of the Recommended Plan.

The southern portion of the project footprint is at the extreme northern reach of the tidal influence; the vast majority of the project area is considered fluvial and not tidal. Changes in sea levels due to climate variability may cause the project area to be more greatly influenced by tidal fluctuations in the future. A rise in water surface elevation through changes in sea levels may exacerbate flood

damages from both rainfall and coastal surge events. An increase in relative sea level may also make flood events more frequent.

Table 30 and Figure 18 show a brief summary of how the Recommended Plan may affect the water surface elevation of the 1-percent flood at different sea level rise scenarios for the period of analysis, as compared to the existing condition. The sea level change analysis within the period of analysis encompasses the water surface elevations for the "low" and "intermediate" sea level change scenarios for the planning horizon. Please see Appendix B.2 – Hydraulics for more details of this uncertainty analysis.

Table 30: Sea Level Change Analysis of Existing and Future With-Project Water Surface Elevations

LOCATION	HEC-RAS CROSS SECTION	1-PERCENT FLOOD STAGE (FT)			
		EXISTING CONDITION*	U.S. ROUTE 1 BRIDGE REMOVAL		
			USACE "Low"	USACE "Intermediate"	USACE "High"
Upstream of North bridge	9633.9	17.95	14.37	14.37	15.75
Immediately upstream of North Bridge	9476.7	17.87	14.04	14.04	15.53
In between bridges	9336.19	15.99	12.44	12.50	14.26
Immediately downstream of South Bridge	9190.9	12.19	12.28	12.35	12.73
Downstream of South bridge	9102.9	12.35	12.28	12.35	12.75

**Existing Condition refers to the "USACE" intermediate sea level rise scenario with the existing U.S. Route 1 bridges in place.*

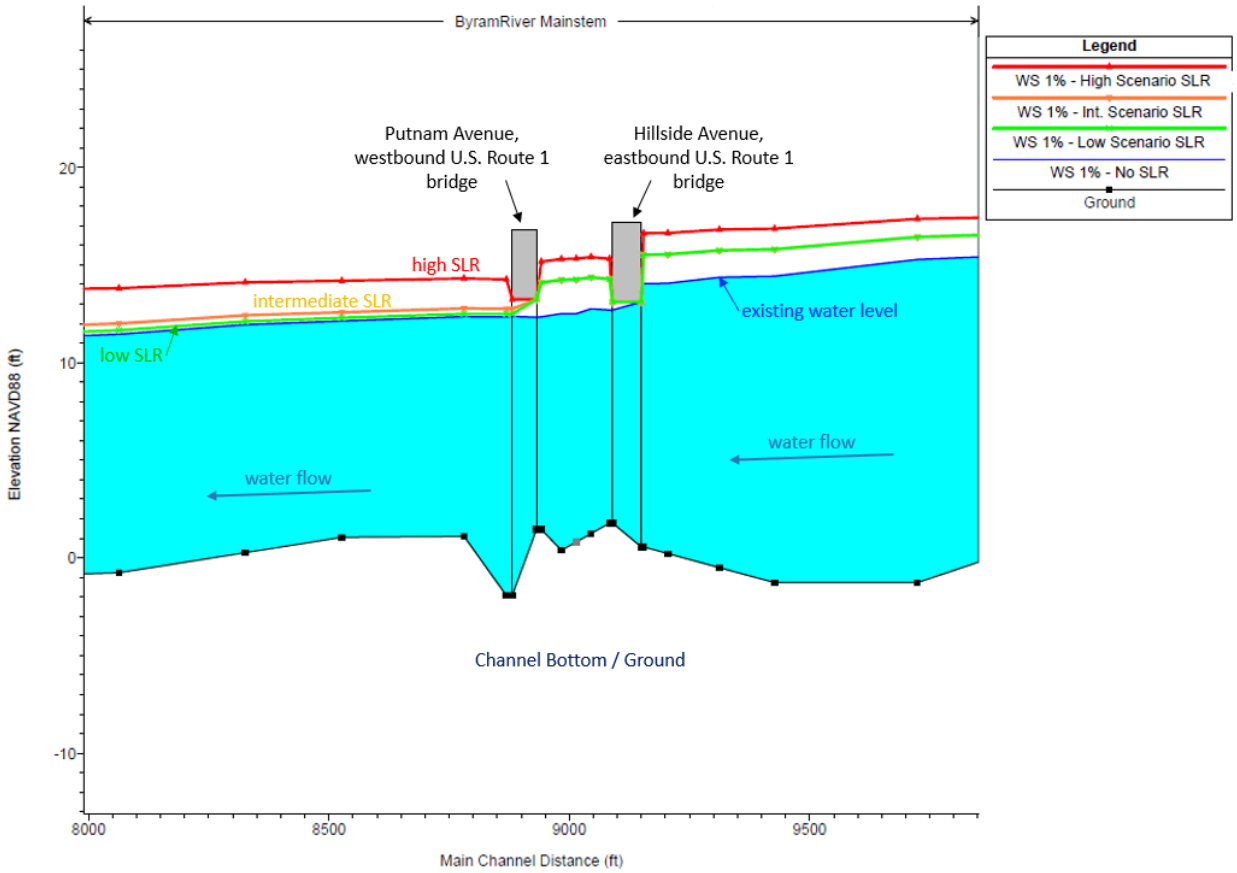

Figure 18: Sea Level Change Analysis of Future With-Project Water Surface Elevations During a 1-Percent Flood Event

Economics

A source of uncertainty for the economic analysis of the Recommended Plan is the remaining life of the bridges. As described in Section 4.2, NYSDOT staff estimate the U.S. Route 1 bridges need to be replaced in 11 to 25 years. This uncertainty is directly related to uncertainty in the amount of advanced bridge replacement benefits the project provides; this uncertainty does not impact the benefits from the reduction of flood risk (Table 31).

The major variables for which uncertainties are estimated include discharges and stages of flooding, structure first floor elevations, structure values, structure-to-content value ratios, and depth-damage functions. HEC-FDA performs many iterations of damage estimates by randomly picking values for these variables with uncertainties described by the type of and error in distributions. Iterations of this procedure are made for each reach until the change in the mean of the damage estimate derived in this manner is minimal. The mean damage estimated in this way is the expected annual damage. Index points in each damage reach are used as points to aggregate stage-damage for that reach.

Because uncertainty has been defined for key input parameters in the economic analysis, uncertainty in the expected benefits may be calculated. Table 32 presents the distribution of expected average annual benefits for Alternative 5, the Recommended Plan, along with the distribution of net benefits and benefit cost ratios. There is a 75% chance that the benefit cost ratio

for the Recommended Plan will exceed 1.07, a 50% chance that it will exceed 1.28, and a 25% chance that it will exceed 1.52. More details can be found in the Appendix C – Economics.

Table 31: Recommended Plan's Range Range of Benefits Under Various Future-Condition Scenarios
(Price Level FY 2020; Discount Rate 2.75%)

SEA LEVEL CHANGE SCENARIO		25-YEAR REMAINING BRIDGE LIFE: $667,000	18-YEAR REMAINING BRIDGE LIFE: $748,000	11-YEAR REMAINING BRIDGE LIFE: $839,000
LOW	Annual Benefits	$1,100,000	$1,182,000	$1,272,000
	Net Benefits	$44,000	$38,000	$128,000
	Benefit Cost Ratio	0.96	1.03	1.11
INTERMEDIATE	Annual Benefits	$1,421,000	$1,503,000	$1,593,000
	Net Benefits	$277,000	$358,000	$449,000
	Benefit Cost Ratio	1.24	1.31	1.39
HIGH	Annual Benefits	$1,907,000	$1,989,000	$2,079,000
	Net Benefits	$763,000	$845,000	$935,000
	Benefit Cost Ratio	1.67	1.74	1.82

Table 32: Economic Summary of Recommended Plan with Uncertainty
(Price Level FY 2020; Discount Rate 2.75%)

	PROBABILITY DISTRIBUTION QUARTILES (Percent chance that the value will be exceeded)		
	75%	50%	25%
Equivalent Annualized Benefits*	$1,222,000	$1,464,000	$1,743,000
Net Benefits	$78,000	$320,000	$599,000
Benefit Cost Ratio	1.07	1.28	1.52

** Annual costs include interest during construction. The 50% quartile is the median estimate; it differs from the mean when the probability distribution is asymmetrical. Equivalent Annualized Benefits include advanced bridge replacement benefits of $748,000 and emergency cost reduction benefits of $26,000. These benefits are reduced by $176,000 due to the cost of traffic delays during construction.*

The hydrologic and hydraulic performance of a project may be described by annual exceedance probability, long-term exceedance probability, and assurance. Annual exceedance probability is the probability of any event equaling or exceeding a specified stage in any given year considering the full range of possible annual floods and project performance; here, the target stage is the water surface elevation that results in damage equal to 5% of the damage attributed to the 1-percent

annual exceedance probability event. Long-term exceedance probability is the probability of a target stage being exceeded within the 10-, 30-, and 50-year timeframes. Assurance, formerly known as conditional non-exceedance probability, represents the probability that a target stage will not be exceeded during the occurrence of a flood of specified recurrence interval. Reach 3 of the Byram River economic analysis was further divided into sub-reaches and left- and right-stream bank. Table 33 presents the project performance in terms of annual exceedance probability and Table 34 presents project performance in terms of both long-term exceedance probability and assurance.

Table 33: Annual Exceedance Probability

Reach	Target Stage [ft]	Annual Exceedance Probability Without-Project Condition	Annual Exceedance Probability Recommended Plan
3-1 Left Bank	10.03	22%	18%
3-1 Right Bank	12.34	8%	5%
3-2 Left Bank	14.04	16%	16%
3-2 Right Bank	21.70	0.6%	0.4%
3-3 Left Bank	18.98	2%	1%
3-3 Right Bank	21.80	0.6%	0.4%
4	22.84	13%	13%
5	36.13	3%	3%
6	37.08	9%	9%
7	41.15	22%	22%
8	81.60	0.4%	0.4%
9	88.80	0.6%	0.6%
10	92.4	0.4%	0.4%
11	125.14	18%	18%
12	140.16	17%	17%
Comparable Probability (Values provided for illustrative purposes only.)			
Fire Damage		0.3%	
Wind Damage		0.5%	
Earthquake		0.1%	

Table 34: Long Term Risk and Assurance for Recommended Plan

REACH	LONG-TERM EXCEEDANCE PROBABILITY			ASSURANCE BY EVENTS					
	10 YEARS	30 YEARS	50 YEARS	10.0%	4.0%	2.0%	1.0%	0.4%	0.2%
31 Left Bank	86%	100%	100%	22%	2%	0%	0%	0%	0%
31 Right Bank	38%	76%	91%	93%	51%	20%	6%	1%	0%
32 Left Bank	82%	99%	100%	28%	4%	1%	0%	0%	0%
32 Right Bank	4%	11%	18%	100%	100%	98%	90%	70%	55%
33 Left Bank	11%	29%	44%	100%	97%	84%	59%	27%	12%
33 Right Bank	4%	11%	18%	100%	100%	97%	89%	69%	53%
4	75%	98%	100%	45%	11%	3%	1%	0%	0%
5	28%	62%	80%	98%	71%	38%	16%	4%	1%
6	60%	94%	99%	66%	14%	2%	0%	0%	0%
7	91%	100%	100%	10%	1%	0%	0%	0%	0%
8	3%	10%	16%	100%	100%	97%	90%	74%	63%
9	6%	16%	25%	100%	100%	95%	82%	56%	36%
10	4%	12%	19%	100%	100%	97%	88%	67%	53%
11	87%	100%	100%	47%	26%	15%	8%	4%	2%
12	85%	100%	100%	21%	2%	0%	0%	0%	0%

4.3.2 Residual, Transferred, and Transformed Risk

Flood risk to people and structures at any location in a floodplain is the function of flood hazard at the location, and their exposure and vulnerability to the flood hazard. No flood risk management project will ever eliminate all flood risk to life and property. The Recommended Plan would decrease the expected annual damages by about $931,000, which includes physical flood damage reduction and emergency cost reduction; this equates to a reduction of approximately 29% as compared with the without-project scenario assuming the USACE "intermediate" sea level change scenario. The majority of these benefits would occur in the Pemberwick area.

Residual risk is the flood risk that remains after the selected plan is in place. About 71% ($2,250,000 of $3,181,000) of the future equivalent average annual damages would remain after the project is constructed. Additionally, the risk of coastal storm damage would not be reduced by the Recommended Plan; areas that experience tidal flooding would not benefit from the project. Post-disaster assistance and aid for owners of these properties may come from other federal agencies, such as FEMA and the U.S. Department of Housing and Urban Development or from programs run by the State of Connecticut.

Transferred risk is a result of implementing a plan in one region of a system to reduce risk and the risk is transferred to another region of the system. The Recommended Plan is not anticipated to increase the risk of flooding or erosion in the study area; hydrologic and hydraulic analyses concluded that there was immeasurable increases in the flood profile and channel velocity downstream of the U.S. Route 1 Bridges. Therefore, the Recommended Plan is not anticipated to have any transferred risks. Additional hydrologic and hydraulic analyses will be conducted during the Preconstruction Engineering and Design phase of the project to ensure the possible creation of transferred risks are avoided or are properly mitigated.

Transformed Risk is a new risk of flooding that emerges or increases as a result of mitigating another risk. The Recommended Plan will not result in transformed risk.

4.3.3 Study Phase/ Preconstruction Engineering and Design/ Implementation

There are a few risks that may affect the study, Preconstruction Engineering and Design, and implementation schedule for the project. The study team used existing data to make assumptions about the geotechnical characteristics and the presence of cultural resources and HTRW; there is a risk that additional information on these items may require redesign of the project or may cause a delay in implementation.

The real estate acquisition needed to implement the project is within two political boundaries; coordination with multiple parties may cause delays in project implementation. The U.S. Route 1 bridges that are proposed to be removed in the Recommended Plan are owned and operated by the NYSDOT. The Town of Greenwich, CT has indicated their willingness to act as the non-federal sponsor for the project, and the NYSDOT has indicated their willingness to act as a non-federal party for the project. The Town of Greenwich, in conjunction with the NYSDOT, agrees to be responsible for all local cooperation requirements for the project. There is a risk of implementation delays with multiple parties involved.

4.4 Economic, Environmental, and Other Social Effects

As previously described in Section 3.6.4, the USACE guidance requires that study alternatives be evaluated under the NED, RED, EQ, and OSE accounts. NED effects of the Recommended Plan have been addressed above and in the Economics Appendix. In reducing damages from future flood events, the proposed project would contribute to NED. EQ is detailed in Chapter 5; overall, the implementation of the Recommended Plan would have minimal environmental impacts with the exception of the permanent adverse effects to historic bridges and temporary adverse effects to traffic.

RED effects are the impact of project spending, either directly or indirectly, on the local economy. Implementation of the Recommended could induce RED benefits in the area as residents and business owners may be able to allocate resources and spending on goods and services rather than on repairing and replacing structures or goods damaged by flooding.

OSE include the effects that are not covered in the NED, RED, and EQ. As compared to the without-project condition, the project would reduce fluvial flooding's risk to life safety because flooding in the study area may not occur as frequently or as severely; decreased road flooding would allow people to effectively evacuate and allow for emergency services to reach people in need during a flood event. The Recommended Plan would also improve community resilience, the measure of the sustained ability of a community to utilize available resources to respond to, withstand, and recover from adverse situations. The community would be able to recover more quickly after rain events; businesses would be able to reopen after a flood event and people would be able to return to work. These effects can support social connectedness and community identity.

The project would maintain the availability of transportation routes, including Riverdale Avenue, for evacuation, emergency operations, and other vital services. The Recommended Plan provides risk reduction the Pemberwick area of Town of Greenwich. Residual risks associated with the Recommended Plan includes remaining average annual damages of $2,250,000 out of a total average annual damage pool of $3,181,000.

4.5 Environmentally Preferable Alternative

Part 1505.2(b) of the NEPA requires the identification of the Environmentally Preferable Alternative. In general, the Environmentally Preferable Alternative is considered the alternative that has the least adverse effects to natural, cultural and historic resources. The Recommended Plan has been identified as the Environmentally Preferable Alternative because it achieves the objective of flood risk management, has been determined to have federal interest, and avoids, minimizes and/or compensates adverse impacts to the environment and cultural resources to the greatest extent practicable. The No Action Alternative would provide no flood risk reduction to the vulnerable populations and infrastructure of the study area.

4.6 Executive Order 11988

Executive Order 11988 requires that federal agencies avoid, to the extent possible, adverse impacts associated with the occupancy and modification of floodplains and to avoid support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize

the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of Executive Order 11988, as referenced in ER 1165-2-26, requires an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to, or are within the floodplain. The eight steps and project-specific responses to them are summarized in Table 35.

Table 35: Executive Order 11988 Steps

Executive Order 11988 STEP	PROJECT-SPECIFIC RESPONSE
Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year).	The proposed action is within the base floodplain. However, the project is designed to reduce damages to existing infrastructure.
If the action is in the base floodplain, identify and evaluate practicable alternatives to the action or to location of the action in the base floodplain.	Practicable measures and alternatives were formulated and evaluated against the USACE guidance, including nonstructural measures such as buy-outs (land acquisition and demolition of structures).
If the action must be in the floodplain, advise the general public in the affected area and obtain their views and comments.	The Draft Integrated FR/EIS was released for public review in June 2018 and coordination with agency officials and the public have occurred throughout the study.
Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial floodplain values. Where actions proposed to be located outside the base floodplain will affect the base floodplain, impacts resulting from these actions should also be identified.	The anticipated impacts associated with the Selected Plan are summarized in Chapters 5 and 6 of this report. The project would not alter or impact the natural or beneficial floodplain values.
If the action is likely to induce development in the base floodplain, determine if a practicable non-floodplain alternative for the development exists.	The project will not encourage development in the floodplain because all properties available for development have been developed. The project provides benefits solely for existing development.
As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial floodplain values. This should include reevaluation of the “no action” alternative.	The project would not induce development in the floodplain. Section 3 of this report summarizes the alternative identification, screening and selection process. The “no action” alternative was included in the plan formulation phase.
If the final determination is made that no practicable alternative exists to locating the action in the floodplain, advise the general public in the affected area of the findings.	The Draft Integrated FR/EIS was released for public review in June 2018.

Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.	The Recommended Plan is the most responsive to all of the study objectives and the most consistent with the executive order.

5. ENVIRONMENTAL EFFECTS *

This chapter discusses the potential positive and adverse environmental consequences of the Recommended Plan. The effects of the Recommended Plan are directly compared against the baseline Future Without-Project /No Action alternative conditions as described in Chapter 3.

Up to approximately 300 feet of the Byram River channel may be disturbed related to the implementation of the Recommended Plan. Approximately 0.09 acres of open water may be filled in from a combination of concrete and riprap associated with the construction of the new abutments while approximately 0.02 acres of open water will be restored as a result of removing the existing center abutments. Approximately 0.13 acres of upland and riparian vegetation will be removed as a result of implementation of the Recommended Plan; however native grass, shrub and tree species will be replanted in disturbed areas once construction is completed. Construction of the Recommended Plan is expected to take approximately two years.

In addition to discussing potential beneficial and adverse environmental effects, this chapter outlines potential mitigation measures for adverse impacts and potential adaptive management methods that may be implemented to ensure success of the mitigation. In accordance with the CEQ NEPA regulations, mitigation includes: 1) Avoiding the impact by not taking a certain action or parts of an action; 2) Minimizing the impact by limiting the degree or magnitude of the action and its implementation; 3) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment; 4) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and 5) Compensating for the impact by replacing or providing substitute resources or environments.

5.1 Topography, Geology, and Soils

5.1.1 Topography and Geology

No short or long term adverse impacts to geology from implementation of the proposed action is anticipated.

Due to the fact that the bridges are being raised, minor grading will be required to immediate surrounding areas to accommodate the raised roadway profiles. However, the topographical changes are expected to be negligible.

There will also be minor grading within the Byram River channel to restore the portion of the channel where the center abutments are removed to existing grade. The topographical changes are expected to be negligible.

5.1.2 Soils

No significant impacts to soils will occur as a result of implementation of the Recommended Plan. Scour protection will be required to prevent erosion. The channel modifications within the Byram River will involve the excavation and fill of the riverbanks and channel in order to remove the existing abutments, center piers, and place the riprap along the toe of the new bridge abutments. The riprap is meant to prevent scouring and erosion of soil around the abutments during high flow events. Overall, the impact to soils will be negligible.

Hydric Soils

The Udorthents soil type occur within the Recommended Plan project footprint along the left bank of the Byram River and meet hydric soil criteria. However, the soils within the Recommended Plan footprint have already been modified by the construction of the original bridges and surrounding development. Therefore, no significant adverse impacts will occur from implementation of the Recommended Plan.

Prime Farmland

The proposed action occurs in an urbanized setting that does not include any additional land uses related to agriculture or silviculture. Therefore, adverse impacts to Prime Farmland soils will not occur.

Mitigation

An Erosion and Sediment Control Plan will be developed and submitted to the Town of Greenwich, CT and the Westchester County, NY Conservation District for approval prior to the construction of the proposed project. Best management practices including, but not limited to, silt fence, turbidity curtains, cofferdams and temporary seeding will be implemented to reduce soil erosion within the project footprint. Following completion of modifications and structures, temporary work locations will be restored to pre-construction conditions.

5.2 Water Resources

5.2.1 Surface Water

Overall, adverse impacts to the Byram River will be minor. Approximately 300 feet of the Byram River will be impacted during construction as a result of the implementation of the Recommended Plan. Of the 300 feet, approximately 150 feet of the impact will be temporary from the creation of equipment access areas. Construction will include the removal of the existing stone bridge abutments and the center piers, and the installation of new concrete abutments along the riverbank within the same footprint as the old abutments. Approximately 0.09 acres of open water will be filled as a result of the new bridge abutments and the rip rap being used for scour protection.

Positive effects from implementation of the Recommended Plan include the restoration of approximately 0.02 acres of open water habitat and natural flow of the river through the removal of the center abutments which will alleviate flooding. Minor regrading will be required to bring the river bottom within the former center pier footprint to the same bed elevation as the surrounding channel bottom. In-situ substrate will be used to form the restored bed.

Mitigation

Discussions of water resources mitigation are included in Section 5.2.2 below.

Monitoring and Adaptive Management

Discussions of water resources monitoring and adaptive management are included in Section 5.2.2 below.

5.2.2 Water Quality and Habitat

The Recommended Plan will have minor temporary adverse impacts and no adverse long term impacts on water quality. As stated in 5.2.1, approximately 300 feet of the Byram River will be impacted during construction as a result of the implementation of the Recommended Plan with approximately 150 feet of the impact being temporary due to construction access areas. Cofferdams will be installed within the work area so that all bridge deconstruction and construction activities will occur in dry conditions. The cofferdams will be installed in a manner to maintain flow of the river. In addition, a silt curtain would be installed downstream of the work area to further prevent any sediment or turbid water from migrating downstream. Furthermore, to minimize impacts to fish and aquatic resources, in-water work will be restricted from January 1 through June 30. This window will not apply once the cofferdams are installed.

Any impacts on water quality would be temporary and localized since turbidity levels and concentration of materials suspended in the water column would quickly return to ambient conditions.

Minor short term impacts to aquatic habitat within the Recommended Plan footprint during the construction are expected as a result of riparian vegetation removal and construction activities within the river channel. Mitigation actions described below will minimize impacts.

Long term adverse effects to aquatic habitat resulting from the Recommended Plan are expected to be minor. The new bridge abutments are being constructed in the same location as the existing abutments and the scour protection will be limited to the immediate toe of the abutments and will not extend into the entire channel. The substrate around the bridges consists of gravel bars and large rock so the rip rap will not constitute a significant change in substrate. Approximately 0.09 acres of open water will be filled as a result of the new bridge abutments and riprap. However, the removal of the center piers of the existing bridges constitutes a positive effect as it will restore approximately 0.02 acres of open water habitat with natural substrate.

Mitigation

During construction, standard erosion and sediment control Best Management Practices to protect water quality during in river work will be implemented to reduce the potential adverse and significant impacts. General post construction site restoration in the form of replanting native grass, shrub and tree species along the riverbank will minimize riparian habitat impacts.

Monitoring and Adaptive Management

As no compensatory mitigation to water resources is proposed, no monitoring or adaptive management will be performed.

5.2.3 Wetlands

Federal

There are no federally regulated wetlands within the Recommended Plan footprint. Therefore, there will not be any direct wetland impacts as a result of implementing the Recommended Plan. Indirect impacts to the small freshwater forested/scrub shrub wetland north of the Recommended Plan footprint is not expected given that the wetlands are located along the river channel and will still be subject to inundation during flood events.

Connecticut Regulated Wetlands

Given that there are no state regulated wetlands within the Recommended Plan project footprint, there will not be any direct wetland impacts. Indirect impacts to any wetlands north of the Recommended Plan project footprint as a result of increasing the channel capacity are not expected given that the wetlands are located along the river channel and will still be subject to inundation during flood events.

New York Regulated Wetlands

There are no state regulated freshwater or coastal wetlands within the immediate footprint of the Recommended Plan. Therefore, there will not be any direct adverse impacts to these resources. There will not be any indirect impacts to coastal wetlands downstream of the Recommended Plan project footprint as they will be subject to the same tidal inundation that currently exists.

Mitigation
As no wetlands will be directly or indirectly impacted by the Recommended Plan, no mitigation is proposed.

5.3 Vegetation

5.3.1 Upland

The implementation of the Recommended Plan will have minor adverse impacts to upland vegetation. Approximately 0.13 acres of upland and riparian vegetation will be removed as a result of implementation of the Recommended Plan. This impact is predominantly considered a temporary impact as the area will be restored to pre-construction site conditions through the replanting of native grass, shrub and tree species once construction is completed.

Mitigation
The restoration of disturbed work areas with native grass, shrub and tree species will minimize adverse impacts to upland and riparian areas.

Monitoring
The vegetation planted as part of site restoration will be subject to the USACE's standard one year contractor warranty period. During this time, the construction contractor will be required to perform activities such as watering and weeding to ensure survivability of the plant material. The District will inspect the vegetation for successful establishment and the contractor will be required to replace any plant material that has not survived during this one year warranty period. As the replanting is part of general site restoration and not compensatory mitigation, no other post construction monitoring or adaptive management actions are proposed.

5.3.2 Wetlands

There are no Federal, Connecticut or New York state regulated wetlands within the footprint of the Recommended Plan. Therefore there will be no direct impacts to wetland vegetation resulting from the implementation of the Recommended Plan.

5.4 Fishery Resources

Implementation of the Recommended Plan is expected to have minor temporary adverse impacts to fishery resources due to noise and turbidity from equipment operating in the stream and along the banks. The turbidity caused by construction activities, mainly the installation and removal of cofferdams, could hinder predation efficiency of sight feeding fish within the project area. However, any juvenile or adult fish within the Recommended Plan project footprint are expected to be mobile enough to leave the area.

In addition, the initial loss of aquatic macroinvertebrate species resulting from channel modifications will eliminate a food source for fish until the area is recolonized by macroinvertebrate species. Given the relatively small project footprint and disturbance associated with the project, recolonization of the project area with aquatic macroinvertebrate species is expected to occur within a couple of months following construction completion.

Long term adverse impacts to fishery resources are expected to be negligible. Approximately 0.09 acres of open water habitat will be lost as a result of the new bridge abutments and riprap. However, the removal of the center piers of the existing bridges will restore approximately 0.02 acres of open water and benthic habitat that fish species could utilize for foraging.

Mitigation
The use of erosion and sediment control best management practices, including a cofferdams, will minimize sedimentation and turbidity that can negatively impact fish species and their habitat. In addition, an in-water work restriction from March 1 through June 30 to protect anadromous fish species as recommended by the Connecticut Division of Fish and Wildlife will be observed. In-water restrictions for EFH species in section 5.4.1.

Monitoring and Adaptive Management
As no compensatory mitigation that would benefit fish species is proposed, no monitoring or adaptive management will be performed.

5.4.1 Essential Fish Habitat

The Recommended Plan will not have any adverse direct or indirect impacts on EFH. A Feasibility level Essential Fish Habitat Assessment has been prepared and is located in Appendix A.5. The Draft FR/EIS and appendices were coordinated with NOAA-NMFS, correspondence is located in Appendix A.12.

Mitigation
Mitigation measures for EFH species are the same as discussed in Section 5.4 with the exception of an in-water work restriction from January 1 to May 31 to protect winter flounder, an EFH designated species. The District has tentatively agreed with this restriction but will re-evaluate the need for it during the PED in coordination with NOAA-NMFS. This re-evaluation is based on results of surveys within the New York Bight area conducted as part of another USACE project indicating that winter flounder would not likely be migrating to their spawning grounds prior to mid-February.

5.5 Aquatic Macroinvertebrates

Implementation of the Recommended Plan will have negligible adverse impacts and negligible positive effects on aquatic macroinvertebrates. Construction of the Recommended Plan will cause

the direct mortality of aquatic invertebrates as a result of the installation of the cofferdams, excavation required to remove the center bridge piers, and the installation of the scour protection. Temporary increases in turbidity and suspended sediments near the construction activities could cause direct mortality or indirect decreased reproductive success in benthic species over the short term.

Approximately 0.09 acres of open water habitat will be lost as a result of the new bridge abutments and riprap. The riprap will constitute a change in substrate that will benefit some species and adversely impact others. The removal of the center abutments will restore approximately 0.02 acres of open water and natural substrate that will benefit macroinvertebrate species within the Byram River.

Recolonization of aquatic macroinvertebrate species within the Recommended Plan project footprint is expected after construction via recruitment of nearby colonies. As stated in Section 5.4, recolonization of the project area with aquatic macroinvertebrate species is expected to occur within a couple of months following construction completion.

Mitigation
The use of erosion and sediment control best management practices, including cofferdams, will minimize sedimentation and turbidity that can negatively impact benthic resources and their habitat. In addition, the in-water work restriction from January 1 through June 30 to protect fishery resources will provide similar protection to any benthic resources that also spawn during this timeframe.

Monitoring and Adaptive Management
As no compensatory mitigation is proposed, no specific monitoring plan will be developed for benthic resources.

5.6 Reptiles and Amphibians

Implementation of the Recommended Plan will have negligible impacts on reptile and amphibian species. As there are no wetlands within the Recommended Plan footprint, project impacts would be limited to open-water areas that are not as commonly frequented by these species. The presence of U.S. Route 1, business development along the riverbanks, and steep riverbank slopes further limit habitat supportive of these species. Construction activities required to remove (and replace) the bridges may cause mortality of any less mobile species inhabiting the Recommended Plan project footprint. More mobile species will be temporarily displaced from the area and are expected to relocate to other, undisturbed locations of the overall project area.

The new bridge abutments will be located in the same location of the riverbanks as the existing abutments, therefore, loss or modification of existing habitat is negligible. Installation of the scour protection along the new bridge abutments may restrict or preclude movement of herpetofauna between the land and river and could potentially reduce the amount of natural banks within the Recommended Plan project footprint. However, the impacts associated with the installation of the rip rap will be negligible given that the steep riverbank slopes and the presence of large stones/rock within the river and along the banks already present a navigation challenge in some portions of the Recommended Plan project footprint. Following construction, reptile and amphibian species are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the Recommended Plan project footprint.

Mitigation

The re-establishment of upland and riparian vegetation as described in Section 5.3 will provide foraging and cover habitat supportive of reptiles and amphibians.

Monitoring and Adaptive Management

As no compensatory mitigation is proposed, no specific monitoring plan will be developed for reptile and amphibian species.

5.7 Birds

The implementation of the Recommended Plan will create short term minor adverse impacts to migratory bird species and will be limited to the period of construction. However, since bird species are highly mobile, they are expected to move away from the Recommended Plan project footprint during construction. Furthermore, outside the breeding season these species do not permanently remain in any one location. Following construction, bird species are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the Recommended Plan project footprint. Certain bird species such as swallows and eastern phoebe sometimes utilize bridges as nesting habitat. The removal of the bridges could result in the temporary loss of potential nesting habitat, but replacement of the bridges will restore such habitat. Replanting native vegetation to disturbed areas after construction will restore nesting and foraging habitat. In addition, the scope of the impacts associated with the Recommended Plan in relation to overall regional availability of nesting and foraging habitat is small. Therefore, long term adverse impacts to bird species as a result of implementing the Recommended Plan will be negligible.

Mitigation

In order to comply with the Migratory Bird Treaty Act, a clearing restriction of shrubs and trees from April 1 through August 31 will be implemented during construction to avoid adverse impacts to any potential nesting birds that are covered under this act. This clearing restriction will provide protection to non-migratory birds as well. Post construction replanting efforts with native vegetation will benefit birds by restoring or enhancing foraging, shelter and nesting habitat. The clearing restriction will also extend to the bridge removal to protect any species that utilize bridges for nesting. If it is determined that bridge removal needs to occur within this restriction period, the District will coordinate with the CTDEEP Division of Wildlife and the U.S. Fish and Wildlife, and conduct the necessary surveys by a qualified biologist to determine the presence of nesting bird species prior to initiating bridge deconstruction activities.

Monitoring and Adaptive Management

As no compensatory mitigation is proposed, no specific monitoring plan will be developed for birds.

5.8 Mammals

Construction activities associated with the Recommended Plan will result in the temporary disturbance of habitat (e.g. vegetation and tree removal). Construction activities may also cause the temporary and permanent displacement of more mobile species due to increased human activity and habitat alterations. Tree clearing restrictions implemented to protect migratory bird and

endangered and threatened bat species will provide some protection for tree-dwelling mammal species. Certain bat species such as northern long-eared bat, little brown bat and big brown bat sometimes utilize bridges as nesting habitat. The removal of the bridges could result in the temporary loss of potential nesting habitat, but replacement of the bridges will restore such habitat. Following construction, mammals are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the Recommended Plan project footprint.

Given the level of development and traffic on U.S. Route 1, long term impacts on local mammal populations will be negligible.

Mitigation

The re-establishment of upland, riparian vegetation as described in sections 5.2.3 Wetlands and 5.3 Vegetation will provide foraging and cover habitat supportive of wildlife.

Monitoring and Adaptive Management

As no compensatory mitigation is proposed, no specific monitoring plan will be developed for mammal resources.

5.9 Endangered and Threatened Species

5.9.1 Federal Threatened and Endangered Species

USFWS Trust Species

Northern long-eared bat

The implementation of the Recommended Plan will not have any short term or long term adverse impacts to northern long-eared bat. Although any tree clearing will be minimal, a tree clearing restriction from April 1 through September 30 will be implemented during construction to minimize any adverse impacts to this species during construction. The implementation of the tree clearing restriction is a standard protocol in this region that does not require formal consultation with the USFWS.

The District prepared a letter determining a "Not Likely to Adversely Effect" for northern long-eared bat and used the Draft FR/EIS as the primary coordination vehicle with the USFWS New England Field Office to complete ESA Section 7 consultation. The District received concurrence on the determination from them via email dated August 2, 2018. Correspondence between the District and the USFWS is included in Appendix A.9. Alternatively, if clearing must occur within this timeframe, the District will reinitiate informal consultation with USFWS to determine the appropriate course of action.

Bog Turtle

The project area does not contain habitat supportive of bog turtle. Therefore, the Recommended Plan will not have any short term or long term adverse impacts to bog turtle. A No Effect determination is included in Appendix A.9. Per USFWS guidance, the District does not need to obtain concurrence from them on No Effect determinations.

NOAA-NMFS Trust Species

The overall project area does not contain habitat supportive of any of the NOAA-NMFS Trust Species. Therefore, there will be no direct adverse impacts to these species. The portion of the river that could potentially be utilized by Atlantic and shortnose sturgeon is approximately one mile downstream of the project area. The small scope of the project relative to the size of the river in combination with the implementation of cofferdams during construction will minimize adverse indirect impacts to any potential sturgeon habitat that may exist in the lower portion of the river. None of the sea turtle species are expected to utilize any portion of the river, therefore indirect adverse impacts to sea turtles will not occur.

No Effect determinations for NOAA-NMFS trust species are included in Appendix A.9. Per NOAA-NMFS guidance, the District does not need to obtain concurrence from them on No Effect determinations.

Mitigation

A tree clearing restriction extending from April 1 through September 30 will be implemented during construction to protect the northern long eared bat. A preference to tree species that provide roosting habitat for northern long eared bat will be given during the development of site restoration plans. If bridge removal activities are scheduled to occur within April 1 through September 30, the District will reinitiate informal consultation with the U.S. Fish and Wildlife Service to determine the need for a qualified biologist to survey the bridges for presence of roosting northern long eared bat prior to initiating deconstruction activities.

The re-establishment of native vegetation within the Recommended Plan project footprint and the replacement of the bridges will restore northern long-eared bat habitat.

As no NOAA-NMFS Trust species occur within the overall project area, no mitigation measures are proposed. Implementation of erosion and sediment control best management practices will minimize any potential indirect impacts to these species.

Monitoring and Adaptive Management

As no compensatory mitigation is proposed, no specific monitoring plan will be developed for the northern long-eared bat.

5.9.2 State Endangered and Threatened Species

Given that no known Connecticut or New York state endangered and/or threatened species occur within the overall project area, implementation of the Recommended Plan will have no effect on such species.

5.10 Socioeconomics

The Recommended Plan will cause the Pemberwick area to experience less fluvial flooding. The population of Town of Greenwich shows an increasing trend from 2000 to 2016, and would be expected to continue increasing with the Recommended Plan in place. Reducing flood damages to the houses in this area will cause less strain on the vulnerable population that lives in this area. Although the entire population that lives and works in the floodplain is vulnerable and at risk of flooding and harm, case studies have shown that certain sub-populations are more susceptible to harm from flooding. These “socially vulnerable groups” are typically children, the elderly, those

disabled, low income, minorities, and female head of households. Some of these have impediments to evacuating and therefore have a higher potential for loss of life. Others have a lack of resources or have special needs that may also inhibit preparing for an impending flood or evacuating. Constructing the Recommended Plan will reduce the impacts to this sector of the population.

Environmental Justice

As discussed in Section 2.10, Environmental Justice considerations are applicable to the Village of Port Chester. The Village of Port Chester will receive flood risk management benefits from implementation of the Recommended Plan. The District has coordinated with the elected officials of the Village of Port Chester and the Town of Greenwich throughout the study via meetings. Based on coordination with the elected officials, public meetings were held when requested.

Notifications about the NEPA Scoping Meeting and comment period, the release of the Draft FR/EIS and the Draft FR/EIS public meeting were distributed to elected officials and were posted on the websites of each municipality.

No local community activist groups focused on Environmental Justice issues within the study area were identified during stakeholder and public coordination. Coordination with the elected officials have not raised any issues that would require an in depth, analysis related to Environmental Justice concerns. In addition, the District did not receive any comments during the NEPA Scoping Period or the Draft FR/EIS comment period regarding Environmental Justice concerns.

Therefore, significant and disproportionate adverse impacts to residents of the Village of Port Chester are not expected.

5.11 Cultural Resources

5.11.1 Cultural Resources in the Area of Potential Effect (APE)

The Area of Potential Effect (APE) for the identification of historic properties and the undertaking's effects on historic properties for this Draft Integrated FR/EIS is the Byram River at the location of the U.S. Route 1 bridges, including both streambanks in Town of Greenwich and Village of Port Chester just upstream and downstream of both bridges (Figure 19).

Known National Register Properties in the Area of Potential Effect

The U.S. Route 1 bridges were built in 1880s and 1920s/1930s. Both U.S. Route 1 bridges were determined to be eligible for the New York State and National Registers in 2015 under National Register of Historic Places criteria A and C for their association with historical events and their architectural characteristics, respectively. The bridges are associated with the federal highway road building movement and possibly the Works Progress Administration. Architecturally, they are examples of craftsmanship and design of double arched stone bridges (New York Office of Parks, Recreation and Historic Preservation 2015).

The Thomas Lyon House, located on West Putnam Avenue immediately adjacent to the U.S. Route 1 bridges in Town of Greenwich, was listed on the Connecticut State and National Register of Historic Places in 1977. The house is the oldest Colonial house in Town of Greenwich. It was built c. 1695 and moved to its current site in 1927. The Town of Greenwich assumed responsibility

of the house in 2007. The house is a classic saltbox and retains much of its original building material.

The Byram School is located just outside but adjacent to the APE along West Putnam Avenue.

Archaeological Resources

A Phase IA cultural resources investigation of the project area was completed in 2014 to provide historic context, identify historic properties and make recommendations for additional studies (Panamerican 2014a and Panamerican 2014b). No sites were identified within the APE for New York or Connecticut.

Figure 19: Area of Potential Effect (APE)

5.11.2 Architectural Resources

There are a number of resources within the APE that are potentially eligible for the National Register. These include:

- 1950s-era buildings on the west side of the river between the two bridges;
- 1920s-early 1930s-era filling station on the Port Chester parcel on the east side of the Byram River; and
- The William James Memorial Gateway Park located on the west side of the river south of the West Putnam Avenue Bridge, including the 1920s-era sewer pump house and historic wrought iron fence.

5.11.3 Coordination and Consultation

The Phase IA survey was coordinated with the NYSHPO and the Connecticut Department of Economic and Community Development (Connecticut State Historic Preservation Office [CTSHPO]), which concurred with the resource determinations. The proposed project and results

of the survey were coordinated with the Mashantucket Pequot (CT) and the Delaware Nation, the Delaware Tribe of Indians and the Stockbridge Munsee Community of Indians (Appendix A.4). Coordination with the Advisory Council on Historic Preservation (ACHP) is being completed.

The demolition of the U.S. Route 1 bridges will constitute an adverse effect on historic properties specifically to the bridges themselves. As currently planning, the removal and replacement of the bridges will not have an adverse effect on the potentially eligible buildings in the William James Memorial Gateway Park or the Thomas Lyon House. The current work will be in the footprint of the existing bridge construction and the new construction should not have an adverse effect on archaeological sites related to the use of the area before the bridges' construction. Both banks, however, may have information related to the construction of the bridges. The visual effect and aesthetics of the dual stone bridges will also be adversely effected by the removal of the bridges.

Mitigation

A preliminary draft Memorandum of Agreement was included for review and comment by the public during the public review and a final Memorandum of Agreement, fully executed on October 15, 2019, is included in Appendix A.4. Requirements of the Memorandum of Agreement include:

- Documentation of the existing bridges that will include the development of an historic context for the construction and use of the bridges, review of available design and as-built be construction drawings and the preparation of current drawings and photographs. The historic context will include consideration of the Works Progress Administration, if it is determined the younger bridge was built during this period. This documentation may be completed in accordance with the Historic American Engineer Record. This work would also include monitoring demolition to identify any archaeological evidence of the bridges' construction.
- Preparation of reports that will be provided to the relevant regulatory agencies and public venues, as well as less technical reports for distribution to local libraries and the general public.
- Re-use of stone and other materials from the current bridges in the new bridge design;
- Consideration of the retention and incorporation of stone wingwalls flanking the end of the historic bridges in the new bridge design;
- Use of the same parapet height and materials from the historic structures in the new bridge design; and
- Continued coordination with the NY and CT State Historic Preservation Offices, the NYSDOT, the Port Chester Historical Society, the Westchester County Historical Society, the Greenwich Preservation Trust, the Stockbridge-Munsee Community, the Delaware Nation, the Delaware Tribe, the Mashantucket Pequot Tribe, and the Mohegan Tribe.

The estimated cost of mitigation has been provided as part of the project cost in Table 28. This estimated cost does not exceed 1% of the federal project cost for data recovery.

5.12 Coastal Zone Management

The Recommended Plan is compliant with all applicable policies. Consistency determinations for the New York State Coastal Zone Management (CZM) policies, the Village of Port Chester LWRP

and the Connecticut CZM policies have been prepared and are located in Appendix A.6. The District received a conditional concurrence on the consistency determination from the Connecticut Department of Energy & Environmental Protection (CTDEEP) on March 13, 2019 and the concurrence with the New York consistency determination from the New York Department of State (NYSDOS) on April 23, 2019. Because the CT consistency determination is tied to permits that will be obtained in the Preconstruction Engineering and Design Phase, the District will receive final concurrence of the CT consistency determination at that time. Correspondence between the District and the CTDEEP and NYSDOS is located in Appendix A.11.

5.13 Floodplains

With the project in place, the 1-percent floodplain of the Byram River within the project area will be reduced in extent. The project will cause the floodplain to be narrower than it currently is (Figure 16). This will reduce the number of structures that are damaged during flooding events. The water surface elevations for the existing conditions and the proposed with-project Recommended Plan conditions assuming the USACE "intermediate" sea level change scenario in 50 years are shown in Table 36. There are minimal increases in the flood profile and channel velocity downstream of the U.S. Route 1 Bridges. Additional hydrologic and hydraulic analyses will be conducted during the Preconstruction Engineering and Design phase of the project to ensure the possible creation of transferred risks are avoided or are properly mitigated.

Table 36: Existing vs. Proposed Stages at U.S. Route 1 Bridge

LOCATION	HEC-RAS CROSS SECTION	EXISTING CONDITION STAGE (FT)			PROPOSED CONDITION STAGE (FT)		
		50% FLOOD	2% FLOOD	1% FLOOD	50% FLOOD	2% FLOOD	1% FLOOD
Upstream of North bridge	9633.9	8.2	16.22	17.95	8.06	12.5	14.37
Immediately upstream of north bridge	9476.7	8.08	16.08	17.87	7.94	12.1	14.04
In between bridges	9405.8	7.9	14.71	16.23	7.8	11.68	12.69
Immediately downstream of south bridge	9190.9	7.62	11.26	12.19	7.64	11.38	12.35
Downstream of south bridge	9102.9	7.59	11.35	12.35	7.59	11.35	12.35

**Existing Condition refers the "USACE" intermediate sea level rise scenario with the existing U.S. Route 1 bridges in place.*

5.14 Land Use and Zoning

The land within the project area is already heavily developed and the Recommended Plan will not contribute to significant adverse effects to land use and zoning. The Recommended Plan will serve to protect current land uses when combined with other past, current, and future flood risk management measures implemented in the basin.

5.15 Hazardous, Toxic and Radioactive Waste

There are no known hazardous, toxic and radioactive waste sites within the project area. Three previously recorded sites within the project area have been remediated. Prior to demolition and/or construction activities, best management practices will include the testing soil to determine if it is suitable for reuse or if special handling is required. If any additional contaminants are identified, the non-federal sponsor will be responsible for remediating the site prior to any demolition or construction efforts by the District.

5.16 Aesthetic and Scenic Resources

The removal of the bridges will have a major adverse impact on to the area's aesthetics. The construction of the Recommended Plan will also have short term, minor adverse impacts to aesthetic and scenic resources with the presence of construction equipment and active construction activities throughout the project area.

Mitigation

Mitigation measures that will be implemented to minimize impacts to aesthetics include:

- Replanting disturbed areas with native vegetation.
- Recreating the aesthetics of the original U.S. Route 1 bridges through re-use of the stone from the original bridges and other features in the design of the new bridge.

5.17 Recreation

Implementation of the Recommended Plan will create short term minor impacts to recreation during construction. The William James Gateway Memorial Park abuts the south western side of the southernmost U.S. Route 1 Bridge. During construction, temporary closures to the sidewalk near the park may occur to ensure public safety near the work zone. Alternate access to the main park feature, the pump house pavilion, will be provided. In addition, minor grading may be required on the northern end of the park property to match the new grade of the bridge. However, this will not affect the ability to use the pump house pavilion. Access to the river through William James Memorial Park during construction will not be impeded.

No significant long term permanent adverse impacts are expected to occur to the park as a result of implementing the Recommended Plan.

Mitigation

Specific mitigation measures that will be evaluated may be implemented to reduce the limited short term and long term effects of the Recommended Plan on recreation include:

- Situating construction access and staging areas away from the pump house pavilion to the greatest extent practicable. This evaluation will occur during the Preconstruction Engineering Design Phase;
- Erecting temporary fences and other physical barriers to control movement through construction areas and maintain a safe distance for pedestrians; and
- Installing signage that informs residents and others using affected recreational spaces of the proposed action’s purpose and closure duration.
- Providing alternate access routes to the park during closures of sidewalks.

- Replanting any trees removed during construction with native species that enhance the character of the park.

5.18 Air Quality

Implementation of the Recommended Plan will have short term, minor impacts on air quality within the project footprint. The project will produce temporary localized emission increases from the diesel powered construction equipment working onsite. The localized emission increases from the diesel-powered equipment will last only during the project's construction period and then end when the project is over, thus any potential impacts will be temporary in nature.

As stated in the Air Quality Section (Section 2.18), Westchester and Fairfield Counties have been designated as: 1) a 'moderate' nonattainment area for the 2008 8-hour ozone standard; 2) in maintenance for the 2006 $PM_{2.5}$ standard; and 3) in maintenance of the 1971 carbon monoxide standard. Westchester and Fairfield Counties are part of a larger Ozone Transport Region. Ozone is controlled through the regulation of its precursor emissions, which include NO_x and Volatile Organic Compounds (VOCs). VOCs are emitted at a fractional rate compared to NO_x emissions. SO_2 is a precursor for $PM_{2.5}$. Because of these designations and since the project is a Federal Action taken by the USACE, this project triggers a General Conformity Review under 40 CFR §93.154. General Conformity ensures that Federal Actions do not have a negative impact on State Implementation Plans (SIPs). For the pollutants to be emitted as part of the project, the annual de minimis levels are: 100 tons for NO_x, 50 tons for VOC, and 100 tons for CO_2, $PM_{2.5}$, and SO_2 (each pollutant separately). Projects that do not have any annual emissions exceeding these threshold levels are considered to be in conformity with the SIP.

The Project's General Conformity-related annual emissions are significantly below all of the de minimis levels. Therefore, by rule (40 CFR §93.153 (b)), the Project is considered de minimis and will have only a temporary impact around the construction activities with no long term impacts and no negative effects on the applicable SIP. Documentation of the emissions calculations is included in Appendix A.8.

Mitigation

Because the impact on air quality will be less than significant, no mitigation measures will be required outside of existing air quality regulations. The CTDEEP and the NYSDEC outline requirements applicable to construction, such as controlling fugitive dust and open burning. All persons responsible for any operation, process, handling, transportation, or storage facility that could result in fugitive dust will take reasonable precautions to prevent such dust from becoming airborne. In addition, construction will be performed in full compliance with current applicable Connecticut and New York air pollution control requirements with compliant practices and/or products. These requirements include the following:

- Control and Open Prohibition of Burning (Connecticut General Statutes (CGS) 22a-174(f); NYSDEC Chapter III, Part 215);
- Control of Particulate Emissions/idling prohibitions (CGS 22a-174-18, NYSDEC Chapter III, Subpart 257-3); and
- Use of Best Management Practices during construction and comply with all applicable air pollution control regulations.

5.19 Noise

The implementation of the proposed action will result in an increase in short term minor adverse impacts related to noise. The specific impact of construction activities on the nearby receptors will vary depending on the type, number, and loudness of equipment in use. Excavators and other heavy equipment, truck removal of excavated material, and the delivery of riprap and concrete to workspaces will be the primary sources of noise. Individual pieces of heavy equipment typically generate noise levels of 80–90 dBA at a distance of 50 feet (15 m). With multiple items of equipment operating concurrently, noise levels can be relatively high during daytime periods at locations within several hundred feet of active construction sites. The zone of relatively high noise levels typically extends to distances of 400–800 feet from the site of major equipment operations. Locations more than 800 feet from construction sites seldom experience substantial levels (greater than 62 dBA) of noise.

Property owners within the footprint and vicinity of the project footprint will experience appreciable amounts of noise from heavy equipment during the two year construction period. In addition, limited truck and worker traffic may be audible at locations along haul roads and roadways approaching the construction area.

There will be no permanent or ongoing sources of noise from the proposed action. Noise will end with the construction phase; therefore, there will be no long term permanent significant impacts on the noise environment.

Mitigation

Due to the nature of the work and the proximity of structures to the project footprint, the ability to fully mitigate noise is limited. Construction activities will adhere to the applicable noise ordinance established by the Town of Greenwich and the Village of Port Chester to minimize adverse impacts to noise to the greatest extent practicable.

5.20 Transportation

The implementation of the Recommended Plan will have significant adverse impacts to traffic within the project area during the approximate two year construction period. An analysis evaluating five potential traffic management scenarios and their effect on traffic was conducted. Alternatives analyzed include:

- Closure of the North U.S. Route 1 bridge;
- Closure of the South U.S. Route 1 bridge;
- Partial closure of both bridges;
- Partial closure of the north U.S. Route 1 bridge; and
- Partial closure of south U.S. Route 1 bridge.

All alternatives will increase travel time through the Byram Traffic Circle. Depending on the alternative, impacts to vehicle delay and queuing will be greatest at several locations:

- Northbound Byram Traffic Circle East approach to Hillside Avenue
- Eastbound Putnam Avenue left turn approach to North Main Street
- Byram Road approach to West Putnam Avenue

Based on the analysis, the District is proposing to implement a partial closure of both bridges during construction. Under this alternative, intersections are expected to be able to accommodate the potential closure of the one lane along each bridge with the exception of the northbound Byram Road approach to West Putnam Avenue. Traffic delays will result from increased difficulty crossing or merging with West Putnam Avenue traffic because of the one lane restriction. It can be expected that bus routes within the project area will be subject to schedule delays.

The new bridges will support the same traffic volume and will have the same flow pattern as the existing bridges. Therefore, there will be no long term adverse impacts to traffic once construction ends. Refer to Appendix A.10 – Traffic Analysis for the full traffic report.

Mitigation

Mitigation measures to further minimize impacts to traffic during construction that may be evaluated during optimization of the Recommended Plan include:

- Additional larger scale detours
- Temporary intersection widening to provide auxiliary lanes
- Temporary intersection traffic signal control

5.21 Climate Change

The construction of this project will have no effect on climate change. The impacts climate change may have on the Recommended Plan are presented in Section 4.3.1. The Recommended Plan is consistent with ER 1100-2-8162 and Engineering Technical Letter 1100-2-1.

5.22 Comparison of Environmental Consequences of the No Action Plan and the Recommended Plan

Topography, Geology and Soils

No Action: Topography, geology and soils would remain unchanged under the No Action Plan.

Recommended Plan: Negligible topographical changes will occur within the immediate project footprint as a result of grading around the new bridge approaches and grading within the Byram River where the existing central bridge abutment is located. The Recommended Plan will not have any significant adverse effects on soils as scour protection in the form of riprap will be installed to prevent erosion.

Water Resources

No Action: Water quality and habitat would remain unchanged. There would be no changes to wetland communities. The river would still be subject to flooding around the U.S. Route 1 bridges.

Recommended Plan: Water quality and habitat would remain unchanged. There would be no changes to wetland communities.

Vegetation

No Action: Upland and wetland communities would remain as they are except for changes associated with natural disturbance events – including future flooding events – and community succession.

Recommended Plan: Approximately 0.13 acres of upland and riparian vegetation will be removed. The majority of the area impacted will be replanted with native vegetation as part of general site restoration.

Fish and Wildlife

No Action: Fish and wildlife utilization of the project areas will be consistent with current conditions. The same is true for any state and/or federal endangered, threatened or special concern species and Essential Fish Habitat designated species that may occur within the project area.

Recommended Plan: Implementation of the Recommended Plan will predominantly have temporary impacts on fish and wildlife resources, with the impacts occurring during construction. Although approximately 0.09 acres of open water will be filled as a result of the new bridge abutments and riprap, the removal of the center piers of the existing bridges constitutes a positive effect as it will restore approximately 0.02 acres of open water habitat with natural substrate. The Recommended Plan will result in the restoration of 0.02 acres of open water habitat that could be utilized by fish and aquatic macroinvertebrates. Mammal and bird species are expected to leave the area during construction but are expected to return following construction completion and site restoration.

Socioeconomics

No Action: Flooding damages would continue within the project area. The Village of Port Chester is an Environmental Justice community that currently is adversely impacted by flooding within the project area.

Recommended Plan: Implementation of the Recommended Plan will manage fluvial flood risk for up to the 1-percent storm event within the project area. As the Recommended Plan manages flood risk to the Village of Port Chester there is no adverse, disproportionate effect to the community as it relates to environmental justice.

Cultural Resources

No Action: Effects to historic properties would remain unchanged.

Recommended Plan: The U.S. Route 1 bridges are eligible for the New York State and National Registers. The demolition of the bridges constitute an adverse effect on historic properties.

Recreation

No Action: Parks and water dependent recreational opportunities within the project would remain the same under the No Action alternative.

Recommended Plan: Temporary closures to the sidewalk near the William James Gateway Memorial Park may be required during construction of the Recommended Plan. However, alternate access to the park will be provided.

Coastal Zone Management

No Action: The No Action Plan would be in compliance with Coastal Zone Management Act policies.

Recommended Plan: The Recommended Plan is compliant with all applicable policies as demonstrated by the receipt of the conditional concurrence with the consistency determination from the CTDEEP and the concurrence obtained from the NYSDOS.

Land Use and Zoning

No Action: Land use and zoning would remain unaffected by the No Action Plan.

Recommended Plan: The Recommended Plan will serve to protect current land uses when combined with other past, current, and future flood risk management measures implemented in the basin.

Floodplains

No Action: The No Action Plan would not have any effects on resources covered under Coastal Zone Management regulations.

Recommended Plan: Temporary closures to the sidewalk near the William James Gateway Memorial Park may be required during construction of the Recommended Plan. However, alternate access to the park will be provided.

Hazardous, Toxic and Radioactive Waste

No Action: With the exception of the possible introduction of pollutants such as oil and/or general debris during flood events, the No Action Plan would not have any effect on HTRW sources.

Recommended Plan: The Recommended Plan will not have an effect on HTRW sources as there are no known HTRW sites within the project area.

Aesthetics

No Action: Aesthetic and scenic resources would remain unchanged from current conditions.

Recommended Plan: Construction activities will have short term minor adverse impacts to the aesthetics within and near the vicinity of the Recommended Plan project footprint. The new bridges will retain the same aesthetic as the existing, historic bridges. Therefore, no long term adverse impacts resulting from Recommended Plan implementation will occur.

Air Quality

No Action: Ambient air quality would remain unchanged when compared to existing condition under the No Action alternative.

Recommended Plan: Localized increases in emissions from construction equipment will occur during implementation of the Recommended Plan. However, project emissions are below the General Conformity de minimis levels. No long term adverse impacts to air quality will occur with implementation of the Recommended Plan.

Noise

No Action: Noise conditions would remain unchanged when compared to existing conditions.

Recommended Plan: An increase in noise will occur during construction of the Recommended Plan. No long term significant adverse impacts to noise will occur from implementation of the Recommended Plan.

Transportation

No Action: Traffic conditions would remain unchanged when compared to existing conditions.

Recommended Plan: Significant adverse impacts to traffic will occur during construction of the Recommended Plan.

5.23 Summary of Mitigation

A summary of mitigation measures is presented below in Table 37.

Table 37: Summary of Mitigation Measures
Note: This table spans two pages.

Land Use
- Disturbed areas will be restored and their use returned to pre-construction land uses.

Soils
- Implementation of Erosion and Sediment Control Best Management Practices during construction.

Water Resources
- Implementation of Erosion and Sediment Control Best Management Practices during construction, including the installation of a cofferdam within the Byram River to remove (and replace) the U.S. Route 1 bridges.

Vegetation
- Restoration of disturbed areas with native grass, shrub and tree species.

Aquatic Resources and Wildlife
- Tree and shrub clearing restriction from April 1 through August 31 to comply with the Migratory Bird Treaty Act.
- Tree clearing restriction from April 1 through September 30 to protect Endangered and Threatened bat species.
- In-water work restriction from January 1 through June 30.
- Re-establishment of native herbaceous, shrub and tree species in disturbed areas.

Federal and State Endangered, Threatened and Special Concern Species
- Implementation of a tree clearing restriction from April 1 through September 30 to protect roosting bat species.
- Including tree species used by bats for summer roosting in site plans where feasible.

Cultural Resources
- Execution and implementation of a Memorandum of Agreement with NY and CT State Historic Preservation Offices to include documentation of the current bridges, re-use of historic stone, retention of wingwalls, similar parapet wall height and materials in new bridge construction, publication of the technical report, preparation of a general report on the historic context of the bridges and their construction, and archaeological monitoring during demolition for recordation of any identified elements associated with the construction of the bridges.

Recreation
- Erecting temporary fences and other physical barriers to control movement through construction areas and maintain a safe distance for pedestrians.
- Installing signage that informs residents and others using the affected recreational spaces of the proposed actions purpose and closure duration.
- Providing alternate access routes to the park during closures of sidewalks.
- Replanting any trees removed within the William James Memorial Gateway Park during construction with native species that enhance the character of the park.

Aesthetics and Scenic Resources
- Replanting disturbed areas with native herbaceous, shrub and tree material after construction.
- Recreating the aesthetics of the original U.S. Route 1 bridges through re-use of the stone from the original bridges or use of a stone façade.

Transportation
- Preparation of a Construction Traffic Management Plan.
- Routing and scheduling construction vehicles to minimize conflicts with other traffic
- Strategically locating localized staging areas to minimize traffic impacts; and

▪ Establishing detours and alternate routes when it is important to close the work area to perform certain construction tasks or when diverting traffic will substantially reduce traffic volumes.
Air Quality ▪ Because the air emissions are below de minimis levels for NOx, VOC, PM2.5 and SO2, no specific mitigation is required. Construction will be performed in compliance with current Connecticut and New York air pollution control requirements.
Noise ▪ Construction will occur within the timeframes allowed as per local noise ordinances.

6. CUMULATIVE EFFECTS*

The Council of Environmental Quality (CEQ) defines cumulative effects as the impact on the environment, which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency or individual takes the action.

The cumulative impact analysis encompasses the Byram River Basin. As stated in previous sections of the report, the Byram River has experienced numerous modifications. In addition to the cumulative impacts associated with those disturbances, the cumulative impacts analysis evaluates the impacts associated with past, present and foreseeable future actions listed in Table 38 and Table 39 in this section. Identification of these actions were completed through internet research, the NEPA scoping process and coordination with study stakeholders. Connecticut is divided into several regions of which the local governments within a specific region form operating councils. The Town of Greenwich is part of the Western Connecticut Council of Governments (WCCoG). The Council prepared a Natural Hazard Mitigation Plan (NHMP) for the years 2016-2021. The NHMP identifies flood risk management measures each municipality has undertaken, is in the process of implementing or will be implementing. Westchester County, New York prepared a Hazard Mitigation Plan (HMP) in 2015. For the purposes of the cumulative impact analysis, the actions identified in both the WCCoG's NHMP and Westchester County's HMP is herein incorporated by reference (WCCoG, 2016).

Table 38: Existing and Future Federal Projects

PROJECT NAME	DESCRIPTION	LOCATION	STATUS
Navigation Channel	1.7 mile navigation channel	Byram River from Mill Street Bridge to Long Island Sound	Constructed in 1910; modified in 1930
Flood Risk Management Project	Levee and minor channel modification	Pemberwick section of Greenwich.	Constructed in 1959

Table 39: Other Actions Within the Byram River Basin

PROJECT NAME	TYPE	DESCRIPTION	LOCATION	RESPONSIBLE ENTITY	STATUS
Bulkhead Reconstruction Project	Bulkhead repair	Reconstruction of collapsed bulkhead	Along Byram River approximately 0.70 miles south of the U.S. Route 1 Bridges	Village of Port Chester	Permits submitted to NYSDEC in 2017.
777 Putnam Avenue	Apartment Building	Construction of a 120 unit apartment building	Town of Greenwich near the U.S. Route 1 bridges	Private Developer	Permits submitted in 2017 but were withdrawn.

6.1 Land Use

The Recommended Plan will not contribute to significant adverse cumulative effects to land use. The Recommended Plan will serve to protect current land uses when combined with other past, current, and future flood risk management measures implemented in the basin.

6.2 Topography, Geology and Soils

The proposed action will not have any significant adverse cumulative impacts to topography, geology or soils. The Recommended Plan and other actions within the Byram River Basin will be required to prevent soil erosion through the preparation and implementation of an erosion and sediment control plan. The Recommended Plan will provide a cumulative benefit of regional flood risk management within the Byram River Basin when combined with changes in topography related to other past, current and future flood storm risk management projects.

6.3 Water Resources

The Recommended Plan, and current and future actions taken by others will be required to protect water quality in and adjacent to water bodies through the acquisition of water quality certifications, wetland permits that include mitigation requirements for water resource impacts, State Pollution Discharge Elimination Systems permits and implementation of erosion and sediment control Best Management Practices. Therefore, the Recommended Plan will not contribute to adverse cumulative impacts to water resources.

In general, the flood risk management measures, stormwater management, habitat mitigation and ecosystem restoration actions when combined with each other could result in minor improvements in water quality and aquatic habitat. Flood risk management measures contribute to water quality and aquatic habitat improvements by reducing the amount of manmade debris and pollutants introduced into waterways during flood events. Stormwater management measures reduce the amount of urban runoff that typically has high levels of nutrients and other pollutants that contribute to water quality and habitat degradation, entering waterways.

6.4 Vegetation

The Recommended Plan and any current and future actions taken by others will result in negligible short term and moderate long term adverse impacts to riparian vegetation within the project area. Short term impacts include removal of vegetation within construction workspaces. These impacts will have minor cumulative impacts due to the restoration of impacted areas. The loss of mature trees in a watershed with high density development may have moderate cumulative impacts.

Replacing trees wherever feasible and in accordance to any local or state requirements will minimize adverse cumulative impacts. Approximately 0.13 acres of riparian and upland vegetation will be removed during construction of the Recommended Plan. However, replanting trees is included as part of site restoration, therefore the proposed project will not significantly contribute to adverse cumulative impacts to vegetation.

6.5 Fish and Wildlife

The Recommended Plan is expected to have minor cumulative impacts to fish and wildlife resources. Although approximately 0.09 acres of open water will be filled as a result of the new bridge abutments and riprap, the removal of the center piers of the existing bridges constitutes a positive effect as it will restore approximately 0.02 acres of open water habitat with natural substrate. The proposed project will be working predominantly within an existing bridge footprint and will restore approximately 0.02 acres of open water habitat previously impacted by a structure. Disturbed areas will be restored with native vegetation after construction. In addition, actions taken by others that effect aquatic, wetland and riparian habitat are subject to permit mitigation requirements. Any mitigation actions taken by others in conjunction with any ecosystem restoration projects could improve fish and wildlife habitat throughout the watershed.

The Recommended Plan will not have significant adverse cumulative impacts to state and/or Federal endangered, threatened and special concern species that may occur in the project area.

6.6 Socioeconomic and Environmental Justice

In general, the objective of the Recommended Plan and other flood risk management measures implemented within the Byram River Watershed is to provide a long term risk reduction of property/infrastructure damages resulting from flood events.

The Recommended Plan will have no adverse cumulative impacts on the existing demographics, economy, housing and Environmental Justice communities in the geographical region analyzed for cumulative impacts. Increasing flood risk management will reduce damage to property and infrastructure and reduce the risk to life safety within the project area; thus implementation of the Recommended Plan is expected to benefit the local economy and housing in the long term.

All of the actions considered could produce positive cumulative socioeconomic impacts within the watershed by reducing flooding, which is disruptive to socioeconomic conditions.

6.7 Cultural Resources

Although the recommended plan will have an adverse effect on the historic bridges, this adverse effect will not be cumulative because the other actions anticipated for the Byram Basin should not adversely affect other historic properties within the vicinity of the project area.

6.8 Coastal Zone Management

The Recommended Plan and other actions within the local and state jurisdictional Coastal Zone Management boundaries are required to demonstrate compliance with State and local CZM policies. Therefore, the majority of impacts will be short term effects resulting from construction activities. The timing of the implementation of the Recommended Plan and any other actions is such that it is not anticipated that construction noted actions will be concurrent.

6.9 Hazardous, Toxic and Radioactive

The Recommended Plan will not contribute to the release and/or exposure of HTRW substances. All state and federally permitted actions, including the Recommended Plan, must implement

measures such as erosion and sediment Best Management Practices and/or an environmental protection plan to manage the risk of improper release, exposure and disposal of HTRW substances.

6.10 Aesthetics and Scenic Resources

The Recommended Plan and any other actions within the project area will not have a significant impact on scenic resources. The aesthetics of the new bridge will replicate the existing bridges to minimize potential cumulative impacts.

6.11 Recreation

The Recommended Plan will result in a short term closure to the William James Gateway Memorial Park, but these impacts overall will have negligible cumulative impacts.

6.12 Air Quality

The Recommended Plan will not have any adverse cumulative impacts on air quality. Air emissions related to land-based construction activities are a short term and local impact accounted for in Connecticut's and New York's State Implementation Plans (SIPs). There are no operable parts of the completed project that will result in air emissions.

There will be no ongoing sources of greenhouse gas emissions resulting from the Recommended Plan once the project is completed.

6.13 Noise

The Recommended Plan will introduce short term increases in the noise environment from construction. These changes will have a negligible cumulative effect. There will be no adverse long term cumulative impacts on the existing environment once construction is completed.

6.14 Transportation

The Recommended Plan will not have any long term adverse cumulative impacts on transportation. Positive cumulative impacts resulting from the combination of the Recommended Plan and with past, actively occurring or future flood risk management actions will be the reduction in road closures and damage to transportation infrastructure in some locations of the project area due to flooding within the Byram River watershed.

7. COORDINATION & COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS*

The Notice of Intent to prepare an Environmental Impact Statement was published in the Federal Register in November 2017. A NEPA Scoping Meeting was held on November 16, 2017. The NEPA Scoping Meeting initiated a 30-day public comment period that was closed on December 15, 2017. A NEPA Scoping Document was prepared and posted on the District website.

No comments were received from the public. One response citing a "No comment" was received via email from the U.S. Fish and Wildlife Service, New England Field Office regarding federally and endangered species. The email is included in Appendix A.3.

The District sent letters extending an invitation to the Federal Highways Administration (FHA) to serve as a cooperating agency in developing the draft FR/EIS. The FHA declined the invitation, however they were provided an opportunity to review and comment on the Draft Integrated FR/EIS and will be on this Final Integrated FR/EIS. Relevant correspondence between the District and the FHA is located in Appendix A.11.

The District coordinated with both the USFWS New England and New York Field Offices as it relates to the Fish and Wildlife Coordination Act and Section 7 of the Endangered Species Act. Both field offices opted not to prepare formal Fish and Wildlife Coordination Act reports. Relevant correspondence between the District and two USFWS field offices is included in Appendix A.3.

The District prepared a letter determining a "Not Likely to Adversely Effect" for northern long-eared bat and used the Draft FR/EIS as the primary coordination vehicle with the USFWS New England Field Office to complete ESA Section 7 consultation. The District received concurrence on the determination from them via email dated August 2, 2018. Correspondence between the District and the USFWS is included in Appendix A.9. The District does not have to coordinate the No Effect determination for bog turtle with the USFWS.

The District has completed coordination with the NOAA-NMFS as it relates to Essential Fish Habitat. Correspondence between the District and the NOAA-NMFS is located in Appendix A.11. Regarding ESA Section 7 compliance for NOAA-NMFS Trust Species, the District completed No Effect Determinations which are presented in Appendix A.9. Per NOAA-NMFS guidance, the District does not need to obtain concurrence from them on No Effect determinations.

The District received a conditional concurrence on the Connecticut Coastal Zone Management consistency determination from the CTDEEP on March 13, 2019. The District will obtain the full concurrence when it applies for the Water Quality Certificate during the Preconstruction Engineering and Design Phase when it submits for the Water Quality Certificate. The District received the concurrence on the New York consistency determination from the NYSDOS on April 23, 2019. Correspondence between the District and CTDEEP and NYSDOS are located in Appendix A.11.

The District has received conditional Water Quality Certificates from the CTDEEP and the NYSDEC on March 13, 2019 and March 29, 2019 respectively and are located in Appendix A.11.

The District has coordinated with the NYSDOT as the owner of the bridges through several meetings, including the NEPA Scoping Meeting. They were given the opportunity to review the Draft and Final Integrated FR/EIS. During the Preconstruction Engineering and Design Phase,

further coordination will occur with the NYSDOT to ensure the project meets NYSDOT criteria or has the appropriate waiver approvals. Relevant correspondence between the District and NYSDOT is included in Appendix F.

The District also coordinated with the New York State Department of Conservation and the Village of Port Chester as study stakeholders and were given the opportunity to review the Draft Integrated FR/EIS. The District has coordinated the results of the Phase I Survey with the NY and CT State Historic Preservation Offices (see Appendix A.11). The District has coordinated the recommended plan and its determination of effect with these offices as well as the Port Chester Historical Society, the Westchester County Historical Society, the NYSDOT, and the Greenwich Preservation Trust, as well as the federally-recognized Tribes, including the Stockbridge-Munsee Community, the Delaware Nation, the Delaware Tribe, the Mashantucket Pequot Tribe, and the Mohegan Tribe. This coordination and consultation included a review of the Memorandum of Agreement.

The Notice of Availability initiating the 45 day review of the Draft Integrated FR/EIS was published in the Federal Register on June 6, 2018. The Notice of Availability was also sent to federal, state, local agencies, non-profit organizations and interested parties identified in the Distribution List located in Appendix A.12. Both the Notice of Availability and the Draft Integrated FR/EIS were posted on the study webpage located on the District website. A public meeting to discuss the Recommended Plan was held on July 23, 2018. A total of 38 comments were received from the public with the majority of the comments supporting the plan. A matrix of comments received and responses are located in Appendix A.13.

The Final Integrated FR/EIS will undergo a 30 day public review prior to the publication of the Record of Decision.

Table 40 and Table 41 show compliance and Table 42 shows the list of report preparers.

Table 40: Summary of Primary Federal Laws and Regulations Applicable to the Proposed Project

Note: This table spans three pages.

LEGISLATIVE TITLE U.S. CODE/OTHER		COMPLIANCE
Clean Air Act	42 U.S.C. §§ 7401 7671g	An air quality analysis was completed for the project. Based upon the completed analysis, the emissions from the project are considered to have an insignificant impact on the regional air quality, and according to 40 CFR 93.153 (f) and (g) the proposed project is presumed to conform to the SIP. A preliminary draft Record of Non-Applicability is located in Appendix A.8.
Clean Water Act	33 U.S.C. §§ 1251 et seq.	A 404(b) Evaluation is located in Appendix A2. Conditional Water Quality Certifications from CTDEEP and NYSDEC are located in Appendix A.11.
Coastal Zone Management Act	16 U.S.C. §§ 1451-1464 N.J.A.C. 7:7 and N.J.A.C. 7:7E	The States of Connecticut and New York are the administering authorities for the CZMA. Consistency determinations to the New York and Connecticut Rules in addition to the Village of Port Chester Local

LEGISLATIVE TITLE U.S. CODE/OTHER		COMPLIANCE
		Waterfront Development Program are located in Appendix A.6. The CTDEEP conditional concurrence on the CT CZM consistency determination and the NYSDOS concurrence on the NY CZM consistency determinations are located in Appendix A.11.
Endangered Species Act of 1973	16 U.S.C. §§ 1531 et seq.	Based on coordination with the U.S. Fish and Wildlife Service, the project may contain habitat supportive of northern long-eared bat and bog turtle. Protection of these species typically involves implementing a tree clearing restriction from April 1 – September 30. A "Not Likely to Effect" determination for northern long-eared bat was prepared and concurred by the USFWS. Refer to Appendix A.9 for documentation. A No Effect determination for bog turtle has been prepared by the District and is located in Appendix A.9. No endangered species under the jurisdiction of NOAA-NMFS occur within the project area. No Effect Determinations are located in Appendix A.9. Note that No Effect Determinations do not need to be coordinated with NOAA-NMFS.
Environmental Justice in Minority and Low Income Populations	Executive Order 12898	The Village of Port Chester meets Environmental Justice criteria. Coordination with the Village of Port Chester has been ongoing throughout the study. Circulation of the Draft FR/EIS will satisfy compliance with this Executive Order.
Fish and Wildlife Coordination Act	16 U.S.C. §§ 661 et seq.	Both the USFWS New England Field and New York Field Offices have opted to not prepare formal Fish and Wildlife Coordination Act (FWCA) reports. The New England Field Office and the New York Field Office were provided the opportunity to review and submit comments on the Draft FR/EIS. Correspondence documenting coordination to date is included in Appendix A.3.
Magnuson-Stevens Act Fishery Conservation and Management Act	Section 305(b)(2) 1996 Amendments	An Essential Fish Habitat Assessment has been prepared and the District is included in Appendix A.5. Correspondence between the District and NOAA-NMFS is located in Appendix A.11.
Migratory Bird Conservation Act of 1928, as amended	16 U.S.C. § 715	A tree clearing restriction from April 1 through September 30 will be implemented during construction to comply with this act.
National Environmental Policy Act of 1969	42 U.S.C. §§ 4321-4347	The draft FR/EIS underwent a 45 day public/agency comment period. Comments received and responses to comments are located in Appendix A.13. The final FR/EIS and draft Record of Decision will undergo a 30

LEGISLATIVE TITLE U.S. CODE/OTHER		COMPLIANCE
		day public/agency comment period. The Record of Decision will fulfill requirements of this act.
National Historic Preservation Act of 1966	16 U.S.C. §§ 470 et seq.	The District has continued to coordinate with the State Historic Preservation Offices to fulfill the requirements of this act. The Memorandum of Agreement for the project is located in Appendix A.4.
Executive Order 11593 Protection and Enhancement of the Cultural Environment	May 13, 1971	Requires Federal agencies to administer to cultural properties under their control to preserve, restore and maintain these properties. This Executive Order does not apply to this project as the bridge and project area is not owned by or under the control of the District.
Executive Order 11990, Protection of Wetlands	May 24, 1977	Circulation of this report for public and agency review fulfills the requirements of this order.
Executive Order 13007 Indian Sacred Sites	May 24, 1996	Requires the Federal agency accommodate access to and ceremonial use of Indian Sacred Sites on Federal lands. This Executive Order does not apply as there are no Federal lands as part of this project.
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	April 21, 1997	Implementation of this project will reduce environmental health risks. Circulation of this report for public and agency review fulfills the requirements of this order.
Executive Order 13112 Invasive Species	February 3, 1999	Best Management Practices to prevent spread, proper disposal of invasive species during construction, replanting with native vegetation monitoring and adaptive management such as invasive species management until mitigation is determined to be successful.
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	November 6, 2000	Requires all federal agencies to consult with Indian Tribes and respect tribal sovereignty as they develop policy on issues that impact Indian communities. This includes conducting government-to-government consultation on agency undertakings. Consultation with the Mashantucket Pequot, the Delaware Nation, the Delaware Tribe of Indians and the Stockbridge Munsee Community of Indians is ongoing.
Presidential Memorandum: Government-to-Government Relations with Native American Tribal Governments	May 4, 1994	Requires Federal agencies to recognize Tribes as sovereign government and consult with them on projects and undertakings. Consultation with the Mashantucket Pequot Tribe, the Mohegan Tribe, the Delaware Nation, the Delaware Tribe of Indians and the Stockbridge-Munsee Community is ongoing.

Table 41: Compliance Status with Applicable State Laws

LEGISLATIVE TITLE/OR CODE		COMPLIANCE
Connecticut Freshwater Wetlands	401 33 U.S.C. § 1341	A conditional Water Quality Certification is located in Appendix A.11.
Connecticut Coastal Zone Management Act	C.G.S. §§ 22a-90 to 22a-111	A consistency determination with the CT CZM is located in Appendix A.6. This consistency determination also includes the compliance statement to the Long Island Sound Coastal Zone Management policies. The conditional concurrence from CTDEEP on the consistency determination is located in Appendix A.11.
Connecticut Environmental Policy Act	C.G.S. §§ 22a-22a-1h; 22a-1a-22-1a-12	Compliance with this law will be completed during the Preconstruction Engineering and Design Phase.
Connecticut Erosion & Sediment Control Regulations	C.G.S. §§ 22a-328	An erosion and sediment control plan will be developed during the construction phase and will be submitted to the Town of Greenwich for approval.
New York Water Quality Certification	401 33 U.S.C.	A conditional Water Quality Certification has been obtained from the NYSDEC and is located in Appendix A.11.
New York Coastal Zone Management Program	Article 42, Section §911	A consistency determination with the New York CZM Rules and the Village of Port Chester LWRP is located in Appendix A.6. The concurrence from the NYSDOS on the NY consistency determination is located in Appendix A.11.
New York State Environmental Quality Review (SEQR)	6 NYCRR Part 617	Compliance with this law will be completed during the Preconstruction Engineering and Design Phase.
New York Erosion and Sediment Control Regulations	Article 15, Article 24 and Article 25	An erosion and sediment control plan will be developed during the construction phase and will be submitted to the Westchester County Soil and Water Conservation District for approval.

Table 42: List of Report Preparers

INDIVIDUAL	DISCIPLINE
Karen Baumert	Plan Formulation
Kimberly Rightler	Environmental Resources
Nancy Brighton	Environmental and Cultural Resources
Anna Jansson	Plan Formulation
Carlos Gonzalez	Real Estate
Olivia Cackler	Plan Formulation
Andre Chauncey	Hydrology and Hydraulics
Mukesh Kumar	Cost Engineering
Robert Muskthel	Cost Engineering
Mitchel Laird	Economics
Maggie Lofstedt	Environmental Resources
Derek Etkin	Hydrology and Hydraulics
Kevin O'Malley	Geotechnical
Timothy Hester	Real Estate
David Giel	Traffic
Eric LeClair	Structural Engineering
Shelby Basel	Environmental Resources

8. PLAN IMPLEMENTATION

8.1 Institutional Requirements

The U.S. Route 1 bridges are owned and operated by the NYSDOT. The Town of Greenwich, CT and NYSDOT have indicated their support for the Recommended Plan. The Town of Greenwich has indicated its willingness to be the non-federal sponsor for the project, and NYSDOT has indicated their willingness to act as a non-federal party for the project. The Town of Greenwich, in conjunction with NYSDOT, agrees to be responsible for all local cooperation requirements for the project. A coordinated Project Partnership Agreement package will be prepared subsequent to the approval of the Final Integrated FR/EIS that would reflect the recommendations of the report.

Federal implementation of the recommended project would be subject to the non-federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent, but not to exceed 50 percent, of the total structural flood damage reduction costs, as further specified below:

    1. Provide, during design, 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

    2. Pay, during construction, a contribution of funds equal to 5 percent of total structural flood damage reduction costs;

    3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material as determined by the Federal government to be required or to be necessary for the construction, operation, and maintenance of the project;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Inform affected interests, at least yearly, of the extent of protection afforded by the flood risk management features; participate in and comply with applicable federal floodplain management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

d. Operate, maintain, repair, rehabilitate, and replace the project at no cost to the Federal government, 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;

e. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

f. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

g. 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 are required, to the extent and in such detail as will properly reflect total cost of the project, 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;

h. Perform, or ensure performance of, any investigations for hazardous substances that 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 USC 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 or operation and maintenance of the project;

i. Assume, as between the Federal government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for construction, operation, maintenance, repair, rehabilitation, or replacement of the project;

j. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and

k. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

l. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the

disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

m. 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; 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 all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)); and

n. Not use funds from other Federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

8.2 Real Estate Requirements

USACE projects require the non-federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. The Recommended Plan will require the non-federal sponsor to acquire temporary and permanent easements for construction (Table 43). Since the project is currently at a feasibility-level design, the size of the real estate interests required are preliminary estimates based on available GIS data. The precise size and location of the required real estate interests will be identified during the Preconstruction Engineering and Design phase when Plans and Specifications and detailed drawings are prepared. As a result, the number of require acreage is subject to change with project refinements. The non-federal costs for LERRDs are estimated to be $20,382,000. Details on cost sharing are provided in Section 0 and details on LERRDs are provided in Appendix E – Real Estate Plan.

Table 43: Required Lands, Easements, and Rights-of-Way

	NY	CT	Total
Permanent Easements Acres	±1.684	±0.013	±1.697
Temporary Easements Acres	±1.084	±0.393	±1.477
Total Acres	***±2.768***	***±0.406***	***±3.174***

8.3 Preconstruction Engineering and Design

In order for Preconstruction Engineering and Design and construction to be initiated, the USACE must sign a Project Partnership Agreement with a non-federal sponsor to cost share Preconstruction Engineering and Design and construction. This project would require congressional authorization for Preconstruction Engineering and Design and construction. The Preconstruction Engineering and Design and construction phases are cost shared 50 percent federal and 50 percent non-federal. Implementation would then occur, provided that sufficient funds are appropriated to design and construct the project. During the Preconstruction Engineering and

Design phase, further coordination will occur with the NYSDOT to ensure the project meets NYSDOT criteria or has the appropriate waiver approvals.

8.4 Construction Schedule

The draft schedule for plan implementation was developed for planning and cost estimating purpose (Table 44). The schedule assumes that the project will be authorized and funded for construction by Congress in a Water Resources Development Act or similar legislation in 2021. All dates are dependent upon this authorization. Dates for design and construction are also dependent upon appropriation of federal and non-federal funding. Table 45 is the proposed construction schedule.

Table 44: Draft Recommended Plan Implementation Schedule

TASK	DATE
Chief of Engineering Report Approval	April 2020
Project Partnership Agreement Execution	May 2020
Pre-Construction Engineering & Design	June 2020 – October 2021
Construction	October 2021 – October 2023

Table 45: Draft Construction Schedule

TASK	DURATION	START	FINISH
Mobilization	**10 days**	**10/01/21**	**10/14/21**
Notice to Proceed	0 days	10/01/21	
Coordination Meeting	5 days	10/01/21	10/07/21
Mobilization	5 days	10/08/21	10/14/21
Roads, Railroads, and Bridges	**493 days**	**10/15/21**	**9/19/23**
Site Prep Work/Setup Traffic Controls North Bridge	20 days	10/15/21	11/11/21
Demolition of North Bridge	34 days	11/12/21	12/31/21
Setup Cofferdams North Bridge	8 days	12/21/21	12/31/21
Abutments and Footings North Bridge	75 days	1/03/22	4/15/22
Set Deck and Pour Roadway North Bridge	112 days	4/18/22	9/23/22
Finishing and Painting North Bridge	5 days	9/26/22	9/30/22
Site Prep Work/Setup Traffic Controls South Bridge	20 days	10/03/22	10/28/22
Demolition of South Bridge	34 days	10/31/22	12/16/22
Setup Cofferdams South Bridge	8 days	12/12/22	12/21/22
Abutments and Footings South Bridge	75 days	12/22/22	4/06/23
Set Deck and Pour Roadway South Bridge	110 days	4/07/23	9/12/23
Finish Work and Painting South Bridge	5 days	9/13/23	9/19/23
Demobilization	**20 days**	**9/20/23**	**10/17/23**
Punchlist	15 days	9/20/23	10/10/23
Demobilization	5 days	10/11/23	10/17/23
Project Closeout, Final Submittals	0 days		10/17/23

8.5 Cost Sharing and Non-Federal Partner Responsibilities

The Town of Greenwich, CT has indicated their willingness to act as the non-federal sponsor for the project, and NYSDOT has indicated their willingness to act as a non-federal party for the project. The Town of Greenwich, in conjunction with NYSDOT, agrees to be responsible for all local cooperation requirements for the project. According to ER 1105-2-100, the non-federal sponsor is responsible for the value of LERRDs; this includes obtaining temporary and permanent easements as well as removing and replacing the bridges.

33 U.S.C. § 2213 (a) states the non-federal share shall not exceed 50 percent of the cost of the project assigned to flood control. In accordance with ER 405-1-12, the non-federal sponsor must perform the relocations or pay the costs of such relocations before work can begin. The non-federal sponsor would then be reimbursed any amount over the 50 percent maximum specified in 33 U.S.C. § 2213 (a).

The non-federal sponsor is required to pay the LERRDS that consist of the non-federal portion of the Lands and Damages 01 Account and Relocations 02 Account. The total project cost share is 50 percent federal and 50 percent non-federal. However, since the sponsor is responsible for LERRDs, the sponsor would have an initial cost of approximately $23 million and would be due a reimbursement of approximately $8 million[1]. Table 46 shows the federal and non-federal costs for the project.

Table 46: Federal and Non-Federal Costs
(Price Level FY 2020; Discount Rate 2.75%)

ACCOUNT	FEDERAL SHARE	NON-FEDERAL SHARE	TOTAL
30 – Preconstruction Engineering and Design	$2,527,000	$2,527,000[1]	$5,054,000
01– Lands and Damages	$203,000[2]	$1,230,000	$1,433,000
02 – Relocations	$0	$19,152,000	$19,152,000
06 – Fish and Wildlife Facilities, 18 – Cultural Resource Preservation, 31– Construction Management	$3,766,000	$0	$3,766,000
Reimbursement[3]	$8,207,000	-$8,207,000	$0
Final Cost Share	**$14,703,000**	**$14,703,000**	**$29,405,000**

[1] Includes 5% required cash contribution
[2] Federal administrative costs only
[3] Reimbursement because the non-federal share is capped at 50% for structural flood risk management features

[1] USACE will be pursuing a budgetary policy exception such that the entire federal share of the project, to include the reimbursement, could be provided prior to project implementation.

8.6 Views of the Non-Federal Sponsor and Other Agencies

The non-federal sponsor, Town of Greenwich, CT, has held several public information meetings to discuss the study and gain feedback. Public information meetings were held on the following dates:

- January 2013 – Public Information Meeting #1
- February 2014 – Public Information Meeting #2
- May 2015 – Public Information Meeting #3
- November 2017 - NEPA Scoping Meeting
- July 2018 – Public Information Meeting during 45 day comment period of Draft Feasibility Report/Environmental Impact Statement

The Town of Greenwich and NYSDOT supports the Recommended Plan as it is presented in this report. The NYSDOT is also supportive of the Recommended Plan. The Town of Greenwich has indicated its willingness to be the non-federal sponsor for the project. Given that this project requires work to be performed in the State of New York, thus outside the jurisdiction of the Town of Greenwich, the NYSDOT has indicated its willingness to be a "Non-Federal Party" to the Project Partnership Agreement and to also enter into a local agreement with the Town of Greenwich in order to fulfill the project requirements that are within New York State's jurisdiction. Their support is exemplified through letters located in Appendix F – Pertinent Correspondence.

9. RECOMMENDATIONS

In making the following recommendations, I have given consideration to all significant aspects in the overall public interest, including environmental, social and economic effects, engineering feasibility and compatibility of the project with the policies, desires and capabilities of the Town of Greenwich, Connecticut, the State of New York, and other non-federal interests.

I recommend that the replacement of the two U.S. Route 1 bridges for flood risk management in the Town of Greenwich, Connecticut be authorized for construction as a Federal project, subject to such modifications as may be prescribed by the Chief of Engineers. The recommended plan is fully detailed in this Final Integrated Feasibility Report and Environmental Impact Statement. The Recommended Plan consists of removing and replacing the two U.S. Route 1 bridges located in the Village of Port Chester, New York that constrict the flow of the Byram River to reduce the risk of flooding upstream of the bridges in Town of Greenwich, Connecticut. The plan is estimated to provide $1,503,000 in annualized benefits and have a Project First Cost of $29,405,000. The plan has a benefit cost ratio of 1.3.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of highest review levels within the Executive Branch. Consequently, the recommendations may be modified (by the Chief of Engineers) before they are transmitted to the Congress as proposals for authorization and implementing funding. However, prior to transmittal to Congress, the partner, the State, interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Thomas D. Asbery
Colonel, U.S. Army
District Engineer

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